MicroPipe

Online edition — User Manual

Pipe network development system for refrigeration plants and secondary fluids. Design, size and analyse suction, liquid, discharge, pumped and hydronic pipe networks in your browser.

Edition 1 · November 2026
Written for the online MicroPipe (calculation engine 1.4). Replaces the manual for the Windows (Visual Basic) version.

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About this manual

This manual describes the online edition of MicroPipe: what it calculates, how the screens are organised, how to describe a pipe network to it, how to read what it reports, and the engineering reasoning behind the inputs it asks for.

It is written for refrigeration design engineers who have a working knowledge of refrigeration system design and the effect that operating parameters have on pipe network performance. MicroPipe applies well-established fluid mechanics and thermodynamics; it does not replace engineering judgement, and the designer remains responsible for the design.

If you used the Windows version

The physics, the fluid mechanics and the thermodynamics behind the online MicroPipe are the same as those of the Windows (Visual Basic) MicroPipe, so the engineering chapters of this manual will be familiar. What has changed is the way you work: there is nothing to install, projects are saved to the server as you work, and the toolbars and dialogue windows of the old program have been replaced by a single browser page with three views. Chapter 1 summarises the differences, and your old project files can be imported (Chapter 6).

How the manual is organised

Part A — Getting started	What MicroPipe is, how to obtain and activate it, a tour of the screen and the ideas you need before you start.
Part B — Working in MicroPipe	Projects, networks, every input field, the circuits table, calculating, reading results, fixing pipe sizes, printing, exporting, the tools and the settings.
Part C — Engineering reference	The operating modes, the design data explained, suction risers and oil return, pipe materials and pressure ratings, refrigerants and fluids, and a reference of the messages MicroPipe can show.
Part D — Worked examples	Seven complete networks across the six modes, with the figures MicroPipe produces for them, so you can check your own installation against known results.
Appendices	A blank data sheet for site surveys, keyboard and efficiency tips, a glossary, the notices that apply to MicroPipe, and a note on this edition.

Conventions used

- Things you see on the screen are written like this: the **Next Label** column, the **Calculate** button, the **Networks** view.
- A switch control is shown as ◯ (off) or ● (on).
- Keys are written like `Tab` and `Enter`.
- Values are given in SI units, which is how MicroPipe stores every figure. The Imperial display is described in Chapter 16.
- The product is spelt *MicroPipe* in this manual; the screen itself shows *Micropipe*.

NOTE
A note gives background or a detail that is easy to miss.

TIP
A tip saves time or effort.

TAKE CARE
A warning marks something that can lose work, or produce a design that looks right but is not.

ENGINEERING NOTE
An engineering note explains the physical reasoning behind an input or a result.

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Quick start

Your first network in ten steps, with the chapter that explains each one.

1. Open **https://now-select.com/micropipe** in the browser of the device you will design on, enter your licence key and your e-mail address, and type the six-digit code that arrives by e-mail. The device is now activated (Chapter 2).
2. In the **Projects** view press **Add**, then **Load** on the new project and give it the name you use for the job (Chapter 5).
3. Click the networks count in the breadcrumb to open the **Networks** view, press **Add**, and click the new network's name to open it (Chapters 3 and 6).
4. In the settings panel set the **Name**, the **Mode** (Dry Suction, Liquid, Discharge, Pumped Liquid, Wet Suction or Fluid), the **Refrigerant** and the **Pipe Material**, then the design conditions the mode asks for: temperatures, superheat, the permitted penalty or pressure drop, the design temperature (Chapters 7, 8 and 18).
5. Press **Add 10** until the circuits table has a row for every pipe section on the drawing. Label each row and choose, in **Next Label**, the circuit it flows into; the last circuit of every path has none (Chapters 9 and 10).
6. Switch **Terminal?** on for every evaporator or load connection and enter its duty. The summed duties of the pipes downstream fill in by themselves.
7. Enter each circuit's length and fittings. On a Dry Suction network set the **Orientation** of every riser and, if the plant will run at part load, the duty at which the riser must still return oil (Chapter 19).
8. Press **Calculate**. Errors stop the calculation and name the circuit at fault; warnings do not. Correct and calculate again (Chapter 11).
9. Read the results table, the totals and the worst path, and check the pressure pass (Chapter 12). To impose a size, switch **Fixed** on for that row and choose it, then calculate again (Chapter 13).
10. Press **Print** for the report, or **Export CSV** for the results table (Chapter 14). Nothing needs saving: every change has already been saved to the server, and the project can be exported as a file for your records (Chapter 5).

Chapter 23 walks through all of this with a four-circuit example whose figures you can check against your own.

Support

Omega Solutions supports MicroPipe by e-mail and telephone: **support@omega-solutions.co.uk**, **+44 (0)1535 322111**, Monday to Friday 09:00–17:00 UK time. We reply by the next working day. Support covers using MicroPipe and your licence; it does not extend to engineering advice on your designs, which remain your responsibility (Appendix D). We are always pleased to help with the use of MicroPipe, and we value feedback: many of MicroPipe's features exist because a user suggested them.

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PART A

Getting started

What MicroPipe is and what it calculates, how to buy and activate it, a guided tour of the screen, and the handful of ideas — projects, networks, circuits, labels and flow paths — on which everything else rests.

- 1 Introduction
- 2 Access and licensing
- 3 A tour of the screen
- 4 How MicroPipe is organised

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CHAPTER 1

Introduction

MicroPipe is a fully featured system for the analysis and development of refrigeration pipe networks. It selects pipe sizes automatically to meet a permitted pressure drop or temperature penalty, checks every selection for oil return, pressure rating and velocity, and totals the lengths, volume and refrigerant charge of the whole system.

1.1 What MicroPipe does

MicroPipe calculates and analyses the pipe networks of a refrigeration plant, in six operating modes:

- **Dry suction** — between the evaporators and the compressors, including single and double suction risers with full oil-return analysis.
- **Liquid** — high-pressure liquid lines between the liquid receiver and the evaporators, including the effect of a rise in the line and the sub-cooling needed to prevent flash gas.
- **Discharge** — between the compressors and the condenser, with the condenser liquid drain lines sized in the same calculation if required.
- **Pumped liquid** — pumped liquid feed lines between the low-pressure receiver and the evaporators.
- **Wet suction** — pumped wet-suction return lines between the evaporators and the low-pressure receiver of a liquid-overfeed system.
- **Fluid** — hydronic circuits for secondary refrigerants and other working fluids (water, steam, glycols, calcium chloride brine or a user-defined fluid), with temperature rise or drop, mass flow and pump head.

Calculations cover copper tube up to 6⅛″ and steel pipe up to 20″, in imperial and metric size series, for all commonly used refrigerants including transcritical CO_2. For every circuit MicroPipe reports the pipe size selected, its pressure loss and temperature penalty, the refrigerant velocity, the fittings and valve losses, the flow-path totals back to the end of the line, the minimum load for oil return, the copper gauge or steel schedule, the maximum working pressure and whether the pipe passes the system design pressure. The design pressure requirements of BS EN 378 and ASME B31.5 are built in, with the leak-test, strength-test, high-pressure cut-out and relief-valve settings that follow from them.

Two stand-alone tools convert between saturation pressure and temperature, and between pressure drop and the equivalent temperature penalty, for any refrigerant in the library.

1.2 What is new in the online edition

If you know the Windows MicroPipe, the engineering is unchanged: the same correlations, the same optimisation and the same checks. The way you use it is different in these respects.

Topic	Windows (Visual Basic) MicroPipe	Online MicroPipe
Installation	CD-ROM, Copy-Control activation, support files.	Nothing to install. Open the address in a browser on the device you have licensed.
Licensing	CopyMinder product key per PC.	A licence key activates one device; a six-digit code sent by e-mail confirms it. Annual, monthly, weekly and daily terms; a free seven-day trial.
Where the work is kept	Project files (.SUC, .LIQ, .DIS, .PUM, .WET, .FLU) on your disk.	Projects are saved to the MicroPipe server as you work, with a working copy in the browser. Export and import as JSON files; old files can be imported.

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Topic	Windows (Visual Basic) MicroPipe	Online MicroPipe
Organisation	One system per file; a "complete project" is a set of files with the same name.	A *project* holds any number of *networks*, each in one mode; each network holds its *circuits*.
Data entry	One circuit at a time in the Pipe-System Details window, with toolbar buttons for risers, headers, dual pipes and fixing.	All circuits in one table, one row per circuit, with the riser, header, dual and fixed settings as columns of that row.
Flow paths	Index mode or Network mode; next flow-path labels.	Always a network. Each circuit names the circuit it flows into (**Next Label**); a series "index" system is simply a chain.
Calculation	On your PC (F12).	On the server, from the **Calculate** button; an internet connection is needed to calculate.
Results	Output windows and a printed window.	A results table, totals tiles, path totals and a pipe summary under the circuits; a printable report; a CSV export of the results table.
Units and language	SI or imperial.	SI or Imperial display, and 26 languages.
Fluids	Separate Fluid Pipe-Network program with pipe-schedule and fluid data files.	Fluid is one of the six modes; the fluid and pipe schedules are built in, with a user-defined fluid table.

1.3 Who MicroPipe is for

MicroPipe is intended for refrigeration design engineers who have a full appreciation of refrigeration system design and the implications that different operating parameters have on the pipe network and, consequently, on system performance. It asks for design conditions rather than deciding them for you: the evaporating temperature, the superheat, the liquid temperatures a plant will actually see over a year, the penalty you are prepared to spend, and the minimum loads at which risers must still return oil. Part C of this manual explains what each of these means and why it matters.

1.4 Support and feedback

Assistance is available from Omega Solutions by e-mail at **support@omega-solutions.co.uk** or by telephone on **+44 (0)1535 322111**, Monday to Friday 09:00–17:00 UK time. We reply by the next working day. Support covers using MicroPipe and your licence; it does not include engineering advice on your designs. If a network will not calculate and the messages do not make the reason clear, export the network (Chapter 14) and send the file with your query; we will examine it and reply.

We greatly value feedback on this product and encourage you to comment freely on any aspect of it. Many enhancements have been implemented over the years as a result of this process; even the simplest suggestion can lead to a significant improvement or a useful new function.

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CHAPTER 2

Access and licensing

MicroPipe runs in a web browser on the device you license it for. This chapter covers what you need, how to buy or start a trial, how to activate a device, and what happens when a licence expires, is moved or is suspended.

2.1 What you need

- **A current web browser** on a desktop or laptop computer — Chrome, Edge, Firefox or Safari released within the last few years. MicroPipe also lays itself out for tablets and phones (section 3.8), but the circuits table is wide and a large screen is far more comfortable for a real network.
- **An internet connection.** Pipe sizing is calculated on the MicroPipe server, so you need a connection to calculate, to use the two converter tools, to save to the server and to import. When the connection drops, your work is kept in the browser and saved when it returns (section 4.5).
- **Pop-ups allowed** for the MicroPipe address, because the printed report opens in a new window (Chapter 14).
- **Browser storage** (cookies and site data) enabled for the address. The device's activation and your working copy both live there; private or incognito windows discard them when closed.

2.2 The MicroPipe address and the public page

MicroPipe is at **https://now-select.com/micropipe**. A browser that has not been activated is shown the public page: what MicroPipe is, what it does, the prices and the three starting points — Buy Micropipe, Start a free trial and Activate a key. An activated device is taken straight into the application; add `?public` to the address if you ever want to see the public page from an activated device.

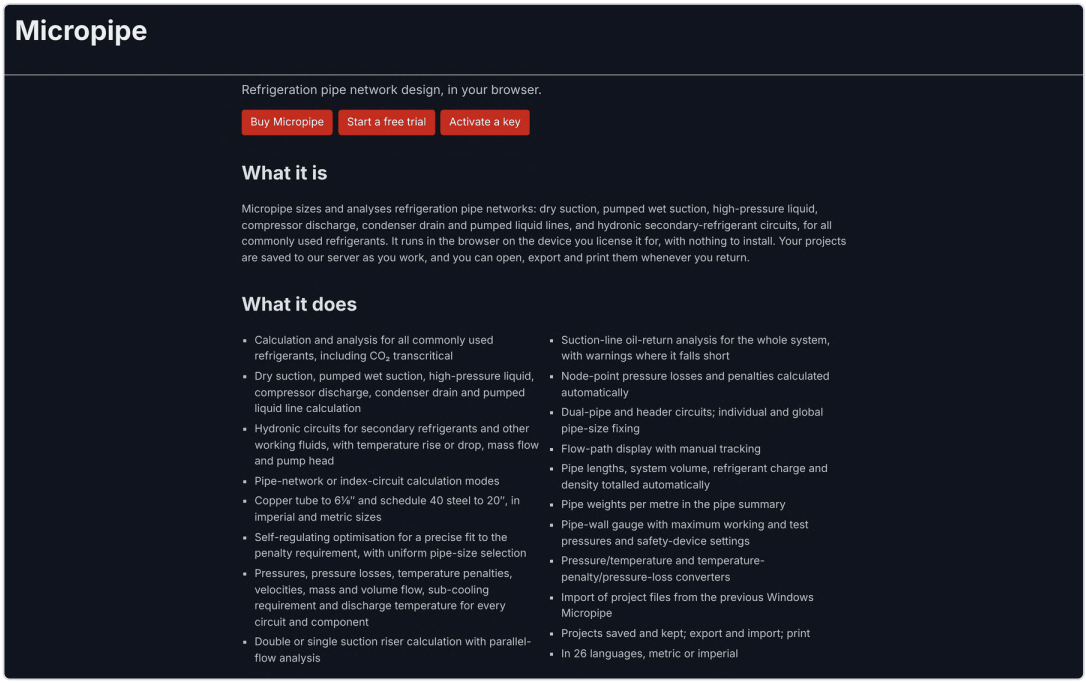


Figure 2.1 The public page, seen by a browser that has not been activated. The language selector at the foot of the page applies to the public, checkout and activation pages as well.

2.3 Buying a licence

A licence is bought from the checkout page, reached from **Buy Micropipe**:

1. Choose the **licence term**: annual (renewing yearly), monthly (renewing monthly), weekly or daily. The prices shown are per device and before tax; VAT or sales tax for your country is added at payment.
2. Choose the **number of licences**. One licence activates MicroPipe on one device. Buy as many as you need in one order; each key activates one device.
3. Enter your name, company (optional) and e-mail address. The licence keys and a link to your order page are sent to this address.
4. Tick the box to confirm that you want immediate access and understand that this gives up the fourteen-day right to withdraw from the purchase, then press **Continue to payment**.
5. Pay on the payment page. Nothing is charged until you confirm it there. The date shown on the payment page is the date the licence *renews*, not the date it starts: you pay for the first term today.

Orders are processed by our online reseller Paddle.com, which is the merchant of record for all orders, handles customer-service enquiries about payment and handles returns. Sales are subject to the MicroPipe terms of sale and refund policy; the privacy notice explains how your details are handled. All three documents are linked from the public page, the checkout and the activation page.

Your licence keys arrive by e-mail within a minute or so. If nothing arrives within a few minutes, check the spam folder, then reply to either message you have received.

2.4 Starting a free trial

A free trial gives one device the annual licence for seven days. It is started from **Start a free trial** on the public page, follows the same checkout, and converts to the paid annual licence when the seven days end unless you cancel before then from your order page. While a trial is running, a notice at the top of the application tells you the date it ends.

Your trial ends on 11 November 2026, when the annual licence begins. Cancel any time before then from your order page.

Figure 2.2 The trial notice. Nothing is wrong and nothing needs doing unless you want to stop the trial before the annual licence begins.

2.5 Activating a device

Activation binds a licence key to the device and browser you are using. Open the MicroPipe address on that device and choose **Activate a key** (or go straight to the activation page):

1. Enter the **licence key** exactly as it appears in the e-mail (the format is XXXX-XXXX-XXXX) and the **e-mail address** registered to the licence, then press **Continue**. By activating a key you accept the terms of sale and refund policy.
2. A **six-digit code** is sent to the registered address. Enter it and press **Activate**. A code is good for ten minutes and five attempts; after that, or if it does not arrive, **Send a new code** sends another (up to five an hour for a licence). **Use a different licence key** takes you back to the first step.
3. The page confirms *This device is now activated* and opens MicroPipe.

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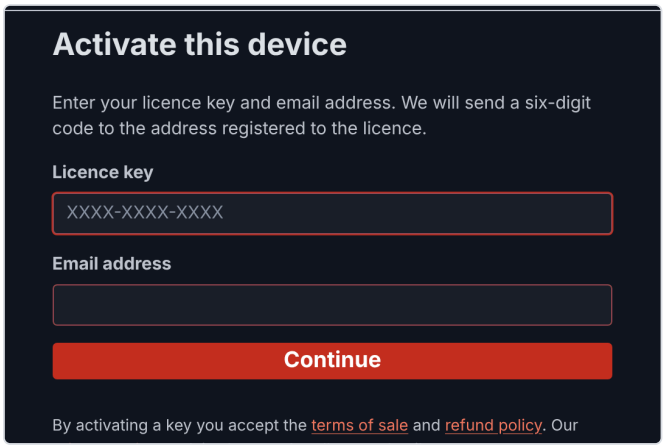


Figure 2.3 Activation, step 1: the key and the registered e-mail address.

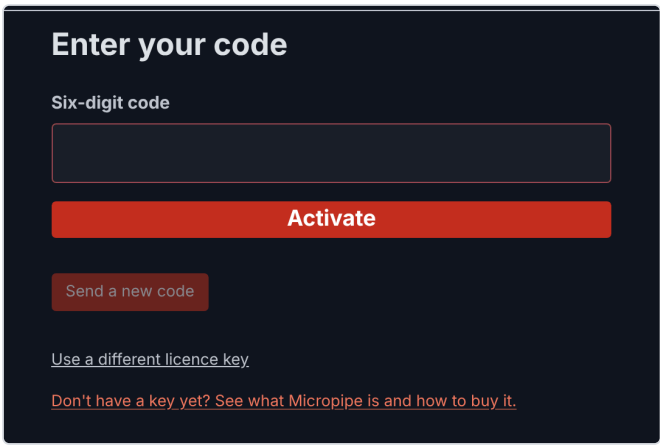


Figure 2.4 Activation, step 2: the six-digit code from the e-mail.

> **NOTE**
>
> The activation is held in the browser's site data. Clearing the browser's data for the MicroPipe address, or using a different browser on the same computer, means activating again with the same key. The key and the code are tied to the licence, not to a password: there is no account name or password to remember.

2.6 One licence, one device

Each licence runs MicroPipe on one device at a time. To move a licence to another device, activate the new device with the same key. The previous device then loses its activation and, when it next loads MicroPipe, is shown the activation page with a notice explaining that the licence has been moved and that the saved work is available on the device now holding it (Figure 2.5). Nothing is lost: projects belong to the licence and are on the server, so they appear on the new device after activation.

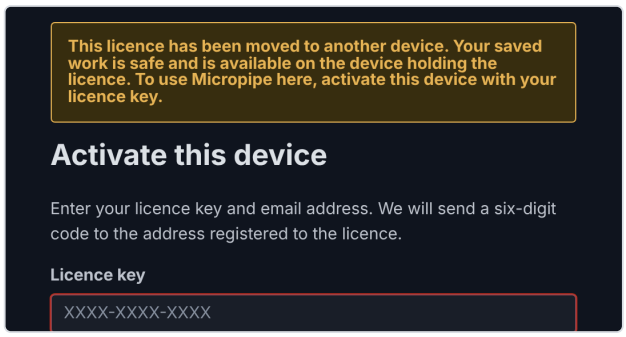


Figure 2.5 A device whose licence has been activated elsewhere. It can be re-activated with the key, which moves the licence back.

Moving is limited: each licence may be moved a set number of times in any ninety-day period (normally once). Re-activating the same computer after its browser data has been cleared counts as a move. When the limit has been reached, activation on a new machine is refused with *This licence is already active on another device. Contact Omega to release it*, and on the same machine with *This licence has been moved too many times recently. Contact Omega*. Omega can release a device for you. If you need MicroPipe on several machines at once, buy a licence for each.

> **NOTE**
>
> Use an individual e-mail address for a licence rather than a shared mailbox. The activation codes are sent to the registered address, so anyone who can read that mailbox can move the licence.

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2.7 Licence states

MicroPipe checks the licence on every calculation, and tells you plainly, in a banner at the top of the page, when something has changed. The states are:

State	What you can do	What the banner says
Active	Everything.	No banner.
Trial	Everything.	The date the trial ends and that the annual licence begins then.
Expired, within 90 days	**Read-only.** Open, export and print saved projects. Calculation, fixing sizes, new projects and importing are refused. Nothing is pushed to the server.	The date it expired and the date the work will be deleted; contact Omega to renew.
Expired, after 90 days	The activation page is shown, with the notice *This licence expired on … Contact Omega to renew*; the projects have been deleted.	—
Renewal payment failed	Read-only while the payment provider retries the card. Calculation resumes by itself when a retry succeeds.	That the renewal payment has not gone through.
Suspended	Read-only. Open, export and print.	That the licence is suspended; contact Omega.
Moved to another device	The activation page, with a notice (section 2.6).	—
Revoked (after a refund or chargeback)	The activation page, with the notice *This licence is not currently active. Contact Omega*. Another key can be entered.	—

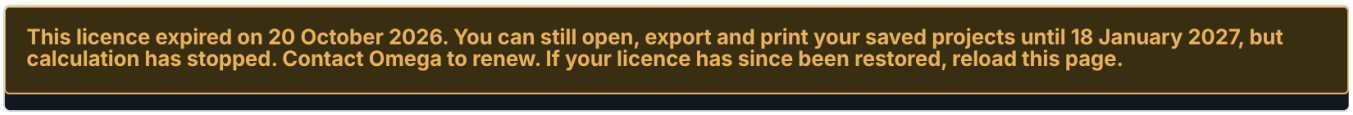


Figure 2.6 An expired licence inside its ninety-day retention period: the banner gives the expiry date and the deletion date.



Figure 2.7 In read-only mode Calculate, Fix All, Unfix All and Export CSV are greyed out; Print stays available so that the record of the work can still be produced.

> **TAKE CARE**
>
> Every read-only banner ends with *If your licence has since been restored, reload this page*: a renewal, a payment retry or a lifted suspension takes effect when the page is next loaded. Projects are deleted ninety days after expiry, so export anything you need to keep before the date in the banner.

2.8 Renewing and cancelling

Annual and monthly licences renew automatically at the end of each term, on the card used at the checkout; weekly and daily licences do not. The order page linked from the order e-mail shows the next renewal date and lets you update the card or cancel a renewal, which leaves the current term running to its end. For anything else, contact Omega.

2.9 Terms, refunds and privacy

The documents that govern the use of MicroPipe are published at the MicroPipe address (Appendix D summarises what bears on everyday use):

- **Terms of sale** — https://now-select.com/micropipe/terms
- **Refund policy** — https://now-select.com/micropipe/refunds
- **Privacy notice** — https://now-select.com/micropipe/privacy

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CHAPTER 3

A tour of the screen

MicroPipe is a single page with three views — **Projects**, **Networks** and the **Network** itself — plus the two converter tools. Everything you do with a pipe network happens in the Network view, which is shown below.

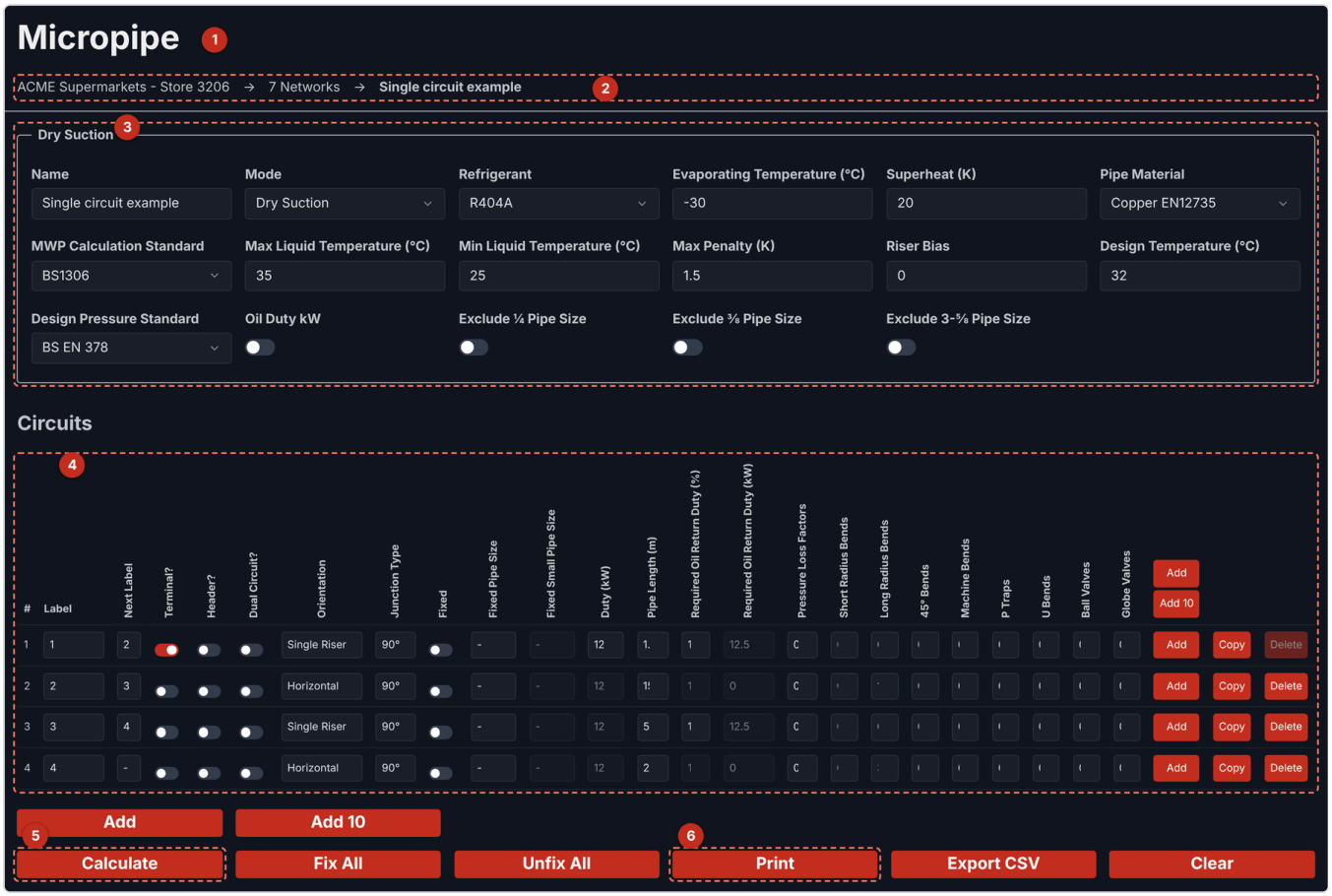


Figure 3.1 The Network view. 1 Title and 2 breadcrumb; 3 network settings; 4 the circuits table; 5 the action buttons, with 6 the print and export buttons. The messages panel and the results appear below the buttons (Figure 3.3).

3.1 Header and breadcrumb

The header carries the title and a breadcrumb that is also the navigation: **Project name** → **n Networks** → **Network name**. Click the project name to open the Projects view, the networks count to open the Networks view, and the network name to return to the network you are working on. The item in bold is the view you are looking at.



Figure 3.2 The breadcrumb. The project is *ACME Supermarkets - Store 3206*, it holds seven networks, and the open network is *Single circuit example*.

3.2 The three views

View	What it shows	Described in
Projects	Every project on this licence: its name, how many networks it holds, and the buttons to load, copy, export, import, add and delete projects.	Chapter 5
Networks	The networks in the open project, with buttons to copy, export, import (including legacy files), add and delete them. Click a network's name to open it.	Chapter 6
Network	The network settings, the circuits table, the action buttons, the messages and the results.	Chapters 7 to 14

3.3 The Network view in detail

Network settings (3) is the panel at the top. Its legend names the mode. The first fields — Name, Mode and Refrigerant or Working Fluid — decide which other fields are shown: changing the mode or the refrigerant redraws the panel with the fields that mode needs. Chapters 7 and 8 describe every field.

The circuits table (4) has one row per circuit, that is, per pipe section. The column headings are turned on their side to keep the table narrow; they stay on screen as you scroll down a long network. Each row ends with Add (insert a new row after this one), Copy and Delete. Chapter 9 describes every column.

The action buttons (5, 6):

Button	What it does
Add / Add 10	Append one or ten blank circuits to the end of the table (also available above the first row).
Calculate	Send the network to the server, size every pipe and show the results. Disabled while any field holds an invalid value, while you are offline, and on a read-only licence.
Fix All	Hold every circuit at the size the last calculation chose, so the next calculation sizes only the circuits that are not held.
Unfix All	Release every held size.
Print	Open the printed report in a new window. Enabled once the network has been calculated (and always on a read-only licence).
Export CSV	Download the results table as a spreadsheet file. Enabled once the network has been calculated.
Clear	Remove every circuit and start again with one blank row, after asking you to confirm. The network settings are kept.

Messages appear in a panel under the buttons when a calculation finds a problem (grey panel, errors) or has something to tell you about what it did (amber panel, warnings). **Results** appear below the messages: the results table, the totals, the worst flow path, the path totals and the pipe summary.

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Figure 3.3 The results of a calculation. 1 the results table, one row per circuit; 2 the totals; 3 the flow path with the highest penalty; 4 the path totals; 5 the pipe summary. Chapter 12 explains them.

3.4 The footer: tools, settings and logos

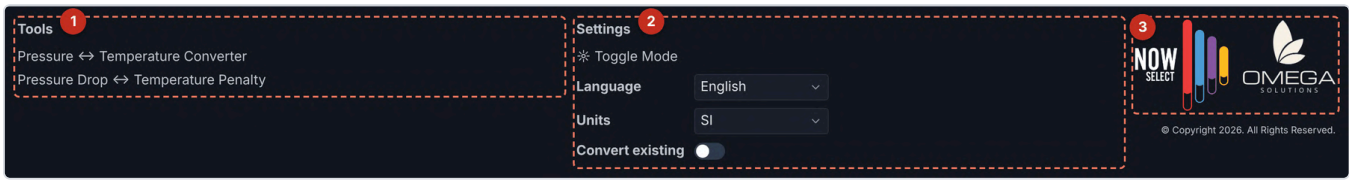


Figure 3.4 The footer. 1 the two converter tools; 2 the settings — colour mode, language, units and the convert-existing switch; 3 the NOW SELECT and Omega Solutions marks.

The **Tools** column opens the **Pressure ↔ Temperature Converter** and the **Pressure Drop ↔ Temperature Penalty** converter in place of the current view (Chapter 15). The **Settings** column holds **Toggle Mode** (dark or light colours), the **Language** list, the **Units** list (SI or Imperial) and the **Convert existing** switch (Chapter 16).

3.5 Notifications and notices

Short confirmations — *Circuit 5 Added*, *Network 2 Exported*, *Units: Imperial (existing values converted)* — drop down from the top centre of the window and go away by themselves after about two and a half seconds. Things you need to act on, or that describe a state that will last, stay until you dismiss them: a project that was changed on another device, a browser whose storage is full, a calculation that could not be made.

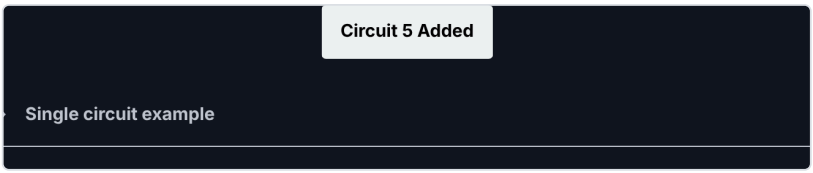


Figure 3.5 A passing notification, at the top centre of the window.

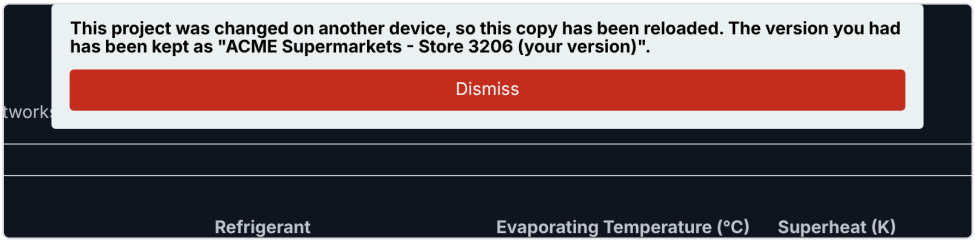


Figure 3.6 A notice that stays until dismissed.

Banners describe the state of the session for as long as it lasts, and sit above the header: offline, read-only licence, trial, server maintenance. They are shown in Chapters 2 and 4.

3.6 The calculation overlay

While a calculation runs, the page is covered by an overlay that says *Calculating on the server*, with a **Cancel** button. Most networks calculate in well under a second; a very large dry-suction network with many risers can take a few seconds, because the optimiser may try many combinations. Cancelling keeps the previous results on screen and tells you that the calculation was cancelled.

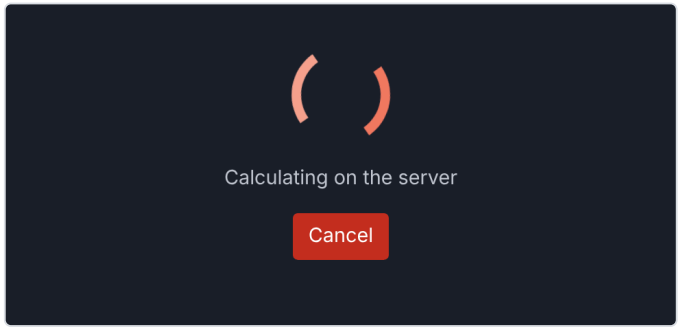


Figure 3.7 The calculation overlay.

3.7 Where things are, compared with the Windows version

Windows toolbar button or window	Online MicroPipe
New project / Load project file / Save project file	**Projects** view: **Add**, **Load**; saving is automatic (section 4.5).
Load complete project (.SUC, .LIQ, .DIS, .PUM with the same name)	A project holds any number of networks of any mode; import each old file with **Import Legacy** (section 6.6).
Merge project file	Import the file as a further network, or copy circuit rows with **Copy**.
Insert circuit before / after; copy and insert	Row buttons **Add** (inserts after) and **Copy** (appends a copy); drag is not needed because circuits are connected by label, not by position.
+10, +1, −10, −1 circuits	**Add**, **Add 10**, the row **Delete** buttons and **Clear**.
Label increment setting	Type the labels; a renamed label is followed automatically by every **Next Label** that pointed at it.
Double / single suction riser buttons	The **Orientation** column (Dry Suction).
Dual circuit, header circuit buttons	The **Dual Circuit?** and **Header?** switches.

Windows toolbar button or window	Online MicroPipe
Fix/unfix current circuit, fix all, unfix all, fix-size selection menu	The **Fixed** switch and **Fixed Pipe Size** columns; **Fix All** and **Unfix All**.
Validate data entries; Start analysis (F12)	**Calculate** does both.
Network mode / Index mode	Always a network; an index (series) system is a chain of circuits (section 10.8).
Percentage mode / kW mode for minimum oil-return duty	The **Oil Duty kW** switch in the network settings.
Globalise design data; globalise junction types	Not needed: each network carries its own settings; copy a network to carry them to another. Junction types are per row.
System design data window; Suction / Liquid / Discharge / Pumped Liquid windows	The network settings panel, which changes with the **Mode**.
Transfer circuit data between suction and liquid / pumped liquid	Copy the network, then change its mode.
Condenser drain selection window	The **Condenser Drain** switch in a Discharge network.
Pressure relief valve and pipework calculations; system design temperature; copper gauges and design pressures	Reported in the totals and the pipe summary of every calculation; **Design Temperature**, **Design Pressure Standard** and **MWP Calculation Standard** are network settings.
Temperature-to-pressure; temperature-penalty-to-pressure-drop	The two tools in the footer.
Flow-path circuit trace	The **Path** column of the Path Totals table, and the **Flowpath** columns of the results table.
Omit ¼″, ⅜″ and 3⅝″ pipe	The three **Exclude … Pipe Size** switches.
Pipe network summary	The totals tiles and the Pipe Summary table.
Project references; add notes	The project and network names, which appear on the printed report.
AutoCAD text files	**Export CSV** gives the labels and sizes as a spreadsheet file.
Print current window	**Print** produces a complete report.
Include/exclude circuit from the pipe-length summary	Not provided per circuit. The condenser drain can be excluded from the summary and totals.

3.8 Small screens

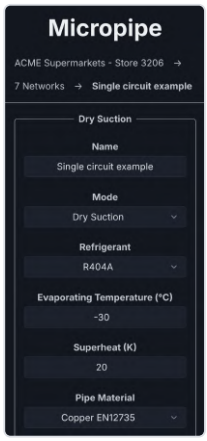


Figure 3.8 The Network view on a phone-sized screen.

On a tablet or phone the settings fields stack one above the other and the circuits table scrolls sideways. Everything works, but entering a network of any size is far quicker on a desktop with a keyboard, and the results table is easier to read there.

CHAPTER 4

How MicroPipe is organised

Four ideas carry the whole of MicroPipe: a *project* holds *networks*, a network holds *circuits*, every circuit names the circuit it flows into, and your work is saved for you. Ten minutes with this chapter will save you an hour later.

4.1 Projects, networks and circuits

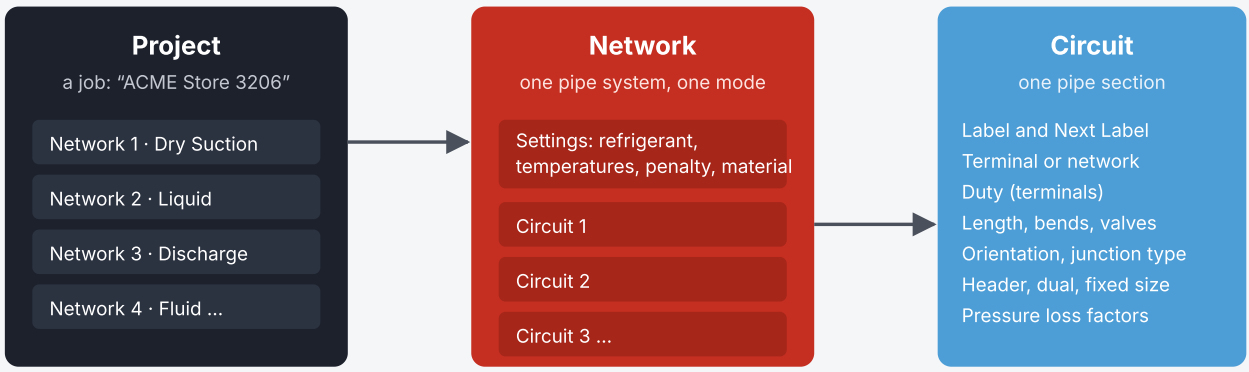


Figure 4.1 A project holds networks; a network holds its settings and its circuits.

A **project** is a job: a store, a cold store, a process plant. It has a name and holds any number of networks. The project is also the unit that is saved, exported and imported as a whole.

A **network** is one pipe system calculated as one thing, in one *mode*: the LT suction system, the MT liquid line, the pack discharge, the chilled-water secondary. It has a name, its design settings (refrigerant, temperatures, penalty, pipe material and so on) and its circuits. A network is calculated on its own; networks in the same project do not interact, which is why a project can hold the suction, liquid and discharge networks of the same plant side by side.

A **circuit** is one section of pipe with a single flow rate: from an evaporator to a tee, from one tee to the next, a riser, the final run to the compressors. Each circuit has a label, the physical description of the pipe run (length, bends, valves, orientation) and, for the circuits that start a flow path, a duty.

4.2 Terminals, network circuits and the end of the line

Circuits are of two kinds. A **terminal** is a circuit that starts a flow path and carries a duty you enter: in suction, liquid, pumped liquid, wet suction and fluid networks a terminal is an evaporator (or a fan coil, in a fluid network); in a discharge network a terminal is a compressor. A **network circuit** is any other section; its duty is not entered, because MicroPipe works it out as the sum of the terminals that flow through it.

Exactly one circuit has no `Next Label`: the **end-of-line circuit**, at the compressor end of a suction network, the receiver end of a liquid network, the condenser end of a discharge network. Every flow path ends there, and its duty is the total duty of the network.

4.3 Labels and next labels: how the flow paths are built

MicroPipe does not need the circuits in any order, and it does not care which row a circuit is in. What it needs is to know how the pipes connect, and you tell it with two columns: each circuit's own `Label`, and the `Next Label` of the

circuit it flows into. From these MicroPipe sorts out the flow paths from every terminal to the end of the line, the duty carried by every network circuit, and where the tees and headers are.

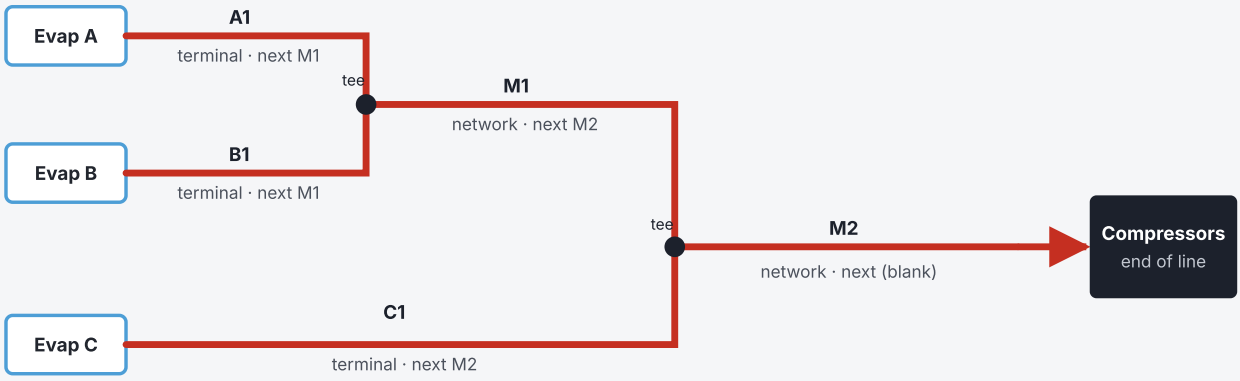


Figure 4.2 A five-circuit suction network. A1, B1 and C1 are terminals carrying the evaporator duties; M1 carries A+B; M2 carries A+B+C and, having no Next Label, is the end of the line. The flow paths are A1→M1→M2, B1→M1→M2 and C1→M2.

Three rules follow, and MicroPipe checks all of them when you calculate:

- Every label must be unique within the network, and every next label must be the label of an existing circuit.
- A next label must point at a *network* circuit, never at a terminal: a terminal starts a flow path, so nothing flows into it.
- There must be exactly one circuit with a blank next label, and every path must reach it without looping back on itself.

Because circuits are connected by label and not by position, you can add, insert, copy and delete rows freely, and the labels can be anything you find convenient: the circuit numbers from your drawing, the evaporator tags, a section code. Chapter 10 goes through the describing of a network in detail, including tees, headers, dual pipes and risers.

4.4 Modes

The **Mode** of a network decides what MicroPipe is sizing and therefore which settings and circuit columns it asks for. The six modes are Dry Suction, Liquid, Discharge, Pumped Liquid, Wet Suction and Fluid; the condenser liquid drain is part of a Discharge network. Chapter 17 describes each mode from the engineering side; Chapter 8 describes their settings. A network's mode can be changed at any time, but the fields that do not exist in the new mode are left behind, so a mode is normally chosen once, when the network is created.

4.5 Where your work is kept, and when it is saved

There is no save button. The browser keeps a working copy of your projects and MicroPipe writes to it on almost every change; the server keeps the record, and the working copy is pushed to it three seconds after you stop typing, immediately when you switch project or calculate, and when the page is hidden or closed. A project that has reached the server is available on any device later activated with the same licence.

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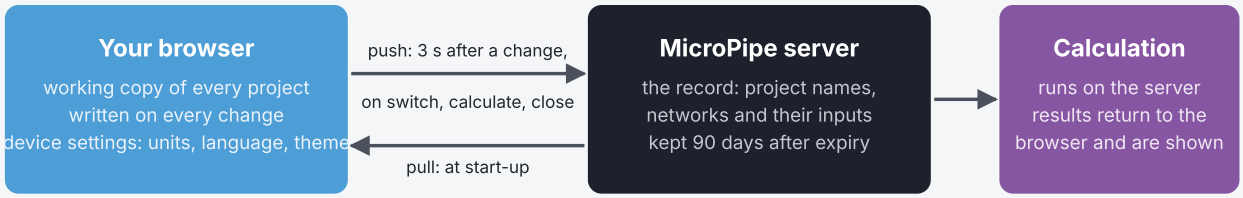


Figure 4.3 The browser holds the working copy; the server holds the record and does the calculating.

Some consequences worth knowing:

- **The server stores inputs, not results.** When a project is pulled from the server — at start-up, or after it was changed elsewhere — each network is calculated again the first time you open it, so the figures you see are always computed against the current reference data. On a read-only licence, which cannot calculate, the results last computed on this device are kept so that they can still be printed.
- **Offline, you can keep working.** A banner says *You are offline. Your work is kept in this browser and will be saved to Micropipe when you are back online.* Changes stay in the browser and are pushed when the connection returns. You cannot calculate, import, create a new project or use the tools while offline; exporting and printing still work.
- **Two devices, one project.** If the same project is changed on another device, your next save is refused as stale and the project is reloaded from the server. The version you had is not thrown away: it is kept as a new project named *… (your version)*, and a notice tells you so. There is no automatic merge of two engineers' pipe networks; compare the two and keep the one you want.
- **Browser storage is finite.** A large project is a few hundred kilobytes; a browser allows several megabytes for the working copy, and the Projects view shows roughly how many more projects fit. If the browser refuses to store the working copy, MicroPipe tells you, and says whether the work is still reaching the server.
- **Server maintenance.** Occasionally the server is briefly unavailable for a scheduled change. A banner says so; your work is kept in the browser and saved shortly afterwards, and calculation is refused until the change is complete.

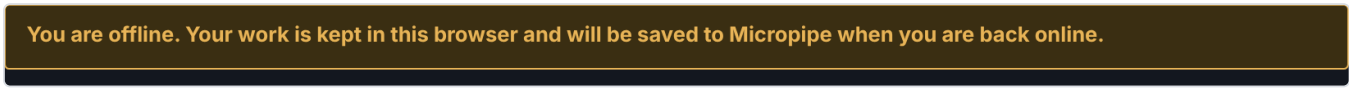


Figure 4.4 The offline banner.

> **TIP**
> Export a project (Chapter 5) at the milestones of a job — the issued design, the as-installed version — and keep the file with the job records. The server keeps the current version of each project; it does not keep a history of changes.

4.6 Device settings

The unit system, the language, the values in the two converter tools belong to the device, not to the project: they are remembered by the browser and are not part of what is saved to the server or exported. The colour mode is not remembered at all; it lasts until the page is next loaded. A project opened on another device is shown in that device's units and language. Every stored value is SI; the Imperial setting is a display and entry skin (Chapter 16).

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PART B

Working in MicroPipe

Projects and networks, every input field, the circuits table, describing a pipe network, calculating, reading and checking the results, fixing pipe sizes, printing and exporting, the converter tools and the settings.

- 5 Projects
- 6 Networks
- 7 Network settings common to every mode
- 8 Network settings mode by mode
- 9 The circuits table
- 10 Describing the pipe network
- 11 Calculating
- 12 Reading the results
- 13 Fixing pipe sizes
- 14 Printing and exporting
- 15 The converter tools
- 16 Settings: colours, language and units

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CHAPTER 5

Projects

The Projects view lists every project on the licence and is where projects are created, loaded, copied, renamed, exported, imported and deleted. Open it by clicking the project name at the left of the breadcrumb.

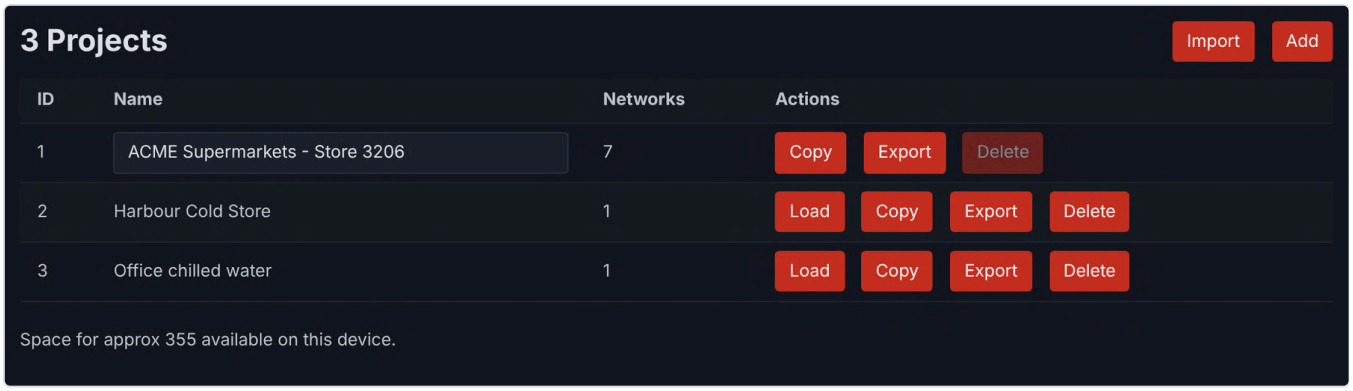


Figure 5.1 The Projects view. The loaded project (here project 1) shows its name in an editable box; the others show a **Load** button.

5.1 The project list

Each row shows the project's **ID** (its position in the list, which is renumbered when a project is deleted and so is not a permanent reference), its **Name**, the number of **Networks** it holds and its **Actions**. The heading counts the projects. The line under the table — *Space for approx. n available on this device* — is an estimate of how many more projects of the present average size the browser's storage will hold (section 4.5).

The projects are listed in the order the server returns them: the most recently updated first (the list shows up to 500). On start-up MicroPipe pushes anything the browser was holding, then pulls the server's list, so the order can change between sessions.

5.2 Adding a project

Add creates a new project named *My project name* with one network, *Network 1*, in Dry Suction mode with R404A and one blank circuit. It is added to the end of the list but is not opened: press its **Load** button to open it, then rename it. A new project cannot be created while offline or on a read-only licence.

5.3 Naming a project

The loaded project's name is an input box in the list. Type the new name and press `Tab` or click elsewhere; the breadcrumb and the printed report use it. A name can be up to 80 characters and may contain letters, digits, spaces and the characters `. , - _ / & ( ) +`. Anything else is refused with a message under the box.

> **TIP**
> Give projects the names you use elsewhere in the job — the customer and site, or the job number — because the name is what identifies the printed report and the exported file.

5.4 Loading, copying and deleting

- **Load** opens the project and shows the network it last had open. Any unsaved changes to the project you are leaving are pushed to the server first.

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- **Copy** makes a complete copy — every network, every circuit — named … *COPY*, at the end of the list. Use it to try an alternative design without disturbing the original.
- **Delete** removes the project and every network in it, on this device and on the server, after a confirmation that names the project. This cannot be undone. The loaded project cannot be deleted (load another first), and neither can the last remaining project, because MicroPipe always has one open.

5.5 Exporting and importing projects

Export downloads the project as a file named `micropipe_project_<name>.json`. The file holds the project name and every network's inputs — the settings, the circuits and any user-defined fluid table — but not the results, which are recalculated when the file is imported. It is a plain-text JSON file: small, readable, and safe to e-mail or archive.

Import asks for a project file and adds it to the list as a new project, which is then opened. The file is checked as it is read: one that is not valid JSON, is not a MicroPipe project file or holds no networks is refused with a notification saying why. The results stored in the file, if any, are discarded and each network is calculated afresh when first opened. A network file (section 6.4) cannot be imported here; import it from the Networks view of the project it belongs in.

Exported files are the way to pass a design to a colleague, to send a problem network to Omega, and to keep a snapshot of a job at a milestone. Importing never overwrites: a file imported twice gives two projects.

> **NOTE**
> When you are offline, **Export** still works (the file is built from the browser's working copy) but **Import** waits until you are back online.

5.6 Changes made on another device

A project can be open on two devices activated with the same licence at different times, or in two browser tabs. The server accepts a save only if it is based on the latest version it holds. If the project has been changed elsewhere in the meantime, your save is refused, the project is reloaded from the server, and the version you had is kept beside it as a new project named *<name> (your version)*. A notice stays on screen until you dismiss it (Figure 3.6). Open both, decide which is right, and delete the other — there is no automatic merge of two engineers' pipe networks.

If a project is deleted on another device while this one still holds it, it is removed here as well when the next save is attempted and a notification says so; if it was the only project it is kept, detached from the deleted record, and saved again as a new one.

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CHAPTER 6

Networks

The Networks view lists the networks of the open project. Open it by clicking the networks count in the breadcrumb. From here you add, copy, export, import and delete networks, and open one by clicking its name.

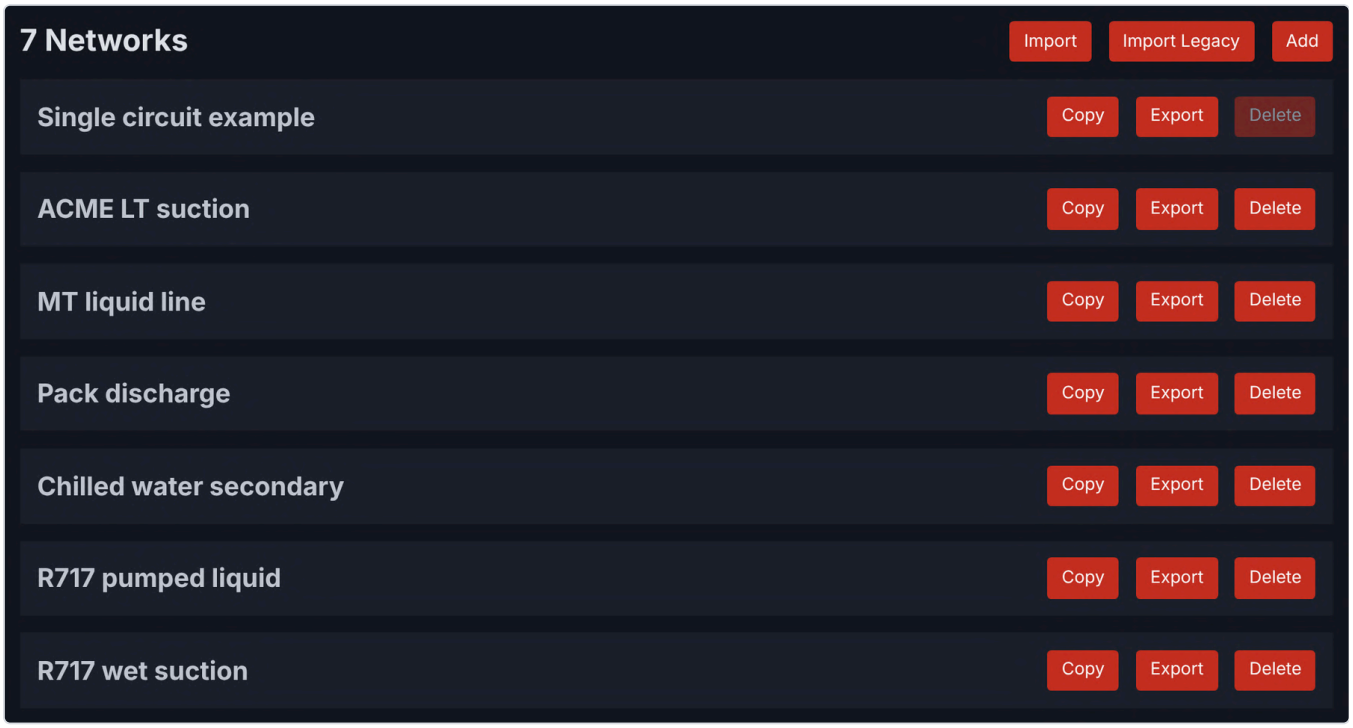


Figure 6.1 The Networks view of a project holding seven networks, which between them cover all six modes.

6.1 Adding a network

Add creates *Network n* in Dry Suction mode with R404A and one blank circuit, at the end of the list, and scrolls to it. Click its name to open it, then set its **Name**, **Mode** and **Refrigerant** in the network settings. A network name follows the same rules as a project name (80 characters; letters, digits, spaces and `. , - _ / & ( ) +`).

6.2 Copying a network

Copy adds a complete copy named … *COPY*. Copying is how you carry the design conditions and circuits of one network to another: copy the suction network, open the copy, change its **Mode** to Liquid, and the circuits are there to be edited into the liquid line. It is also the way to keep a calculated design while you try a variation.

6.3 Deleting a network

Delete removes the network after asking you to confirm. The open network cannot be deleted (open another first), and a project always keeps at least one network.

6.4 Exporting and importing a single network

Export downloads one network as `micropipe_network_<name>.json`, holding its settings and circuits (inputs only, as for a project). **Import** adds a network file to the open project and opens it; the network is calculated as it opens. A project file cannot be imported here — use the Projects view.

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6.5 Opening a network

Click the network's name. The project remembers which network was open, and the breadcrumb's right-hand item takes you back to it from the other views.

6.6 Importing files from the Windows MicroPipe

Import Legacy reads the project files written by the Windows (Visual Basic) MicroPipe and converts one into a network of the open project. Every field position in those files has been taken from the original program's source, and the conversion reproduces the job settings, the circuits, their labels and connections, the fittings, the riser settings and any fixed pipe sizes.

File	Written by	Becomes
`.SUC`	Suction system	A Dry Suction network, or a Wet Suction network if the file was saved with wet-suction calculations on.
`.WET`	Suction system (wet)	A Wet Suction network.
`.LIQ`	Liquid system	A Liquid network.
`.DIS`	Discharge system	A Discharge network, including the condenser drain settings if they were in use.
`.PUM`	Pumped liquid system	A Pumped Liquid network.
`.FLU`	Fluid Pipe-Network program	A Fluid network.
`.WRP`	Pipe schedule data file	Not a network: supplies the pipe schedules a `.FLU` file refers to. Select it together with the `.FLU` file.
`.FDA`	Fluid data file	Not a network: supplies user-defined fluids a `.FLU` file refers to. Select it together with the `.FLU` file.

To import:

1. Open the project the network belongs in and go to its Networks view.
2. Press **Import Legacy** and select **one** project file. For a fluid job, select its `.WRP` and `.FDA` files in the same selection; once loaded they are remembered for the rest of the session, so a folder of fluid jobs needs them only once. Selecting more than one project file at a time is refused.
3. If the file does not name its refrigerant unambiguously, the **Confirm Refrigerant** dialogue (Figure 6.2) lists the candidates, ranked by how closely their properties match the saturation pressure stored in the file. Choose the refrigerant the job was designed for and press **Import**. The ranking is a guide, not an identification: several refrigerants have properties within a per cent or two of each other.
4. The network is added, named after the drawing title stored in the file (or the file name), and opened; if the project still has its default name and the file names the job, the project is renamed after the job. The network is calculated as it opens.

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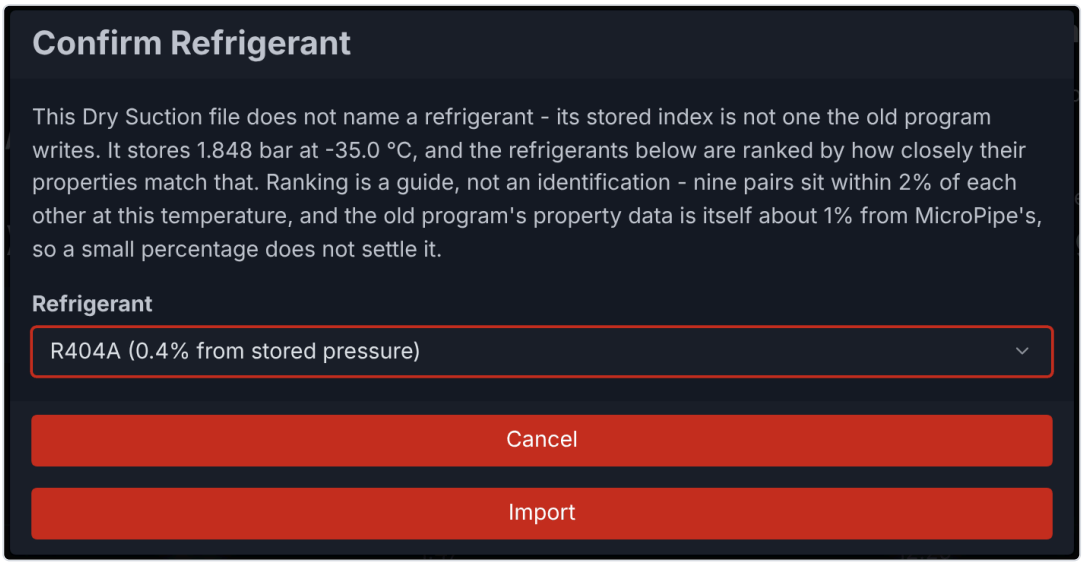


Figure 6.2 The Confirm Refrigerant dialogue, shown when a legacy file's refrigerant cannot be read from the file.

After an import, read the messages panel. The conversion reports, as warnings:

- values in the file that lie outside the range MicroPipe allows for the field (the value is kept and reported, not changed);
- relationships MicroPipe enforces between fields that the file disagrees with — for example an evaporating temperature above the minimum liquid temperature. MicroPipe adjusts these when the network is opened (Chapter 8), so check the settings against the original job sheet;
- anything the old file carried that has no equivalent, such as a pipe schedule category the online MicroPipe does not have.

The legacy engine's own results are not imported: they were results, not inputs, and the online engine recalculates the network. Expect the figures to agree closely but not to the last decimal: the online engine was checked against the Windows program when it was ported, but the reference data has been maintained and corrected since (Appendix D.2).

OLDER FILES

The Windows MicroPipe could also read a still older project format (tagged STARTSUC2 and so on inside the file). The online MicroPipe detects these files but does not convert them. Open such a file in the Windows program and save it once; it is then written in the current format and can be imported.

UNITS IN OLD FILES

The old files record which unit system was in use when they were saved, and the import converts accordingly, so a job entered in imperial units arrives correctly in SI. Pipe sizes are resolved against the material's own size list (copper, steel, K65 or Reflok), so a K65 or steel job keeps its sizes.

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CHAPTER 7

Network settings common to every mode

The network settings panel at the top of the Network view holds the design conditions for the whole network. This chapter covers the fields that appear whatever the mode; Chapter 8 covers the fields each mode adds. Chapter 18 explains the engineering behind the design data.

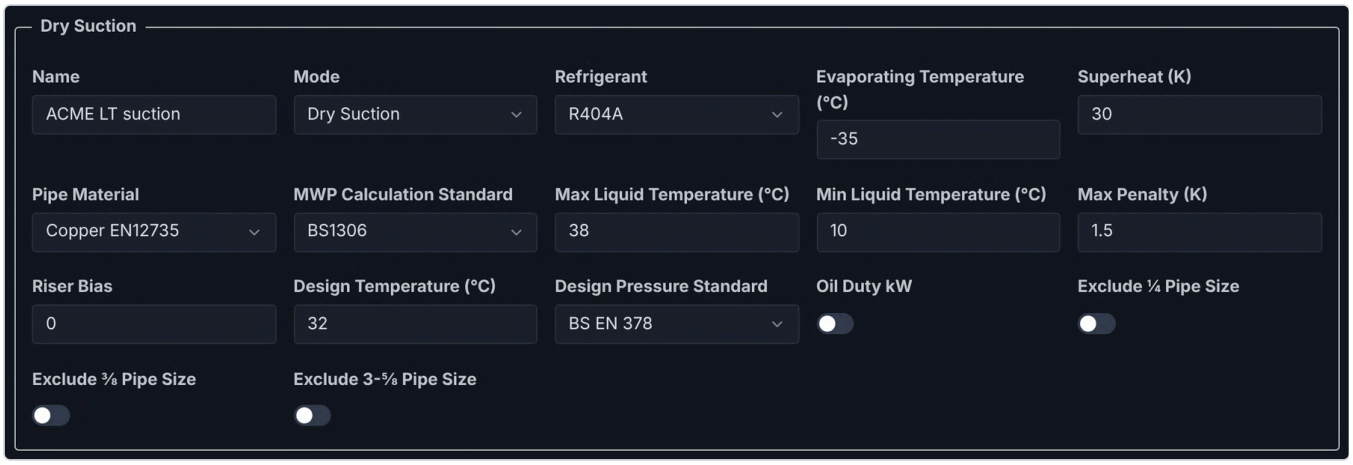


Figure 7.1 The network settings of a Dry Suction network with R404A. The legend names the mode.

7.1 How the panel behaves

- Every field is saved as soon as you leave it (`Tab`, or a click elsewhere). Number fields have a step, a minimum and a maximum; the spinner arrows move by the step, and a value outside the range is refused with a message and not stored until corrected. While any field holds a refused value, **Calculate** is disabled.
- Changing **Mode**, **Refrigerant**, **Working Fluid**, **Pipe Material**, **Design Pressure Standard**, **Condenser Drain**, **Oil Duty kW** or an **Exclude … Pipe Size** switch redraws the panel, because these decide which other fields exist and what their limits are.
- Changing any setting marks the results stale: the results and messages disappear until you calculate again. (Fixing or unfixing a pipe size also marks them stale, but leaves **Fix All** available.)
- Some fields are adjusted for you when the refrigerant, mode or standard changes, and a notification says what was done — *Design Temperature (°C) Default Value 55 Applied*, for example. Section 8.8 lists these rules.

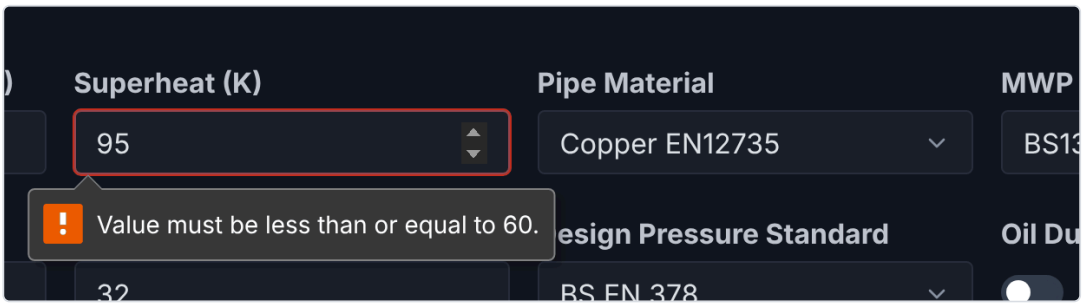


Figure 7.2 A value outside the field's range is refused and explained. The figure you typed stays in the box with the message, but the stored value is unchanged until you correct it.

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7.2 The fields

Field	Meaning and use
Name	The network's name, shown in the breadcrumb, the Networks view and the printed report. Up to 80 characters: letters, digits, spaces and `. , - _ / & ( ) +`.
Mode	Dry Suction, Liquid, Discharge, Pumped Liquid, Wet Suction or Fluid (Chapter 17). Changing the mode redraws the settings and the circuit columns for the new mode and clears the fields that have no meaning in it; the **Max Pressure Drop** field is reset to the new mode's default.
Refrigerant	The refrigerant, from a list grouped as *Naturals* (R744 TC, R744, R717, R290, R1270, R600a) and *Synthetics* by GWP class — low, mid, high, legacy and ultra-low-temperature. Section 21.1 lists them all. R744 TC is transcritical CO_2 and changes several fields (section 8.7); it is not available in Wet Suction or Pumped Liquid, where it is replaced by R744. Changing the refrigerant re-applies the temperature defaults for the new refrigerant family and may reset the pipe material (ammonia, R717, excludes copper and aluminium).
Pipe Material	The tube or pipe series the network is built in: Copper EN12735, Copper ASTM, K65 Copper, Steel SCH40, Steel SCH80, Stainless Steel SCH10, Stainless Steel SCH40 or Reflok Aluminium for refrigerant networks; a longer list of steel, copper and plastic schedules for fluid networks (Chapter 20). The material fixes the sizes available, the wall thicknesses or gauges, the maximum working pressures and the weights per metre. Changing it clears any fixed pipe size that the new material does not offer.
Design Pressure Standard	BS EN 378 or ASME B31.5 – 2006. Decides the default design temperature and the pressure limits derived from the design pressure (section 20.5). Not shown in Fluid mode.
MWP Calculation Standard	BS1306 or DKI: the method used to calculate the maximum working pressure of each copper gauge (section 20.4). Not shown in Fluid mode.
Design Temperature (°C)	The saturation temperature at which the system design pressure is taken. MicroPipe looks up the refrigerant's saturation pressure at this temperature and uses it, as a gauge pressure, as the design pressure of the network: the pressure every pipe is checked against and from which the test, cut-out and relief settings follow (section 12.3). The default depends on the mode, the standard and the refrigerant family (section 8.8); change it if your specification uses a different design temperature.
Exclude ¼ Pipe Size **Exclude ⅜ Pipe Size** **Exclude 3-⅝ Pipe Size**	Each switch removes that copper size from the selection process, so that a small circuit is not sized in a tube you do not stock or a run is not sized at 3⅝″ where you would rather jump from 3⅛″ to 4⅛″. They apply to copper and aluminium series; the steel series do not include these sizes.

ENGINEERING NOTE

The design pressure is taken from the saturation temperature, not from the condensing temperature you design the system at, because a plant must be safe when it is standing idle in a warm plant room with no refrigeration running. BS EN 378 gives the design temperatures that correspond to the ambient conditions a high-side or low-side can reach; MicroPipe's defaults (32 °C for the low side, 55 °C for the high side) follow it, with 27 and 50 °C for ASME.

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CHAPTER 8

Network settings mode by mode

Each mode adds its own design fields to the common ones. The tables below give each field's meaning, its default and the range MicroPipe accepts; the defaults and ranges of the temperature fields depend on the refrigerant (section 8.8).

8.1 Dry Suction suction gas

Field	Meaning	Default · range
Evaporating Temperature (°C)	The refrigerant temperature in the evaporator — not the saturated suction temperature at the compressor, which MicroPipe calculates from it and reports as SST.	−10 · −50 to 30
Superheat (K)	The rise of the suction gas above saturation between the evaporator and the compressor, including the evaporator's own superheat.	10 · 0 to 60
Max Liquid Temperature (°C)	The highest liquid temperature likely at the evaporator inlet under maximum design ambient conditions. Used to calculate the refrigerant mass flow for the given duty and therefore the penalty.	40 · −50 to 60
Min Liquid Temperature (°C)	The lowest liquid temperature likely at minimum ambient conditions, when the condensing pressure is allowed to float down. Used to select suction risers for oil return, because the lower mass flow at low liquid temperature is the worst case for oil return (Chapter 19).	20 · −50 to 60; never above Max Liquid Temperature
Max Penalty (K)	The maximum temperature penalty — the loss of saturated suction temperature between the farthest evaporator and the compressors — that you will tolerate. MicroPipe sizes the network so that the worst flow path uses as much of this as possible without exceeding it.	1.0 · 0 to 6
Riser Bias	Shifts the share of the penalty allocated to suction risers. 0 lets the optimiser decide; a higher value spends more of the penalty on the risers and so enlarges the rest of the network (section 18.10).	0 · 0 to 10
Oil Duty kW	Off: each riser's required oil-return duty is entered as a percentage of the load through it. On: it is entered in kW, and the percentage is derived. Section 9.4.	off

The R744 TC form of this mode replaces the liquid temperatures with gas-cooler outlet conditions: see section 8.7.

8.2 Liquid high-pressure liquid

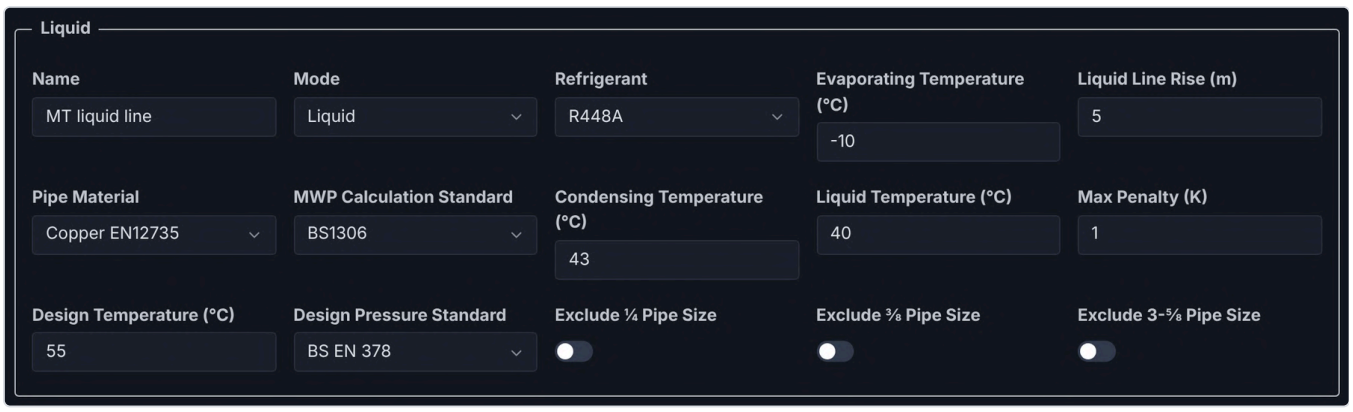


Figure 8.1 Liquid network settings (R448A).

Field	Meaning	Default · range
Evaporating Temperature (°C)	The evaporating temperature of the system the liquid line feeds; fixes the evaporator inlet condition and so the duty-to-mass-flow relationship.	−10 · −50 to 30
Liquid Line Rise (m)	The height of the evaporator inlet above the liquid receiver. MicroPipe converts it to a static pressure loss (the *head penalty*) and reports the additional sub-cooling needed to prevent flash gas at the expansion valve.	0 · 0 to 30
Condensing Temperature (°C)	The condensing temperature at maximum design ambient. Sets the pressure at the receiver and the compression ratio reported in the totals.	43 · −23 to 60; never below the liquid or evaporating temperature
Liquid Temperature (°C)	The liquid temperature leaving the receiver (the condensing temperature less the sub-cooling). Fixes the liquid density and the enthalpy at the evaporator inlet.	40 · −50 to 60; never above the condensing temperature
Max Penalty (K)	The permitted loss, expressed as the saturation temperature drop corresponding to the pressure drop along the worst path.	1.0 · 0 to 6

With R744 TC the penalty is replaced by **Max Pressure Drop (kPa)** and the gas-cooler fields appear (section 8.7).

8.3 Discharge compressor discharge

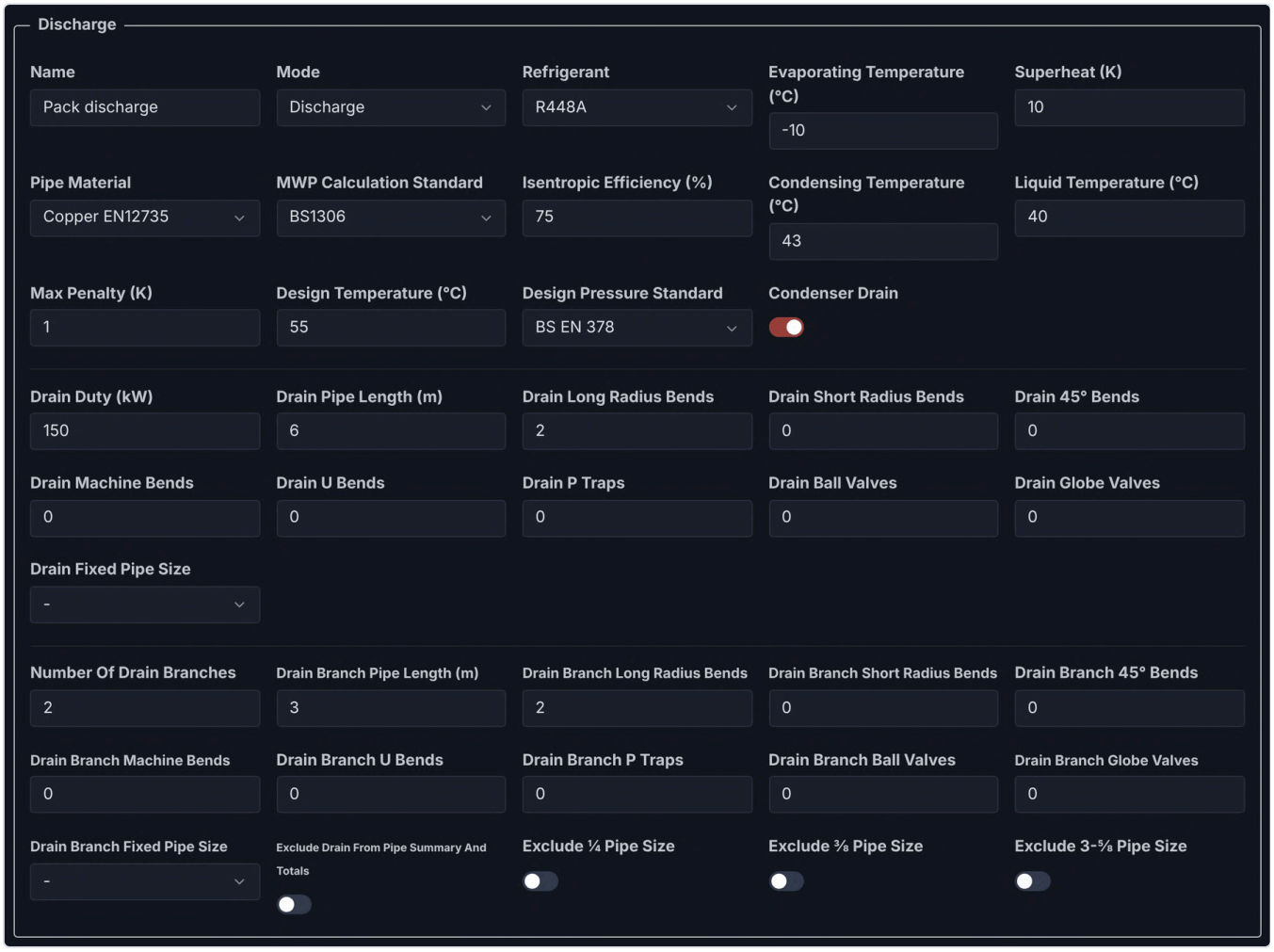


Figure 8.2 Discharge network settings with the condenser drain switched on. The drain fields fill the lower half of the panel.

Field	Meaning	Default · range
Evaporating Temperature (°C), Superheat (K)	The suction condition at the compressor inlet, from which the discharge condition is calculated.	−10; 10 K
Isentropic Efficiency (%)	The compressor's isentropic efficiency, used to calculate the discharge temperature and hence the discharge gas density. 75% is a reasonable general figure; the discharge temperature calculated from it is reported in the totals.	75 · 50 to 90, step 5
Condensing Temperature (°C), Liquid Temperature (°C)	The condensing condition at maximum ambient and the liquid leaving the condenser; as for Liquid mode.	43; 40
Max Penalty (K)	The permitted loss along the worst path, expressed as saturation temperature.	1.0 · 0 to 6
Condenser Drain	On: the condenser liquid drain line is sized in the same calculation and reported as its own group of totals (section 8.4).	off

8.4 The condenser liquid drain

A condenser drain runs full of liquid under gravity from the condenser outlet to the receiver, so it is sized for a low velocity rather than for a pressure drop. When **Condenser Drain** is on, these fields describe it:

Field	Meaning	Default · range
Drain Duty (kW)	The condenser duty carried by the drain. Enter 0 to use the network's own total duty (the sum of the compressor terminals); any other value overrides it, and the totals say which was used.	0 · 0 to 20 000
Drain Pipe Length (m)	The length of the main drain, condenser outlet to receiver.	10 · 0.1 to 300
Drain Long Radius Bends, Short Radius Bends, 45° Bends, Machine Bends, U Bends, P Traps, Ball Valves, Globe Valves	The fittings in the main drain.	0
Drain Fixed Pipe Size	Hold the main drain at a chosen size instead of letting MicroPipe select it. If the chosen size gives a velocity above the drain target, a warning says so and the size is kept.	– (automatic)
Number Of Drain Branches	How many condenser outlets (or condenser sections) drain into the main: 0 for none, or 2 to 10. A single branch is not permitted and is ignored with a warning; each branch is sized for an equal share of the duty.	0 · 0 to 10
Drain Branch Pipe Length (m), bends, traps, valves	The length and fittings of *one* branch; all branches are assumed alike. A branch length of 0 means the branches are ignored.	0
Drain Branch Fixed Pipe Size	Hold the branches at a chosen size.	– (automatic)
Exclude Drain From Pipe Summary And Totals	On: the drain's length, volume and refrigerant charge are reported in the drain group but not added to the network totals or the pipe summary — for when the drain is in another contractor's scope or is being sized for information only.	off

The drain's results — the duty used, the sizes and velocities of the main and the branches, the liquid density, the volume and whether it is included in the totals — are reported in a *Condenser Liquid Drain Details* group under the totals (section 12.6), and the pipe summary gains separate length and pressure rows for the drain.

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8.5 Wet Suction pumped overfeed return

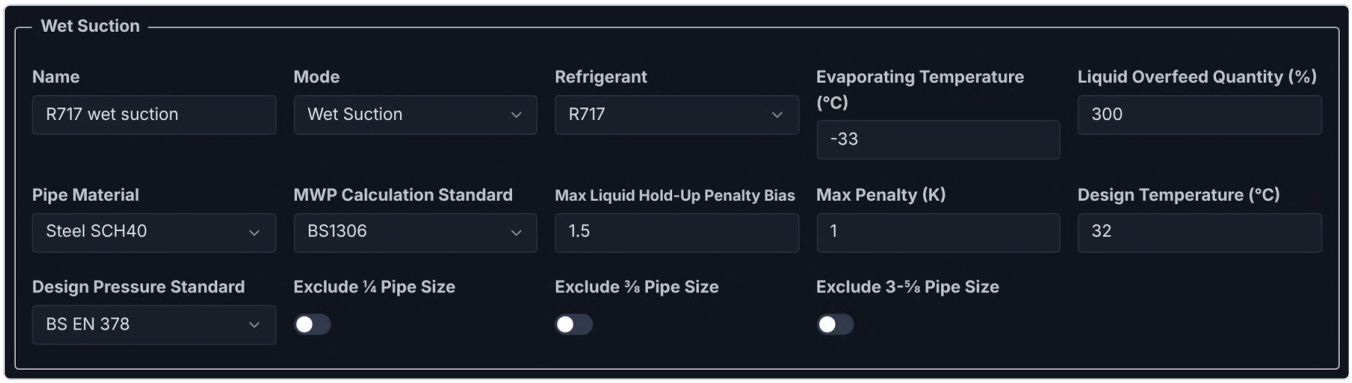


Figure 8.3 Wet Suction network settings (R717, steel).

Field	Meaning	Default · range
Evaporating Temperature (°C)	The evaporating temperature of the overfeed system.	−10 · −50 to 30
Liquid Overfeed Quantity (%)	The liquid leaving the evaporators as a percentage of the liquid evaporated. 100% means a 2:1 circulation ratio: each wet-suction line carries the vapour for the duty plus an equal mass of liquid; 300% means 4:1 (section 18.8).	100 · 0 to 2000, step 25
Max Liquid Hold-Up Penalty Bias	Adjusts the allowance made for liquid hold-up in the wet-suction lines (section 18.10). 1.5 is the recommended value.	1.5 · 1 to 3
Max Penalty (K)	The permitted saturation temperature loss along the worst path.	1.0 · 0 to 6

8.6 Pumped Liquid pumped overfeed feed

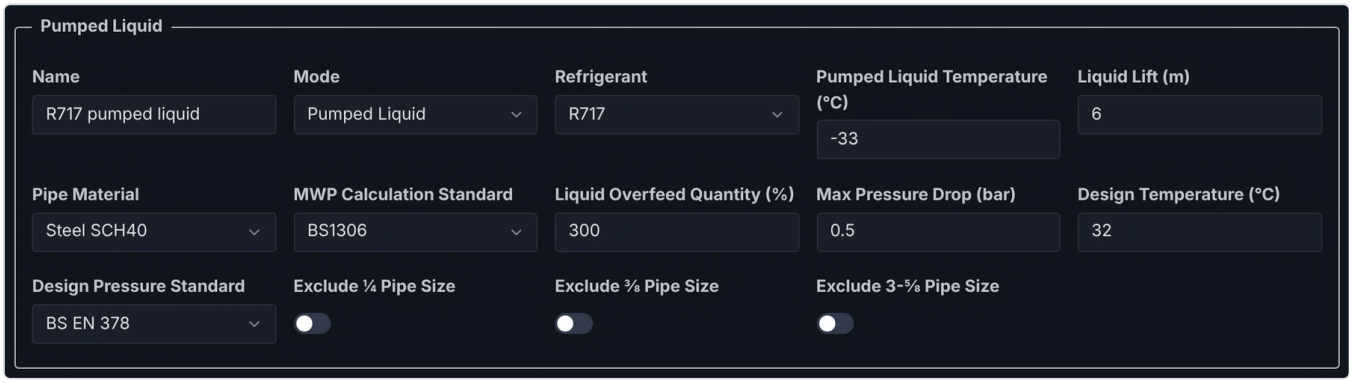


Figure 8.4 Pumped Liquid network settings. The evaporating temperature field is labelled **Pumped Liquid Temperature** in this mode.

Field	Meaning	Default · range
Pumped Liquid Temperature (°C)	The refrigerant temperature in the low-pressure receiver, which is the temperature of the pumped liquid.	−10 · −50 to 30
Liquid Lift (m)	The vertical distance from the pump to the highest evaporator inlet. MicroPipe adds the corresponding static head to the friction loss to give the system pump head.	0 · 0 to 30
Liquid Overfeed Quantity (%)	As for Wet Suction: 100% means each line carries twice the liquid that evaporates. In pumped liquid lines all of the mass flow is liquid.	100 · 0 to 2000
Max Pressure Drop (bar)	The permitted friction loss along the worst path. Pumped liquid is sized on pressure drop, not temperature penalty, because the liquid is sub-cooled by the pump head and a pressure loss does not change its temperature.	0.5 · 0.01 to 2

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8.7 Transcritical CO_2 (R744 TC)

Choosing **R744 TC** as the refrigerant tells MicroPipe that the high side is above the critical point, so there is no condensing temperature and no liquid temperature: the high side is described by the gas-cooler outlet condition instead, and the pressure limits cannot be derived from a saturation temperature.

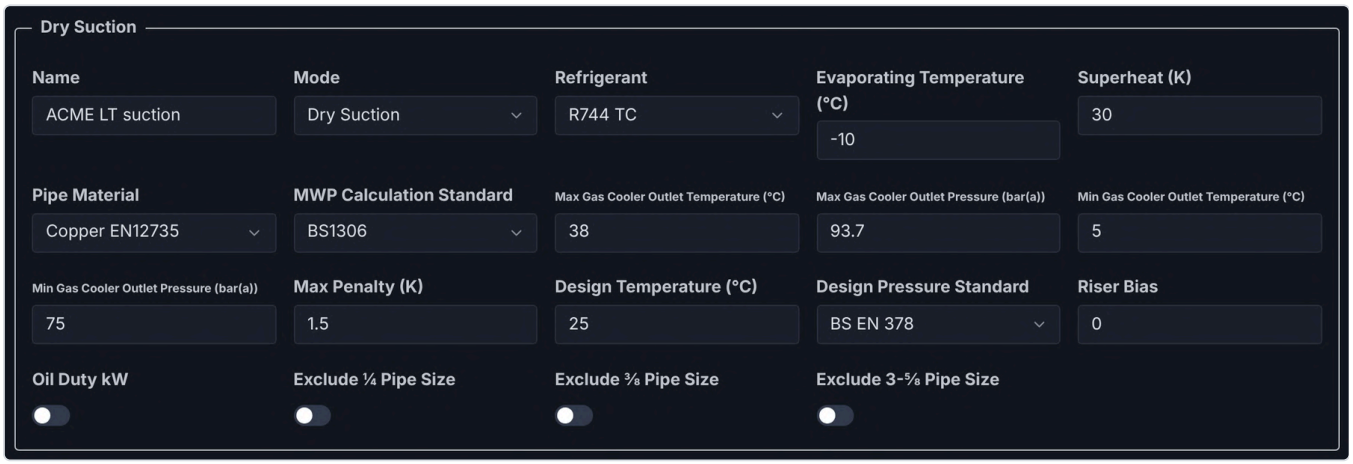


Figure 8.5 A Dry Suction network with R744 TC: the liquid temperatures are replaced by maximum and minimum gas-cooler outlet temperatures and pressures.

Field	Meaning	Default · range
Max / Min Gas Cooler Outlet Temperature (°C) (Dry Suction)	Replace the maximum and minimum liquid temperatures: the gas-cooler outlet condition at maximum and minimum ambient, used for the mass flow and the oil-return check respectively.	38 / 5 · −50 to 50
Max / Min Gas Cooler Outlet Pressure (bar(a)) (Dry Suction)	The gas-cooler pressure at those two conditions. The minimum may be subcritical (at or below 72.13 bar(a), the minimum condition is treated as saturated liquid); pressures between 72.13 and 73.8 bar(a) are not allowed.	93.7 / 75 · 73.8–150 / 40–150
Gas Cooler Outlet Temperature (°C), Gas Cooler Outlet Pressure (bar(a)) (Liquid, Discharge)	The single gas-cooler outlet condition for the high side.	38; 93.7
Design Pressure (bar(g)) (Liquid, Discharge)	The high-side design pressure, entered directly because it cannot come from a saturation temperature. The pipe pressure checks and the test and relief settings use it.	120 · 75 to 150, step 5
Max Pressure Drop (kPa) (Liquid, Discharge)	Replaces Max Penalty: a transcritical fluid has no saturation temperature to express a penalty in, so the limit is a pressure drop.	Liquid 15, Discharge 50 · 0 to 250

The condenser drain does not apply to a transcritical discharge and its fields are hidden. R744 TC is not offered in Wet Suction or Pumped Liquid: the low side of a CO_2 overfeed system is subcritical, so choose R744.

8.8 Ranges, defaults and the rules between fields

The temperature fields have ranges and defaults that depend on the refrigerant family and, for the design temperature, on the mode and the standard. When you change the refrigerant, every temperature field in the panel is reset to the new family's default and a notification lists what was applied; when you change the mode or the standard, only the design temperature is reset.

Field	Standard refrigerants	R744 (and R744 TC on the low side)	R23, R508B
Evaporating Temperature	−50 to 30, default −10	−50 to 20, default −10	−100 to −20, default −80

Field	Standard refrigerants	R744 (and R744 TC on the low side)	R23, R508B
Max Liquid Temperature	−50 to 60, default 40	−50 to 30, default 15	−100 to 10, default −30
Min Liquid Temperature	−50 to 60, default 20	−50 to 30, default 10	−100 to 10, default −40
Condensing Temperature	−23 to 60, default 43	−23 to 30, default 15	−100 to 10, default −30
Liquid Temperature	−50 to 60, default 40	−50 to 30, default 10	−100 to 10, default −40
Design Temperature, suction and pumped modes	20 to 50; default 32 (BS EN 378) or 27 (ASME)	−20 to 25, default 25	−60 to 10, default 10
Design Temperature, Liquid and Discharge	25 to 60; default 55 (BS EN 378) or 50 (ASME)	0 to 25, default 25	−30 to 10, default 10

MicroPipe also keeps the temperatures in a physically sensible order, and adjusts a field the moment you leave another that conflicts with it:

- **Dry Suction:** the minimum liquid temperature cannot exceed the maximum liquid temperature, and the evaporating temperature cannot exceed the minimum liquid temperature. Entering a higher value lowers it to the limit.
- **Liquid, Discharge and Wet Suction:** the liquid temperature cannot exceed the condensing temperature; the evaporating temperature cannot exceed the liquid temperature; and when the network is opened the condensing temperature is raised, if necessary, to at least the liquid and evaporating temperatures.

> **TAKE CARE**
> These adjustments are made silently as you type, apart from the design-temperature and refrigerant-change notifications. If a value does not stay where you put it, look at the field it is being compared with. The same applies to networks imported from old files, which are brought into line when first opened.

8.9 Fluid secondary fluids

A Fluid network has no refrigerant; it has a working fluid, its temperature and (for the mixtures) a concentration, and its circuits are sized for pressure drop. The fluid's properties at the working temperature are shown in a panel under the settings and follow the inputs as you change them.

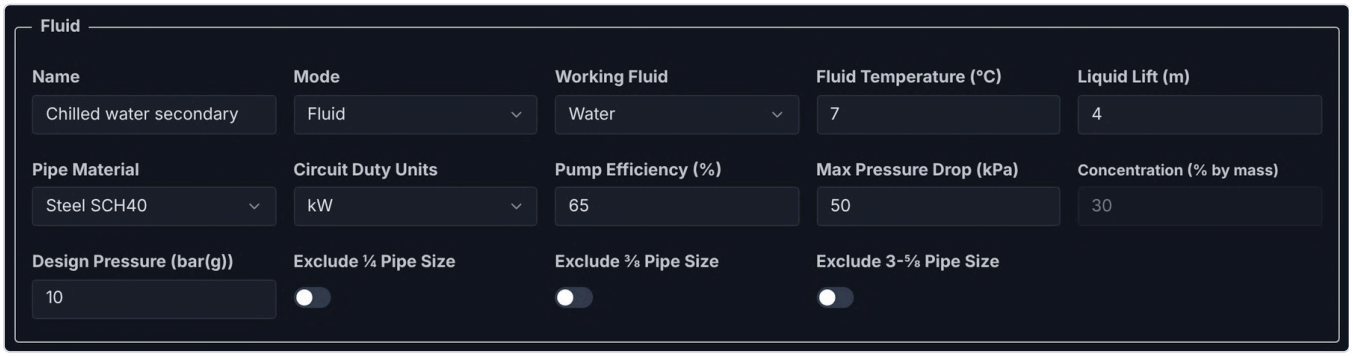


Figure 8.6 Fluid network settings for chilled water at 7 °C in schedule 40 steel.

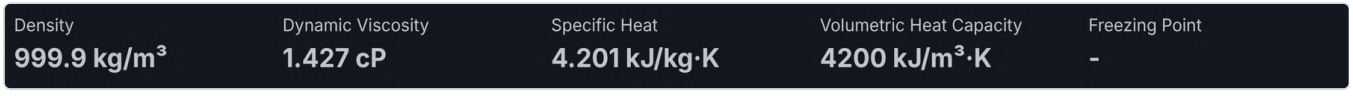


Figure 8.7 The fluid properties panel: density, dynamic viscosity, specific heat and volumetric heat capacity at the working temperature, and the freezing point for a mixture.

Field	Meaning	Default · range
Working Fluid	Water, Saturated Steam, Propylene Glycol, Ethylene Glycol, Calcium Chloride or User-Defined. The mixtures take a concentration; steam is a latent fluid and is treated differently (below); a user-defined fluid takes a property table (section 8.10).	Water
Fluid Temperature (°C)	The fluid operating temperature at which properties are taken. The lower limit is the fluid's freezing point at the entered concentration; a value below it is raised to the freezing point and a notification says so.	7 · water 0–220; steam 100–250; mixtures −45 to 30; user-defined −60 to 300
Concentration (% by mass)	The mixture strength, for the glycols and calcium chloride only (disabled otherwise). It is kept within the range the property correlations cover: propylene glycol 15–57%, ethylene glycol 14–56%, calcium chloride 9–29.4%. The freezing point in the properties panel follows it.	30 ($CaCl_2$ 15)
Liquid Lift (m)	The static height the pump must lift the fluid; added to the friction loss in the system pump head.	0 · 0 to 100, step 0.5
Pipe Material	The fluid pipe schedules (section 20.2): steel, stainless, copper and the ABS and PVCu plastics, in inch or millimetre series.	Copper EN12735
Circuit Duty Units	How terminal duties are entered: kW (with a temperature rise or drop per terminal, from which the flow is calculated), kg/s mass flow, or l/s volume flow.	kW
Pump Efficiency (%)	Used to report the pumping power from the system pump head and the flow. Disabled for steam, which is not pumped.	65 · 30 to 100
Max Pressure Drop (kPa)	The permitted friction loss along the worst path.	50 · 0.01 to 500
Design Pressure (bar(g))	The system design pressure the pipe schedules are checked against; the test and relief settings follow from it.	10 · 0 to 100, step 0.5

Saturated steam is a latent fluid: a terminal's duty is carried by condensing steam at the saturation temperature, so there is no temperature rise, the properties panel shows the latent heat and saturation pressure instead of the specific heat, and no pumping power is reported.

8.10 User-defined fluids

Choosing **User-Defined** adds a property table under the settings: rows of temperature, density, viscosity (centipoise) and specific heat. MicroPipe interpolates the properties at the working temperature, and takes the lowest tabulated temperature as the freezing point. The table starts with five rows of water properties to show the format; edit them, add rows and delete rows as for circuits. Every row must be complete or the calculation stops with *The user-defined fluid property table is empty or incomplete*. The table is saved with the network and travels with it in exports.

> **NOTE**
>
> For a user-defined fluid the properties panel is filled from the calculation, so it reads *Fluid properties are shown once the network has been calculated* until you press **Calculate**. For the built-in fluids it follows the fields as you type.

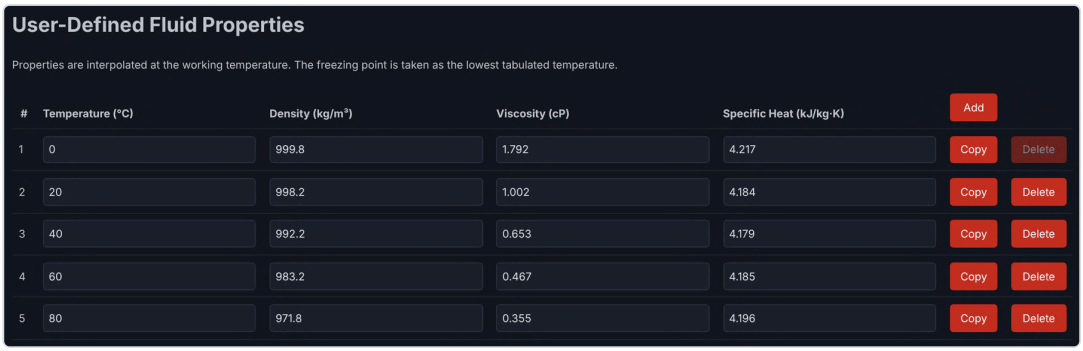


Figure 8.8 The user-defined fluid property table.

CHAPTER 9

The circuits table

Every circuit of a network is a row of the circuits table, and every property of a circuit is a column. The columns that appear depend on the mode; this chapter describes all of them, how rows are added, copied, inserted and deleted, and how to enter a large network quickly.



Figure 9.1 The circuits table of a four-circuit Dry Suction network, shown in two halves with the # and Label columns repeated: the connection, flag and size columns above, the duty, length, oil-return and fittings columns below. Greyed boxes are fields that do not apply to that row: the duty of a network circuit (which shows the duty MicroPipe has summed for it), the oil-return duty of a horizontal circuit, the small riser size of anything but a double riser.

9.1 Row operations

Control	Effect
Add (header row and below the table)	Appends one blank circuit at the end and scrolls to it. A notification confirms *Circuit n Added*.
Add 10	Appends ten blank circuits at once.
Add (on a row)	Inserts one blank circuit immediately after that row. The rows below are renumbered; because circuits are connected by label, not by row number, nothing else changes.
Copy (on a row)	Appends a copy of that row — every field, including the label — at the end of the table. Change the copy's label before calculating, since labels must be unique.

Control	Effect
Delete (on a row)	Removes that row after confirmation. Row 1 cannot be deleted; a network always has at least one circuit.
Clear	Removes every row and leaves one blank circuit, after confirmation. The network settings are kept.

Inserting, deleting and clearing discard the current results, because the results are stored by row; the next calculation rebuilds them. Adding at the end merely marks the results stale.

9.2 The columns

The `#` column is the row number, which is only a position. The remaining columns are:

Column	Meaning	Modes · range
Label	The circuit's name: up to 40 characters of letters, digits, spaces and `. _ - /`. Every circuit must have one, and no two circuits in a network may share one. When you rename a circuit, every **Next Label** that pointed at the old name is changed to the new one.	all
Next Label	The label of the circuit this one flows into, chosen from a list of the network's labels. Leave it blank ("-") on the end-of-line circuit only. A circuit not yet labelled does not appear in the list.	all
Terminal?	On: the circuit starts a flow path and carries the duty entered in **Duty** — an evaporator (or compressor, in Discharge). Off: a network circuit, whose duty is the sum of the terminals upstream. A terminal cannot also be a header, and in Dry Suction cannot be a double riser; MicroPipe switches the flag off and warns if it is.	all
Header?	On: the circuit is a header into which more than two circuits may connect (section 10.5). MicroPipe sets this itself when three or more circuits connect, and clears it when fewer do, with a warning each time.	all
Dual Circuit?	On: two parallel pipes are selected for this circuit, each sized for half the duty (section 10.6). Not allowed on a header or on a riser.	all
Orientation	Horizontal, Single Riser or Double Riser (Chapter 19). A riser is checked for oil return at its required oil-return duty; a horizontal circuit is reported but not constrained.	Dry Suction
Junction Type	How this circuit enters the next one at a tee: 90° (the branch) or 180° (the straight run). Section 10.4.	all
Fixed	On: the circuit is held at the size in **Fixed Pipe Size** instead of being selected by the optimiser. Chapter 13.	all
Fixed Pipe Size	The held size, from the material's size list. For a double riser it is the *large* riser. Switching **Fixed** on after a calculation fills it with the size the calculation chose.	all
Fixed Small Pipe Size	The held size of the *small* riser of a double riser; it must not be larger than the large one.	Dry Suction, double riser only
Duty (kW)	The refrigeration duty of a terminal: the evaporator capacity, or the compressor capacity in Discharge. Disabled on network circuits, where it shows the summed duty. In Fluid mode the heading follows **Circuit Duty Units**: **Duty (kW)**, **Mass Flow (kg/s)** or **Volume Flow (l/s)**.	all · 0.03–20 000 kW (Fluid 0.001–25 000; flows to 5000)
Pipe Length (m)	The developed length of the straight pipe in the circuit, excluding the fittings, which are counted separately.	all · 0.1–300 (Fluid 0.01–1000)
Temp. Rise/Drop (K)	The temperature change of the fluid across a terminal, from which its flow is calculated. Only enabled when duties are in kW and the fluid is not steam.	Fluid · 0.1–30, default 5

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Column	Meaning	Modes · range
Required Oil Return Duty (%)	For a riser: the lowest load, as a percentage of the duty flowing through it, at which it must still return oil. 100% means oil return is only required at full load; 35% means the riser must return oil at 35% of its load. Section 19.3.	Dry Suction, risers · 0–100, step 5, default 100
Required Oil Return Duty (kW)	The same requirement in kW. Enabled instead of the percentage when **Oil Duty kW** is on; the other is derived and shown greyed.	Dry Suction, risers
Pressure Loss Factors	The sum of the velocity-head loss coefficients (K factors) of any components in the circuit that are not in the fittings columns — a strainer, a check valve, a solenoid. The loss added is K × ½ρv² (section 18.9).	all · 0–20 (Fluid 100)
Short Radius Bends, Long Radius Bends, 45° Bends, Machine Bends	The number of each kind of bend in the circuit. Machine bends are counted with long radius bends; a 45° bend counts half a short radius bend.	0–50 (no machine bends in Fluid)
Short 90° Elbows	Mitred or short-pattern elbows in a fluid circuit.	Fluid · 0–50
P Traps, U Bends	Oil traps at the foot of risers and inverted traps at the top. A P trap counts three short radius bends, a U bend two.	refrigerant modes · 0–10
Ball Valves, Globe Valves	Full-bore ball valves and (straight) globe valves. Disabled on a double riser, which has no valves in the riser legs.	0–20 (Fluid 50)
90° Globe Valves, Gate Valves, Butterfly Valves	Further valve types for fluid circuits.	Fluid · 0–50
Other Losses (kPa)	A known pressure loss in a fluid circuit, entered directly: a control valve, a heat exchanger, a strainer with a published loss.	Fluid · 0–500

> **NOTE**
> A terminal's duty must be at least 0.03 kW (0.001 in Fluid mode); a row with a smaller duty stops the calculation with a message naming it. A blank duty on a terminal is reported the same way, and a blank label is caught before the calculation is sent: the first blank label box is brought into view with a message.

9.3 Which columns apply in each mode

Column	Dry Suction	Liquid	Discharge	Wet Suction	Pumped Liquid	Fluid
Label, Next Label, Terminal?, Header?, Dual Circuit?, Junction Type, Fixed, Fixed Pipe Size, Duty, Pipe Length, Pressure Loss Factors, Short/Long Radius Bends, 45° Bends, Ball Valves, Globe Valves	✔	✔	✔	✔	✔	✔
Orientation, Fixed Small Pipe Size, Required Oil Return Duty (% and kW)	✔	–	–	–	–	–
Machine Bends, P Traps, U Bends	✔	✔	✔	✔	✔	–
Temp. Rise/Drop, Short 90° Elbows, 90° Globe Valves, Gate Valves, Butterfly Valves, Other Losses	–	–	–	–	–	✔

9.4 Oil-return duty in per cent or kW

With **Oil Duty kW** off (the default), each riser's requirement is a percentage of the duty flowing through it and the kW box shows the equivalent, worked out from the terminal duties upstream as soon as they are known. With the switch on, you enter the requirement in kW — useful when you know the minimum load in absolute terms, say one cold room of a group — and the percentage is derived. A kW value larger than the riser's total duty is an error; a kW value entered before the upstream duties exist is stored and converted when they do, and a warning says so.

9.5 Entering a network quickly

- Press **Add 10** as many times as you need rows, then fill the table down each column rather than across each row: all the labels, then all the next labels, then the terminal switches, then the duties. `Tab` moves along a row; typing

the first characters of an option selects it in a list box.

- Set the terminals first. A terminal's duty box is enabled the moment its switch goes on, and the summed duties of the network circuits fill in as you connect them, which is a quick check that the labels are right.
- Label the circuits as they are numbered on your drawing, and enter the rows in that order, so that the results table reads like the drawing.
- Use **Copy** for runs of similar circuits — a row of identical cabinets with the same tail length and fittings — and change only the label and the next label on the copies.
- The spinner arrows step by the field's step (1 for bends and lengths, 5 for the oil-return percentage, 0.1 for the penalty); typing is usually faster.
- Every change is saved as you make it; there is nothing to save before you calculate.

> **TIP**
> Appendix A is a blank data sheet with the same columns as the circuits table, for noting a system down on site before entering it.

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CHAPTER 10

Describing the pipe network

This chapter is about getting the description of the pipework right: which circuits are terminals, how the next labels build the flow paths, how tees, headers, dual pipes and risers are expressed, and the checks MicroPipe makes before it will size anything.

10.1 Break the system into circuits

A circuit is a length of pipe that carries one flow rate. Start a new circuit wherever the flow changes — at every tee, where a branch joins the main — and wherever you need a separate result: a riser (which must be its own circuit so that it can be checked for oil return), a section in a different material or a section whose size you want to see on its own. A straight run that passes several closed-off future connections is one circuit.

Number or name the circuits on the drawing first. The labels can be anything within the character rules; the examples in this manual use the drawing numbers for suction networks and short codes (E1, L1, C1, H, M) for the others.

10.2 Terminals and the end of the line

Every flow path starts at a terminal and ends at the one end-of-line circuit:

Mode	A terminal is	The end of the line is
Dry Suction, Wet Suction	An evaporator (its suction outlet)	The last circuit before the compressors or the low-pressure receiver
Liquid, Pumped Liquid	An evaporator (its liquid inlet)	The circuit at the receiver or pump
Discharge	A compressor (its discharge connection)	The circuit at the condenser inlet
Fluid	A fan coil, cooler or other load	The circuit at the pump or plant

In the liquid and pumped-liquid modes the refrigerant flows the opposite way to the suction modes, but the description is the same: the terminal is the evaporator and the flow paths are followed towards the common end. The duty of each terminal is its evaporator (or compressor) capacity; MicroPipe sums the duties through the network and uses the mode's thermodynamics to turn each duty into a mass flow.

10.3 Tees

A tee is simply a circuit that two others name as their next label. MicroPipe counts the incoming connections of every circuit; two is a tee and needs nothing from you. The entering circuits' **Junction Type** says how each one joins, and the junction loss is charged to the entering circuit.

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10.4 Junction types: 90° and 180°

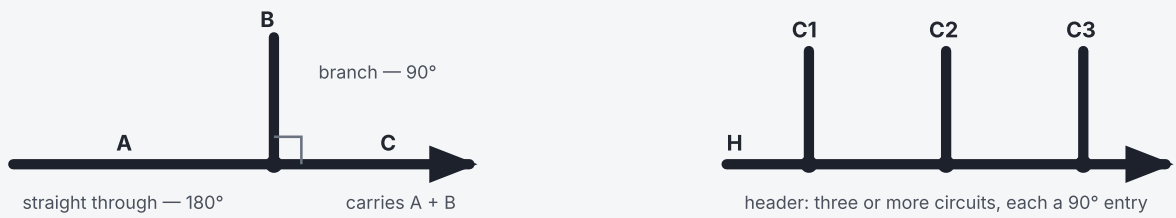


Figure 10.1 Left: a tee. Circuit A continues straight through into C (180°); circuit B enters from the side (90°). Right: a header H, into which three compressor discharges connect, every connection taken as 90°.

At a tee, one of the two entering circuits is normally the straight run and the other the branch. Set the straight run to **180°** and the branch to **90°**; where the tee is a true side entry for both (a run that turns at the tee), set both to 90°. A tee cannot have two 180° entries, and MicroPipe says so. The junction type of a circuit that does not enter a tee — one that simply continues into a single next circuit — has no effect, and the end-of-line circuit has none.

> ENGINEERING NOTE
>
> Where a circuit enters a tee or header, the junction loss is charged as a multiple of its velocity pressure: 0.2 velocity heads for a straight-through (180°) entry, and 0.5 velocity heads plus one short-radius bend for a branch (90°) entry. In addition, wherever the next circuit is a different size — tee or not — the loss of the enlargement or reduction at the connection is charged, worked out from the ratio of the two bores at the velocity pressure of the smaller pipe. Both appear in the **Fittings kPa** column of the entering circuit. (A single riser feeding a double riser directly, the special case of section 19.5, is charged as a 90° entry.)

10.5 Headers

A tee can only have three connections, so only two circuits may name the same next circuit — unless that circuit is a **header**. Switch **Header?** on for a circuit that several circuits connect into: a compressor suction or discharge header, a liquid header feeding a run of coils, a manifold. MicroPipe applies the rule for you: when it finds three or more circuits connecting into one that is not marked as a header it marks it (and warns you), and when a marked header has fewer than three it unmarks it. A header cannot be a terminal or a dual circuit, and in Dry Suction it must be horizontal; if either rule blocks the automatic change you are told why. Every connection into a header is taken as a 90° entry and the entering circuits' junction types are set accordingly.

10.6 Dual circuits

Dual Circuit? instructs MicroPipe to select two pipes in parallel instead of one, each sized for half the circuit's duty, and reports them in the results as a *Dual Network* or *Dual Terminal* with the size of one pipe. This is useful where the largest available size is not large enough for the duty, or where the maximum working pressure of the single larger pipe would be lower than the design pressure requires. A dual circuit is counted twice in the pipe lengths, volume and charge. It cannot be a header or a riser.

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10.7 Suction risers in the table

In a Dry Suction network, every circuit that rises — or even slopes upward in the direction of flow — should have its `Orientation` set to **Single Riser** or **Double Riser**, with a `Required Oil Return Duty`. Chapter 19 explains how to choose between them; here are the rules that apply to the table:

- A **double riser** is one circuit of the table: MicroPipe selects both legs and reports them as *large + small*. It needs a next label (it cannot be the end of the line), it must be fed by exactly one circuit and must discharge into a circuit that nothing else joins — so a double riser cannot sit directly at a tee or header on either side; put a short horizontal circuit between.
- Two risers cannot follow each other directly. Between a riser and a double riser, and between two double risers, insert a normal circuit (the horizontal run between them, however short). The one exception is the *special case* of section 19.5: a **terminal** that is a single riser may discharge straight into a double riser, and MicroPipe adds the extra loss of that arrangement automatically.
- A double riser cannot be a terminal or a dual circuit, and its valve columns are disabled: put the valves in the circuits before and after it.
- The two risers of a double riser are sized together; if you fix sizes, both legs must be given and the small one must not be larger than the large one.

10.8 Series systems (the old Index mode)

The Windows MicroPipe had an Index mode for a single flow path of circuits in series. The online MicroPipe has no separate mode: a series system is simply a chain — one terminal whose next label is the second circuit, whose next label is the third, and so on to the end of the line, as in the single-circuit example of Chapter 23. Several evaporators on one line are a terminal for the first and further terminals connecting into the chain at their tees.

10.9 Limits

There is no fixed limit on the number of circuits in a network; networks of several hundred circuits are routine, and the browser's storage is the practical bound (section 4.5). A single flow path — from one terminal to the end of the line — may pass through at most 100 circuits.

10.10 What MicroPipe checks before sizing

When you press `Calculate`, the description is checked before any pipe is sized, and the first fault found stops the calculation with an error naming the circuit (Chapter 22 lists every message). The checks are, in order:

1. Every label is present and unique (*Invalid circuit label*, *Duplicate label* …).
2. Every next label names an existing circuit that is not a terminal (*Broken link while following load …*, *Invalid next label: … points to terminal/load …*).
3. There is at least one terminal (*No loads found*) and every terminal has a duty above the minimum.
4. There is exactly one end-of-line circuit (*No end-of-line circuit found*, *Multiple end-of-line circuits found (3, 4)*).
5. No path loops back on itself (*Cycle detected following load …*) or exceeds 100 circuits.
6. Every network circuit carries some duty (*… has zero calculated duty; check for a broken flow path or missing terminal duty*).
7. The header, tee, dual-circuit and riser rules above.

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10.11 A checklist before you calculate

- Every evaporator (or compressor) is a terminal with its duty entered.
- Every next label points downstream, and exactly one circuit has none.
- Circuits that join at a tee have one 180° and one 90° entry (or two 90°), and manifolds are headers.
- Every circuit that rises is a single or double riser with a realistic required oil-return duty, and no two risers touch.
- Lengths are developed lengths; bends, traps and valves are counted, not included in the length.
- The network settings — refrigerant, temperatures, penalty, material, design standard — are the ones on the job sheet.

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CHAPTER 11

Calculating

One button does everything the Windows version's validate and run buttons did: **Calculate** checks the description, sends the network to the server, sizes every pipe, and shows the results or tells you what stopped it.

11.1 What happens when you press Calculate

1. MicroPipe first checks that every circuit has a label. If one is blank, the box is brought into view with a message and nothing is sent.
2. Any unsaved changes are pushed to the server, and the network — its settings, circuits and any fluid table — is sent to the calculation service. The overlay *Calculating on the server* appears, with **Cancel**.
3. The server checks the description (section 10.10). A fault stops the calculation and comes back as an error.
4. It then sizes the network: for each flow path it chooses sizes that bring the path's loss as close as possible to the permitted penalty without exceeding it, checks every riser for oil return, checks every pipe against the design pressure, and optimises the shared sections so that the whole network is consistent. Where the standard pass of a dry-suction network cannot find a solution, a second pass tries again with wider tolerances before reporting an error.
5. The results come back and are shown under the buttons; the page scrolls to them (or to the messages if there are warnings). **Fix All**, **Unfix All**, **Print** and **Export CSV** are enabled.

Most networks calculate in a fraction of a second. A large dry-suction network with many risers can take longer because the riser selection is iterative; the overlay stays up until it finishes, and **Cancel** abandons it, keeping whatever results were on screen before.

11.2 Automatic corrections

Some settings are corrected by the calculation rather than refused, because the right answer follows from the rest of the network. Each correction is written into the circuits table and reported as a warning with a **Show field** link that scrolls to the field and highlights it:

- A circuit that three or more circuits connect into is set as a header; a header that fewer connect into is unset.
- A circuit entering a header is set to a 90° junction.
- A terminal that is also a header, or a double riser, has its **Terminal?** switch cleared (it cannot be both), and its duty box is disabled.
- A dual circuit that is a header or a riser has its **Dual Circuit?** switch cleared.

Read these warnings: a terminal being unset means its duty has been dropped from the network, which is rarely what you intended. Usually the orientation or the header flag was set on the wrong row.

11.3 Errors and warnings

Messages appear in two panels. The grey **error** panel means the calculation did not complete: nothing is sized and there are no results until the problem is fixed. The amber **warning** panel reports something you should know about a calculation that did complete, or a correction that was made. Each message that concerns one circuit is prefixed with the circuit's label; where it concerns a field, **Show field** takes you to it.

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Figure 11.1 An error: two circuits have blank next labels.



Figure 11.2 An error: the permitted penalty cannot be met.

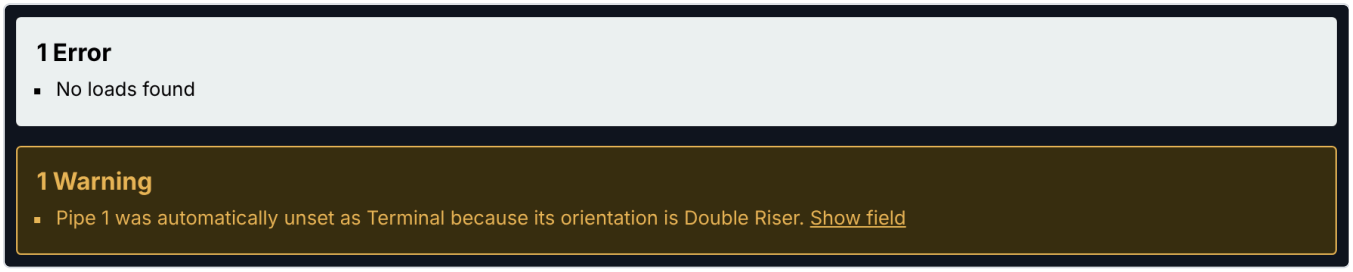


Figure 11.3 A warning and the error it led to: circuit 1 was made a double riser, so its Terminal flag was cleared — and the network then had no terminal at all.

Chapter 22 lists the messages and what to do about each. The commonest are a next label pointing at the wrong circuit, more than one blank next label, and a penalty or pressure drop that the network cannot meet with the sizes available.



Figure 11.4 A network opened from the server, or imported, is calculated automatically. When that automatic calculation cannot run — typically because the network is unfinished — the heading says so instead of counting errors at you.

11.4 Stale results

The results describe the inputs they were calculated from. The moment you change a setting, a circuit, or add, insert or delete a row, the results and messages disappear and **Print** and **Export CSV** are disabled until you calculate again. Fixing or unfixing a size does the same, except that **Fix All** stays available so that you can hold sizes one after another. There is no way to see out-of-date figures beside changed inputs, which is deliberate.

11.5 When a calculation cannot be made

If the calculation is refused or fails to arrive — the connection drops, you cancel, the server is busy with your previous calculation, the licence has lapsed, or the server is being maintained — nothing on the screen changes: the previous results stay, and a notice that stays until dismissed explains what happened. The cases:

Notice	Meaning
The server calculation was cancelled.	You pressed **Cancel**.
The server could not be reached. Please check your connection and try again.	No connection. The offline banner appears and **Calculate** is disabled until the connection returns.
Your previous calculation is still running. Please wait a moment.	One calculation runs at a time per licence; a second tab asked while the first was busy.

Notice	Meaning
Micropipe has been updated and needs to refresh before calculating. Your work has been saved.	A new version changed the way the browser and server talk. The page saves your work and reloads itself.
A newer version of Micropipe is available. Reload the page when convenient.	A new version is available but this one still works; the calculation was made. Reload when you reach a convenient point.
This licence expired on … / is suspended / renewal payment has not gone through	The licence is read-only (section 2.7).
Micropipe is briefly unavailable while we make a scheduled change…	Maintenance. Try again shortly.

11.6 Calculating on opening

A network restored from the server, or imported, is calculated automatically the first time it is opened, so that the figures shown were computed against the current reference data. If you see results appear on a network you have not touched, that is why. On a read-only licence, which cannot calculate, the results last computed on this device are kept and shown instead.

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CHAPTER 12

Reading the results

A calculation produces five things: the results table with a row per circuit, the totals, the worst flow path, the path totals and the pipe summary. This chapter explains every column and every total, and what to look for in them.

12.1 The results table

Label	Type	Next	Duty kW	Orientation	Size(s)	Fixed	Length m	Bends	Valves	Oil Return %
1	Terminal	9	1.50	Horizontal	7/8	✘	2.00	2	1	90.4
2	Terminal	9	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9
3	Terminal	11	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9
4	Terminal	13	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9
5	Terminal	12	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9
6	Terminal	12	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9
7	Terminal	14	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9
8	Terminal	10	1.50	Horizontal	7/8	✘	2.00	2	1	90.4
9	Network	10	4.00	Horizontal	1-5/8	✘	3.00	0	0	180.2
10	Network	11	5.50	Horizontal	1-5/8	✘	0.50	0	0	131.0

Label	Velocity m/s	Penalty K	Penalty kPa	Pipe kPa	Fittings kPa	Valves kPa	Flowpath K	Flowpath kPa	Gauge(s)	MWP bar(g)	Pressure Pass
1	6.96	0.12	0.84	0.34	0.41	0.09	1.49	10.52	18	42.59	✔
2	6.69	0.07	0.46	0.11	0.27	0.09	1.44	10.14	18	32.75	✔
3	6.69	0.07	0.51	0.11	0.31	0.09	1.38	9.77	18	32.75	✔
4	6.69	0.07	0.46	0.11	0.27	0.09	1.45	10.22	18	32.75	✔
5	6.69	0.07	0.46	0.11	0.27	0.09	1.49	10.53	18	32.75	✔
6	6.69	0.07	0.46	0.11	0.27	0.09	1.49	10.53	18	32.75	✔
7	6.69	0.07	0.51	0.11	0.31	0.09	1.40	9.87	18	32.75	✔
8	6.96	0.12	0.84	0.34	0.41	0.09	1.46	10.32	18	42.59	✔
9	4.88	0.03	0.20	0.12	0.08	0.00	-	-	18	22.39	✔
10	6.71	0.03	0.22	0.04	0.18	0.00	-	-	18	22.39	✔

Figure 12.1 The first ten rows of the results table of the 28-circuit supermarket example of Chapter 24 (Dry Suction), shown in two halves so that the columns can be read: the left-hand columns above, the right-hand columns below, with the Label column repeated. Figure 24.3 shows rows 15 to 28 of the same table.

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Column	Meaning
Label, Type, Next	The circuit's label, its kind — Terminal, Network, Header, Dual Terminal or Dual Network — and the circuit it flows into.
Temp Rise K (Fluid)	The temperature rise or drop across a terminal, when duties are in kW.
Duty kW	The duty flowing through the circuit: the entered duty of a terminal, the summed duty of a network circuit. In Fluid mode with flow units the column is the mass or volume flow.
Orientation (Dry Suction)	Horizontal, Single Riser or Double Riser.
Mass Flow kg/s (Fluid)	The fluid mass flow in the circuit.
Size(s)	The nominal size selected: an inch size for the copper, aluminium and steel series, a millimetre size for the metric fluid schedules. A double riser shows *large + small*; a dual circuit shows the size of each of its two pipes.
Fixed	✔ if the size was held by you, ✘ if MicroPipe selected it, – where the circuit has no size of its own.
Length m, Bends, Valves	The straight length, the number of bends (all types, including traps and U bends) and the number of valves (all types).
Oil Return % (Dry Suction)	The lowest load, as a percentage of the duty through the circuit, at which the selected pipe will still carry oil up a vertical riser, taken at the worse of the maximum and minimum liquid temperatures. For a riser, this must be at or below the required oil-return duty you entered, and the optimiser makes sure it is. For a horizontal circuit the figure is for information: a value over 100% means the pipe would *not* return oil if it were a riser, which is a reminder that any circuit which rises must be entered as a riser and that horizontals need a fall and traps (Chapter 19).
Velocity m/s	The refrigerant (or fluid) velocity in the selected size, at full duty.
Penalty K	The circuit's pressure drop expressed as the corresponding drop in saturation temperature. Not shown in the modes that are sized on pressure drop (Pumped Liquid, Fluid, and Liquid or Discharge with R744 TC).
Penalty kPa	The circuit's total pressure drop: pipe, fittings, valves and any junction allowance.
Pipe kPa, Fittings kPa, Valves kPa	How that total is made up: straight-pipe friction; bends, traps, pressure-loss factors and the loss at the connection into the next circuit (the tee or header entry, and any change of size — section 10.4); valves.
Flowpath K, Flowpath kPa	On a terminal's row, the total penalty and pressure drop of its flow path to the end of the line. A dash on network circuits.
Gauge(s)	The copper gauge (wall thickness number) selected for the size: the thinnest gauge whose maximum working pressure meets the design pressure. For steel and plastic series there is no gauge.
MWP bar(g)	The maximum working pressure of the selected size and gauge, calculated by the MWP standard chosen. Steel sizes list it for each manufacturing type available at that size — seamless, CW and ERW — because the allowable stress differs.
Pressure Pass	✔ where the maximum working pressure is at least the design pressure, ✘ where it is not. For steel, one mark per manufacturing type.

WHAT TO LOOK AT FIRST

- **The worst flow path and its total penalty** against your permitted penalty: the optimiser aims to use the budget, so a total well below it usually means a size step prevented a closer fit, and one at the limit means there is no slack for a longer run on site.
- **Oil Return %** on every riser, and on every horizontal that might in reality rise.
- **Velocity** in the large sections (noise, erosion in liquid lines) and in the risers (oil return at part load).
- **Pressure Pass** on every row, and the gauge or schedule it implies.

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12.2 The totals

The totals tiles summarise the network. Which tiles appear depends on the mode:

Tile	Meaning	Modes
Total Duty (kW)	The sum of the terminal duties (in Fluid mode with flow units, *Total Flow*).	all
Total Penalty (kPa), Total Penalty (K)	The pressure drop and the saturation-temperature penalty of the worst flow path.	all (K not in pressure-drop modes)
SST (°C)	Saturated suction temperature at the compressors: the evaporating temperature less the worst-path penalty.	Dry Suction
Saturated Temperature (°C)	The same, for the wet-suction return.	Wet Suction
Evaporating Pressure, Suction Pressure (bar(a))	Saturation pressure at the evaporating temperature, and at the compressors after the penalty.	suction modes
Condensing Pressure (bar(a))	Saturation pressure at the condensing temperature (for R744 TC, the gas-cooler pressure).	Liquid, Discharge
Compression Ratio	Condensing pressure over evaporating pressure, absolute.	Liquid, Discharge
Discharge Temperature (°C)	The compressor discharge temperature from the suction condition and the isentropic efficiency.	Discharge
Head Penalty (K)	The saturation-temperature equivalent of the static head of the liquid line rise.	Liquid
Additional Subcooling Required (K)	The sub-cooling needed, beyond that implied by the liquid temperature, to keep the liquid from flashing after the friction and head losses. Zero when the available sub-cooling covers them.	Liquid
System Pump Head (bar or kPa)	The friction loss of the worst path plus the static lift.	Pumped Liquid, Fluid
Fluid Pressure (bar(a))	The saturation pressure of the fluid at its temperature (relevant to steam).	Fluid
Suction Density, Liquid Density, Vapour Density, {mode} Density (kg/m³)	The density used for the velocities, at the relevant condition.	by mode
Mass Flow Rate (kg/s, kg/hr), Volumetric Flow Rate (m³/s, m³/hr, lpm)	The total flow at the end of the line. Wet Suction separates the vapour and liquid mass and volume flows.	by mode
Pipe-System Volume (litres), Pipe-System Contents (kg)	The internal volume of all the pipes and the mass of refrigerant (or fluid) in them at the operating density. Dual circuits count twice; the condenser drain is included unless excluded.	all
Design Pressure (bar(g))	The design pressure the pipes were checked against (section 7.2).	all
Leak Test Pressure, Pressure Test, High Pressure Cut-out, Relief Valve Setting, Relief Valve Rated Discharge (bar(g))	The settings that follow from the design pressure under the chosen standard: leak test at the design pressure; strength (pressure) test at 1.3 times it; high-pressure cut-out at 0.9 times it (shown as N/A on the low side); relief valve set at the design pressure, rated discharge at 1.1 times it.	all

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Figure 12.2 Totals of a Dry Suction network (the supermarket example of Chapter 24).



Figure 12.3 Totals of a Liquid network, with the head penalty and additional sub-cooling.

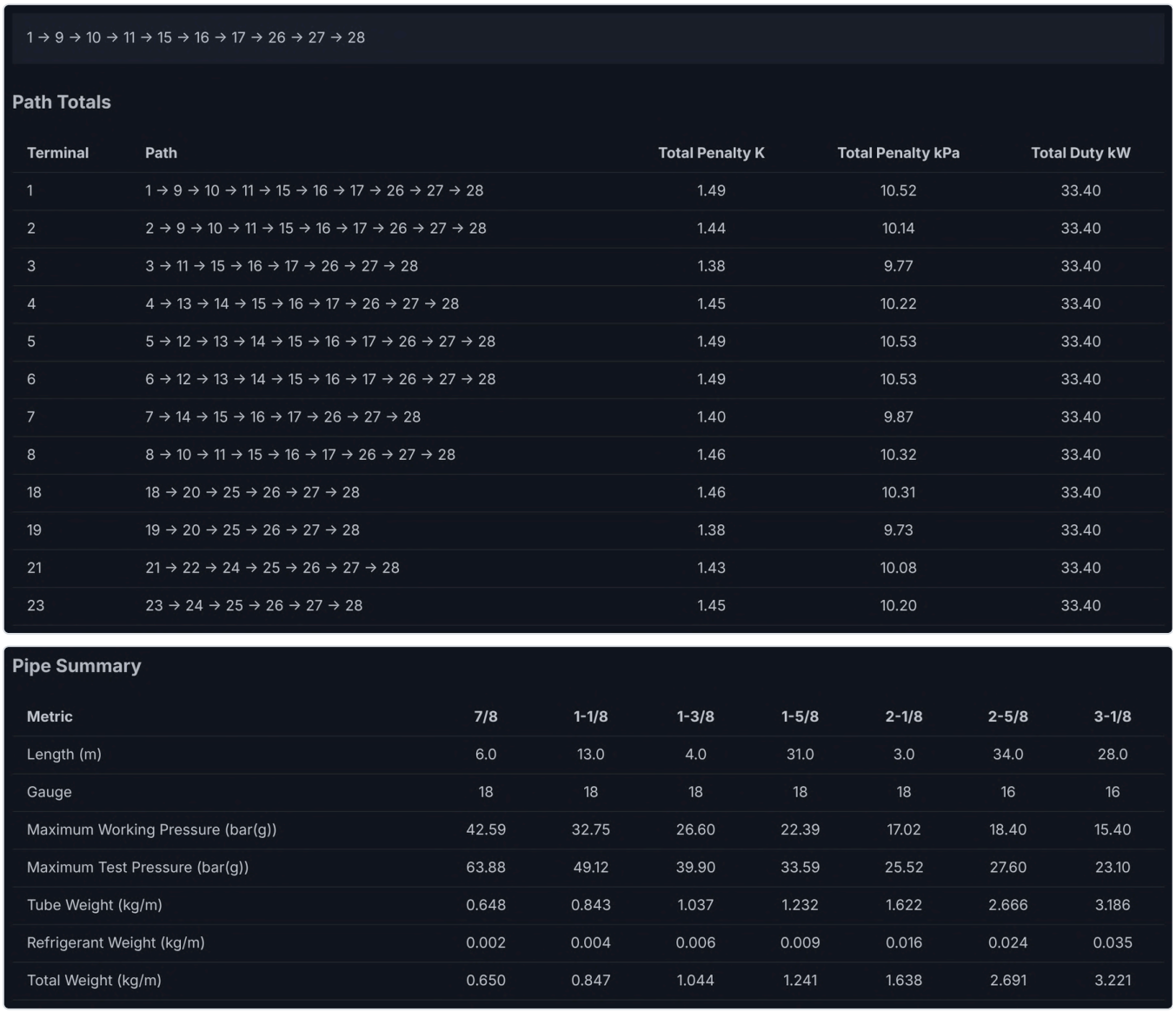
12.3 Design pressure, test pressures and safety settings

> **ENGINEERING NOTE**
>
> The design pressure is the gauge saturation pressure of the refrigerant at the **Design Temperature** : for a suction or discharge network the dew-point pressure; for a liquid or pumped-liquid network, and for the condenser drain, the bubble-point pressure (the two differ only for zeotropic blends). From it follow the leak-test pressure (equal to it), the strength-test pressure (1.3 ×), the high-pressure cut-out (0.9 ×, high side only), the relief valve set pressure (equal to it) and the relief valve's rated discharge pressure (1.1 ×), as BS EN 378 and ASME B31.5 provide. For R744 TC and for Fluid networks the design pressure is entered directly. These are the figures for the pipework MicroPipe has sized; vessels and components may have their own.

12.4 The worst flow path and the path totals

Under the totals, a single line names the flow path with the highest penalty — *1 → 9 → 10 → 11 → 15 → 16 → 17 → 26 → 27 → 28* — which is the path the network was sized to. The **Path Totals** table then lists every terminal with its path to the end of the line, the path's total penalty in K and kPa, and the total duty of the network. It is the online equivalent of the flow-path trace: read a path from left to right to follow the refrigerant from an evaporator to the compressors, and compare the penalties to see which evaporators are near the limit and which have slack.

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1 → 9 → 10 → 11 → 15 → 16 → 17 → 26 → 27 → 28

Path Totals

Terminal	Path	Total Penalty K	Total Penalty kPa	Total Duty kW
1	1 → 9 → 10 → 11 → 15 → 16 → 17 → 26 → 27 → 28	1.49	10.52	33.40
2	2 → 9 → 10 → 11 → 15 → 16 → 17 → 26 → 27 → 28	1.44	10.14	33.40
3	3 → 11 → 15 → 16 → 17 → 26 → 27 → 28	1.38	9.77	33.40
4	4 → 13 → 14 → 15 → 16 → 17 → 26 → 27 → 28	1.45	10.22	33.40
5	5 → 12 → 13 → 14 → 15 → 16 → 17 → 26 → 27 → 28	1.49	10.53	33.40
6	6 → 12 → 13 → 14 → 15 → 16 → 17 → 26 → 27 → 28	1.49	10.53	33.40
7	7 → 14 → 15 → 16 → 17 → 26 → 27 → 28	1.40	9.87	33.40
8	8 → 10 → 11 → 15 → 16 → 17 → 26 → 27 → 28	1.46	10.32	33.40
18	18 → 20 → 25 → 26 → 27 → 28	1.46	10.31	33.40
19	19 → 20 → 25 → 26 → 27 → 28	1.38	9.73	33.40
21	21 → 22 → 24 → 25 → 26 → 27 → 28	1.43	10.08	33.40
23	23 → 24 → 25 → 26 → 27 → 28	1.45	10.20	33.40

Pipe Summary

Metric	7/8	1-1/8	1-3/8	1-5/8	2-1/8	2-5/8	3-1/8
Length (m)	6.0	13.0	4.0	31.0	3.0	34.0	28.0
Gauge	18	18	18	18	18	16	16
Maximum Working Pressure (bar(g))	42.59	32.75	26.60	22.39	17.02	18.40	15.40
Maximum Test Pressure (bar(g))	63.88	49.12	39.90	33.59	25.52	27.60	23.10
Tube Weight (kg/m)	0.648	0.843	1.037	1.232	1.622	2.666	3.186
Refrigerant Weight (kg/m)	0.002	0.004	0.006	0.009	0.016	0.024	0.035
Total Weight (kg/m)	0.650	0.847	1.044	1.241	1.638	2.691	3.221

Figure 12.4 The worst flow path, the path totals and the pipe summary of the supermarket example.

12.5 The pipe summary

The pipe summary has a column for every size used in the network, and rows for:

- **Length (m)** — the total straight length in that size (dual circuits twice; both legs of a double riser; discharge networks show the discharge and drain lengths separately).
- **Gauge** — the copper gauge selected for that size (copper and aluminium series).
- **Maximum Working Pressure (bar(g))** and **Maximum Test Pressure (bar(g))** — of the size and gauge selected; for steel, one row per manufacturing type (Seamless, CW, ERW).
- **Tube Weight, Refrigerant (or Fluid) Weight and Total Weight (kg/m)** — the weight per metre of the empty pipe, of its contents at the operating density, and the two together, for pipe-support design.

This is the schedule to take to the estimator: sizes, lengths, gauges and weights in one table.

12.6 The condenser liquid drain group

In a Discharge network with the condenser drain on, a **Condenser Liquid Drain Details** group under the totals reports the drain duty and whether it was the network total or an override, the main and branch sizes, velocities and lengths,

the number of branches, the pressure pass of each, the liquid density, the drain volume and whether the drain is included in the totals. The drain is sized for a velocity of about 0.55 m/s, the usual target for a gravity drain running full.

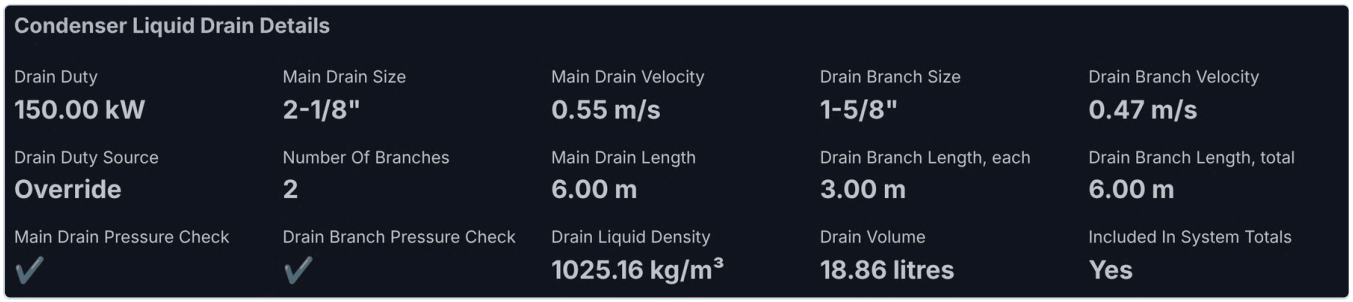


Figure 12.5 The *Condenser Liquid Drain Details* group.

12.7 Fluid networks: pumping power

A Fluid network reports the pumping power under the worst path — the hydraulic power from the system pump head and the flow, divided by the pump efficiency entered — except for steam, which is not pumped.

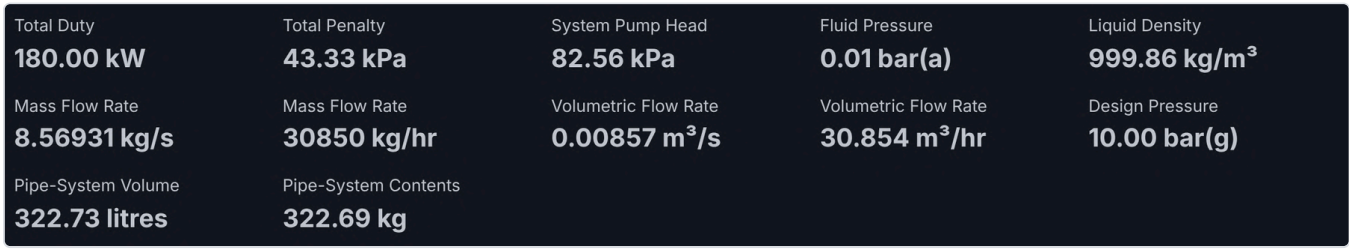


Figure 12.6 Totals of a Fluid network.



Figure 12.7 The pumping power line, shown under the worst path.

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CHAPTER 13

Fixing pipe sizes

MicroPipe selects every size itself, but you can hold any circuit at a size of your choosing — to match an existing pipe, to standardise a run, to try a larger riser, or to lock a design you are happy with while you change something else. Held sizes are called *fixed*.

13.1 Fixing one circuit

Each row has a **Fixed** switch and a **Fixed Pipe Size** list (and, for a double riser, a **Fixed Small Pipe Size** list). There are two ways to fix a circuit:

- **After a calculation, switch Fixed on.** The size list is filled with the size the calculation chose (both sizes for a double riser). Change it if you want another size.
- **Choose a size in the list.** The switch goes on by itself once the size (or, for a double riser, both sizes) is complete.

Switching **Fixed** off clears the sizes; switching it on before the network has been calculated, with no size chosen, does nothing — the switch drops back off. For a double riser the small riser must not be larger than the large one: choosing a pair the wrong way round clears the one you just changed, and blanking either leg clears both. The size lists offer only the sizes the material has and that no **Exclude … Pipe Size** switch removes; a held size that is no longer offered — after a change of material or of an Exclude switch, or in an imported network — is cleared silently when the network is redrawn: the switch goes off and the list shows "-". (The condenser drain's fixed sizes are the exception: a notification says they were cleared.)

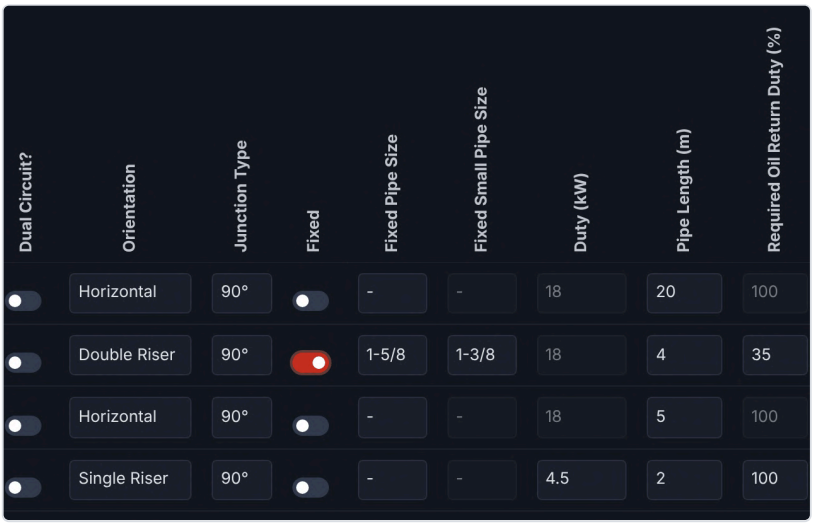


Figure 13.1 Circuit 16, a double riser, fixed at 1⅝″ + 1⅜″ — the sizes the calculation chose, filled in when the switch was turned on.

13.2 Fix All and Unfix All

Fix All fills every row that is not already fixed with the size the last calculation chose (a row already holding a size keeps it). It needs current results, so it is disabled until the network has been calculated and again as soon as an input other than a size changes. **Unfix All** releases every circuit. Both mark the results stale; calculate again to see the effect. **Unfix All** stays available after a failed calculation and while the results are stale, because a network that will not calculate because of a held size needs a way to release it. Both buttons are taken away only when the server cannot be reached or the licence is read-only; the **Fixed** switch on each row still works then.

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Dual Circuit?	Orientation	Junction Type	Fixed	Fixed Pipe Size	Fixed Small Pipe Size	Duty (kW)	Pipe Length (m)	Required Oil Return Duty (%)
	Horizontal	90°		2-1/8	-	10	1.5	100
	Horizontal	90°		2-5/8	-	18	20	100
	Double Riser	90°		1-5/8	1-3/8	18	4	35
	Horizontal	90°		2-5/8	-	18	5	100
	Single Riser	90°		1-1/8	-	4.5	2	100
	Single Riser	90°		1-1/8	-	4.5	1	100

Figure 13.2 After Fix All: every row is held at the size the calculation selected.

13.3 What a fixed size does to the calculation

A fixed circuit is not sized: its pressure drop, velocity, oil return and pressure pass are calculated at the size you gave, and the optimiser distributes the remaining penalty over the circuits that are free. In the results table the **Fixed** column shows ✔ on held rows and ✘ on free rows (a column of ✘ is normal, not a fault), and "-" on a row that has no size of its own.

Label	Type	Next	Duty kW	Orientation	Size(s)	Fixed	Length m	Bends	Valves	Oil Return %
1	Terminal	9	1.50	Horizontal	7/8	✔	2.00	2	1	90.4
2	Terminal	9	2.50	Horizontal	1-1/8	✔	1.00	1	1	107.9
3	Terminal	11	2.50	Horizontal	1-1/8	✔	1.00	1	1	107.9
4	Terminal	13	2.50	Horizontal	1-1/8	✔	1.00	1	1	107.9
5	Terminal	12	2.50	Horizontal	1-1/8	✔	1.00	1	1	107.9
6	Terminal	12	2.50	Horizontal	1-1/8	✔	1.00	1	1	107.9
7	Terminal	14	2.50	Horizontal	1-1/8	✔	1.00	1	1	107.9
8	Terminal	10	1.50	Horizontal	7/8	✔	2.00	2	1	90.4

Figure 13.3 The results table after Fix All and a recalculation (first eight rows, left-hand columns): every row is marked fixed and the figures are unchanged, because the sizes are the ones MicroPipe had chosen.

Consequences to be aware of:

- If the fixed sizes alone use more than the permitted penalty, the calculation stops with *Calculated total penalty (… K) exceeds the user input max penalty (… K). Please relax Max Penalty and/or Required Oil Duty* (in the pressure-drop modes, *Calculated total pressure drop … exceeds the user input Max Pressure Drop*). Relax the limit, or release a size.
- A fixed riser that cannot return oil at its required duty stops the calculation with *One or more rows cannot satisfy the user input Required Oil Duty (%). Responsible row labels: …*; it is not silently accepted.
- A fixed size that fails the design pressure is accepted but shown with ✘ in **Pressure Pass**.

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- A fixed size the network cannot use at all never reaches the calculation: the size lists only offer what the material has (section 13.1).

13.4 Using fixing to refine a design

> **FROM THE WINDOWS MANUAL**
> Branch networks can be further optimised by fixing the sizes of the complete system and then unfixing the lower pressure-loss branch networks. This will force further optimisation of the unfixed branch networks. Do not unfix the common circuits.

In practice:

1. Calculate, and note the worst path and its penalty.
2. **Fix All**, so the common sections (the trunk the worst path runs along) are held.
3. Switch **Fixed** off on the circuits of a branch whose path total is well below the limit, and calculate again. If a size in the branch can come down while the branch stays within the limit, it does.
4. Repeat for other branches; keep the common sections fixed throughout.

The online optimiser already ends every calculation with a pass that tries to reduce each free circuit, so this procedure now usually confirms the sizes rather than changing them; it remains the way to explore a branch deliberately, and it costs only a calculation.

Fixing is also how you check a size you already have — the *manual calculation* of the Windows version: fix the circuit at the size on site and read its penalty, velocity and oil return in the results table.

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CHAPTER 14

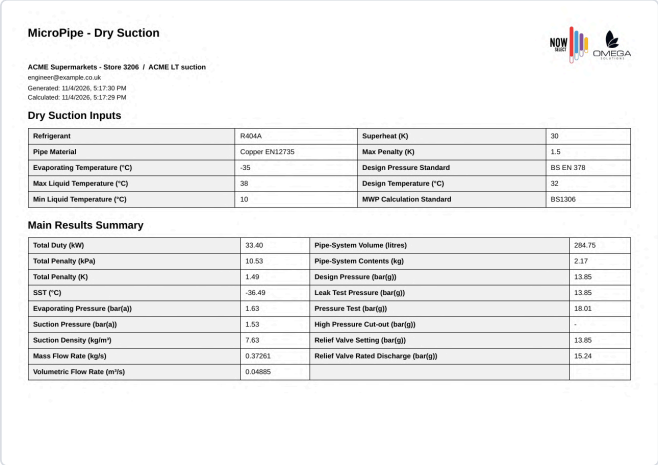
Printing and exporting

A calculated network can be printed as a report, exported as a CSV file of its results, and exported (with or without its project) as a file that another MicroPipe can import.

14.1 The printed report

Print opens the report in a new browser window and shows the browser's print dialogue, from which you can print it or save it as a PDF. The results report is laid out for A4 landscape (the inputs-only report described below is portrait) and holds:

1. A header with the NOW SELECT and Omega marks, the mode, the project and network names, the e-mail address of the licence holder, the date and time the report was generated and the date and time the figures were calculated (which can differ: a lapsed licence prints results it calculated earlier).
2. The **inputs**: the network settings, in two columns. The three **Exclude … Pipe Size** switches are not printed, and nor, in Dry Suction, are **Riser Bias** and **Oil Duty kW**.
3. The **main results summary**: the totals.
4. The **pipe summary**, and for a discharge network the condenser drain group.
5. The **main results table**, with the column headings written out horizontally. A long table continues over several pages with the headings repeated.



MicroPipe - Dry Suction

ACME Supermarkets - Store 3206 / ACME LT suction
engineer@example.co.uk
Generated: 11/4/2026, 5:17:30 PM
Calculated: 11/4/2026, 5:17:29 PM

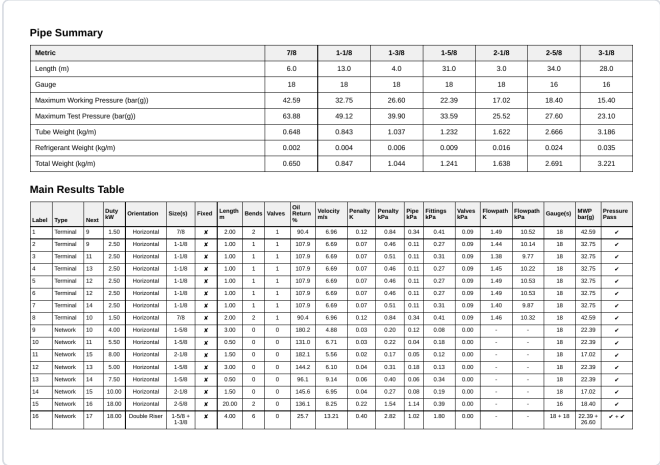
Dry Suction Inputs

Refrigerant	R404A	Superheat (K)	30
Pipe Material	Copper EN12735	Max Penalty (K)	1.5
Evaporating Temperature (°C)	-35	Design Pressure Standard	BS EN 378
Max Liquid Temperature (°C)	38	Design Temperature (°C)	32
Min Liquid Temperature (°C)	10	MWP Calculation Standard	BS1306

Main Results Summary

Total Duty (kW)	33.40	Pipe-System Volume (litres)	284.75
Total Penalty (kPa)	10.53	Pipe-System Contents (kg)	2.17
Total Penalty (K)	1.49	Design Pressure (bar(g))	13.85
SST (°C)	-36.49	Leak Test Pressure (bar(g))	13.85
Evaporating Pressure (bar(a))	1.63	Pressure Test (bar(g))	18.01
Suction Pressure (bar(a))	1.53	High Pressure Cut-out (bar(g))	-
Suction Density (kg/m³)	7.63	Relief Valve Setting (bar(g))	13.85
Mass Flow Rate (kg/s)	0.37261	Relief Valve Rated Discharge (bar(g))	15.24
Volumetric Flow Rate (m³/s)	0.04885		

Figure 14.1 Page 1 of the printed report: header, inputs and results summary.



Pipe Summary

Metric	7/8	1-1/8	1-3/8	1-5/8	2-1/8	2-5/8	3-1/8
Length (m)	6.0	13.0	4.0	31.0	3.0	34.0	28.0
Gauge	18	18	18	18	18	16	16
Maximum Working Pressure (bar(g))	42.59	32.75	26.60	22.39	17.02	18.40	15.40
Maximum Test Pressure (bar(g))	63.88	49.12	39.90	33.59	25.52	27.60	23.10
Tube Weight (kg/m)	0.648	0.843	1.037	1.232	1.622	2.666	3.186
Refrigerant Weight (kg/m)	0.002	0.004	0.006	0.009	0.016	0.024	0.035
Total Weight (kg/m)	0.650	0.847	1.044	1.241	1.638	2.691	3.221

Main Results Table

Label	Type	Next	Duty kW	Orientation	Size(s)	Fixed	Length m	Bends	Valves	Oil Return %	Velocity m/s	Penalty K	Penalty kPa	Pipe kPa	Fittings kPa	Valves kPa	Flowpath K	Flowpath kPa	Gauge(s)	MWP bar(g)	Pressure Pass
1	Terminal	9	1.50	Horizontal	7/8	✘	2.00	2	1	90.4	6.96	0.12	0.84	0.34	0.41	0.09	1.49	10.52	18	42.59	✔
2	Terminal	9	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9	6.69	0.07	0.46	0.11	0.27	0.09	1.44	10.14	18	32.75	✔
3	Terminal	11	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9	6.69	0.07	0.51	0.11	0.31	0.09	1.38	9.77	18	32.75	✔
4	Terminal	13	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9	6.69	0.07	0.46	0.11	0.27	0.09	1.45	10.22	18	32.75	✔
5	Terminal	12	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9	6.69	0.07	0.46	0.11	0.27	0.09	1.49	10.53	18	32.75	✔
6	Terminal	12	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9	6.69	0.07	0.46	0.11	0.27	0.09	1.49	10.53	18	32.75	✔
7	Terminal	14	2.50	Horizontal	1-1/8	✘	1.00	1	1	107.9	6.69	0.07	0.51	0.11	0.31	0.09	1.40	9.87	18	32.75	✔
8	Terminal	10	1.50	Horizontal	7/8	✘	2.00	2	1	90.4	6.96	0.12	0.84	0.34	0.41	0.09	1.46	10.32	18	42.59	✔
9	Network	10	4.00	Horizontal	1-5/8	✘	3.00	0	0	180.2	4.88	0.03	0.20	0.12	0.08	0.00	-	-	18	22.39	✔
10	Network	11	5.50	Horizontal	1-5/8	✘	0.50	0	0	131.0	6.71	0.03	0.22	0.04	0.18	0.00	-	-	18	22.39	✔
11	Network	15	8.00	Horizontal	2-1/8	✘	1.50	0	0	162.1	5.56	0.02	0.17	0.05	0.12	0.00	-	-	18	17.02	✔
12	Network	13	5.00	Horizontal	1-5/8	✘	3.00	0	0	144.2	6.10	0.04	0.31	0.18	0.13	0.00	-	-	18	22.39	✔
13	Network	14	7.50	Horizontal	1-5/8	✘	0.50	0	0	96.1	9.14	0.06	0.40	0.06	0.34	0.00	-	-	18	22.39	✔
14	Network	15	10.00	Horizontal	2-1/8	✘	1.50	0	0	145.6	6.95	0.04	0.27	0.08	0.19	0.00	-	-	18	17.02	✔
15	Network	16	18.00	Horizontal	2-5/8	✘	20.00	2	0	136.1	8.25	0.22	1.54	1.14	0.39	0.00	-	-	16	18.40	✔
16	Network	17	18.00	Double Riser	1-5/8 + 1-3/8	✘	4.00	6	0	25.7	13.21	0.40	2.82	1.02	1.80	0.00	-	-	18 + 18	22.39 + 26.60	✔ ✔ ✔

Figure 14.2 Page 2: the pipe summary and the start of the results table.

If the browser blocks the new window, MicroPipe says *Allow pop-ups to print this network*: allow pop-ups for the MicroPipe address in the browser's settings and press **Print** again. The report needs results, so **Print** is enabled only after a calculation. On a read-only licence it is enabled when the network is opened and, if no results are held on this device, prints the inputs alone, in portrait, with the note *This is a record of the inputs only. The results are not included because this network has not been calculated on this device*; if you edit a field it is greyed until you reopen the network.

> **TIP**
>
> To keep a report, choose *Save as PDF* in the print dialogue. Chrome and Edge leave "Background graphics" off by default; the report is designed to print correctly without them.

14.2 Export CSV

Export CSV downloads `micropipe_results_<network>.csv` (the network name with anything but letters and digits replaced by an underscore: `micropipe_results_ACME_LT_suction.csv`), a spreadsheet file of the results table reduced to the columns an installer or estimator needs: Label, Type, Next, Duty, Size(s), Length, Bends, Valves and Gauge(s) (plus Temp Rise and Mass Flow for a fluid network). The figures are exactly those displayed, in the unit system in force. Pipe sizes carry their inch sign (`7/8"`) so that spreadsheet programs do not read them as dates, and the file is encoded so that Excel on Windows shows the ° and µ characters correctly. This replaces the AutoCAD text files of the Windows version as the way to get labels and sizes onto a drawing.

14.3 Export and import files

Projects and networks export as JSON files (sections 5.5 and 6.4). The file holds inputs only, so it is small and the results are recalculated on import. Use them to:

- send a design to a colleague who has MicroPipe, or to Omega with a support query;
- archive the design at a milestone, since the server holds only the current version;
- move a project between licences.

Exported files are plain text: do not edit them by hand, because an edited file may be refused on import, and never rely on them as the only copy of a job while the project is still on the server.

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CHAPTER 15

The converter tools

Two stand-alone tools, opened from the **Tools** column of the footer, convert between saturation pressure and temperature, and between a pressure drop and the equivalent temperature penalty, for any refrigerant in the library except transcritical CO_2, which has no saturation table. They calculate on the server as you change a field, and remember their last values on the device.

15.1 Pressure ↔ Temperature Converter

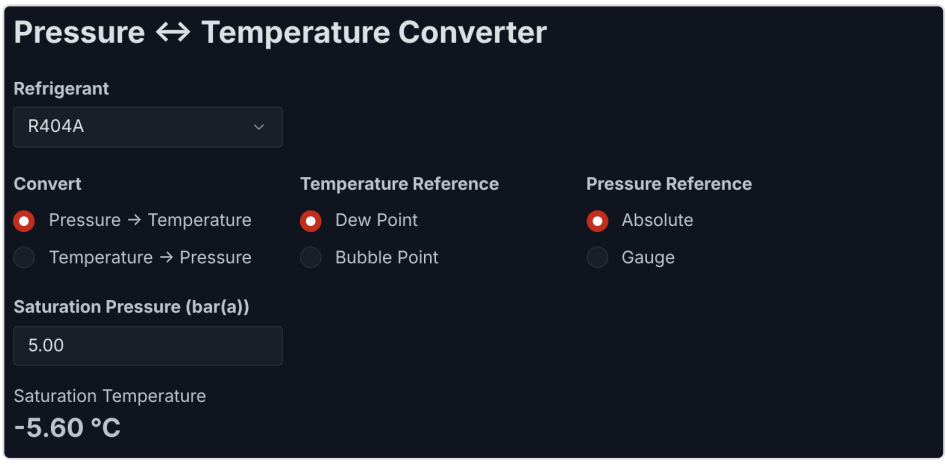


Figure 15.1 5.00 bar(a) of R404A corresponds to a dew-point temperature of −5.60 °C.

Control	Meaning
Refrigerant	Any refrigerant in the library except R744 TC, which has no saturation table.
Convert	**Pressure → Temperature** asks for a pressure and gives the saturation temperature; **Temperature → Pressure** the other way round.
Temperature Reference	**Dew Point** or **Bubble Point**. For a pure refrigerant or an azeotrope they are the same; for a zeotropic blend (R448A, R449A, R407 series, R454 series…) the dew point is the saturated vapour temperature used on the suction side and the bubble point the saturated liquid temperature used on the liquid side.
Pressure Reference	**Absolute** (bar(a)) or **Gauge** (bar(g)); gauge pressures are converted with 1.01325 bar atmospheric pressure.

The input field's limits follow the refrigerant's table: for most refrigerants −60 to 60 °C at the dew point (the bubble-point column of a zeotropic blend has its own ends, R448A −66.4 to 56.1 °C for instance); R744 from −56.56 °C, its triple point, to 30 °C, where the table ends just below the critical point at 72.14 bar(a); R23 and R508B −110 to 10 °C. A value outside the table is refused; if a stored value falls outside the table when you change refrigerant, a warning says the result has been limited to the nearest table value.

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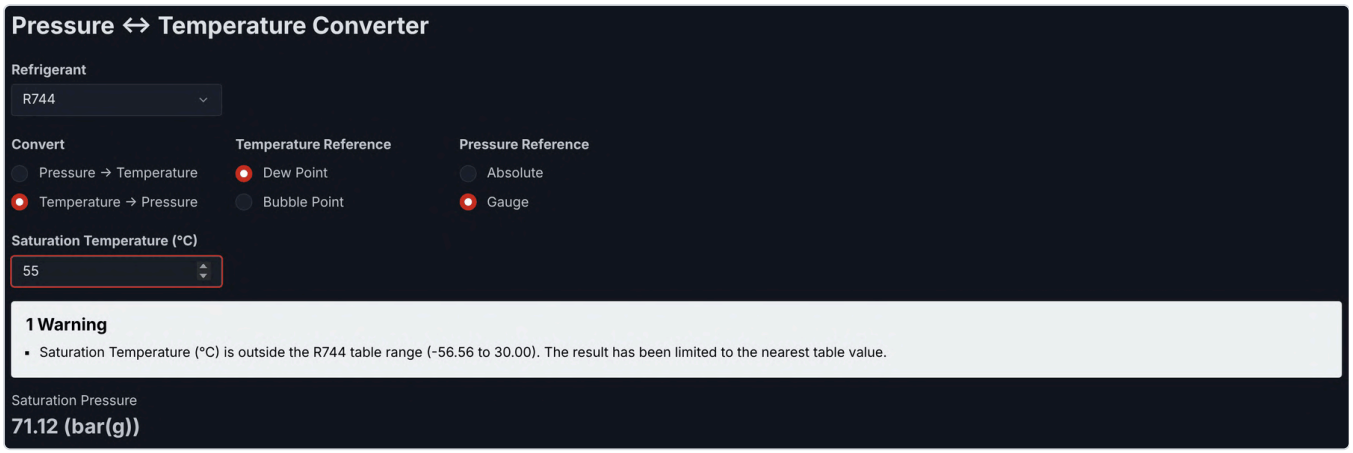


Figure 15.2 A stored temperature of 55 °C is above the R744 table, so the result is limited to the table's end and a warning says so.

15.2 Pressure Drop ↔ Temperature Penalty

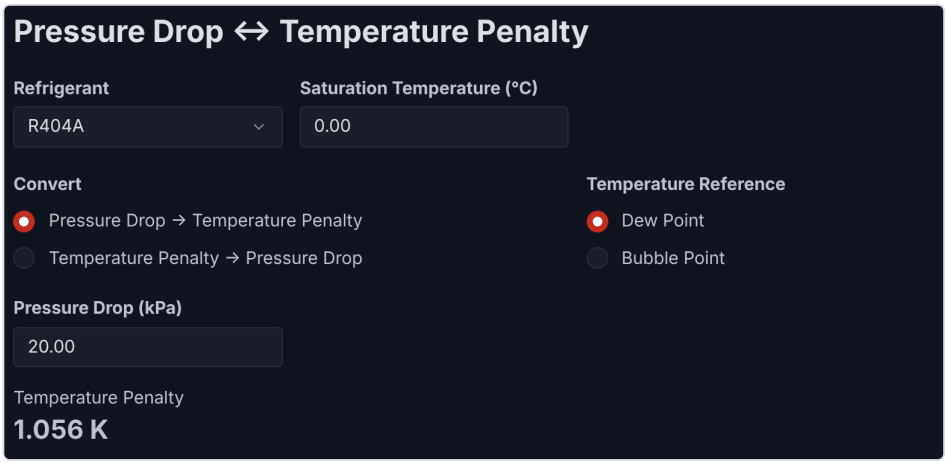


Figure 15.3 A pressure drop of 20 kPa at a saturation temperature of 0 °C in R404A is a penalty of 1.056 K.

Enter the refrigerant, the saturation temperature at which the loss occurs and either the pressure drop (kPa) or the temperature penalty (K); the tool gives the other. Use it when a component's pressure loss is quoted by its maker and you want to know how much of your penalty it will consume, or to translate a penalty specification into a pressure-drop one. If the saturation temperature is outside the refrigerant's table — possible only for a stored value after a change of refrigerant — a warning ending *No temperature penalty can be calculated* is shown and the result reads 0.000 K. A pressure drop larger than the saturation pressure itself is not refused: the result is simply limited at the bottom of the table (200 kPa at −35 °C in R404A reads 25.000 K), so treat such a figure as meaningless.

> **ENGINEERING NOTE**
>
> The same pressure drop costs more saturation temperature at a lower temperature, because the slope of the saturation curve flattens as the pressure falls: 20 kPa is about 1.1 K at 0 °C in R404A but about 3.0 K at −35 °C. This is why low-temperature suction lines are sized to a penalty and not to a pressure drop.

15.3 Leaving a tool

Click any item in the breadcrumb to go back to the project, networks or network. The tool that was open is reopened if the page is reloaded (for example by a change of language). The tools need the server, so they are not available while you are offline.

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CHAPTER 16

Settings: colours, language and units

The settings in the footer belong to the device, not to the project: they change how everything is shown and entered. The language, the unit system and the **Convert existing** switch are remembered by the browser; the colour mode is not.

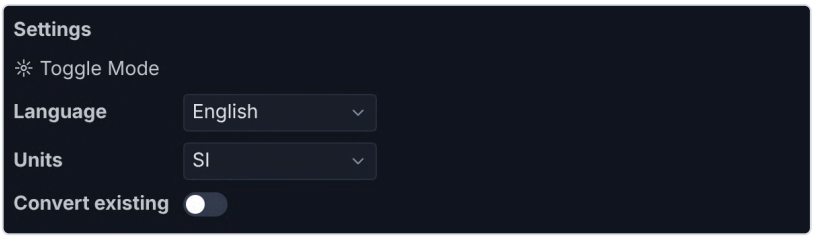


Figure 16.1 The settings column of the footer.

16.1 Toggle Mode

Switches between the dark colours (the default, used for the screenshots in this manual) and light colours. The choice lasts until the page is next loaded — including the reload a change of language performs — after which the page opens in dark mode again. The printed report is always black on white.

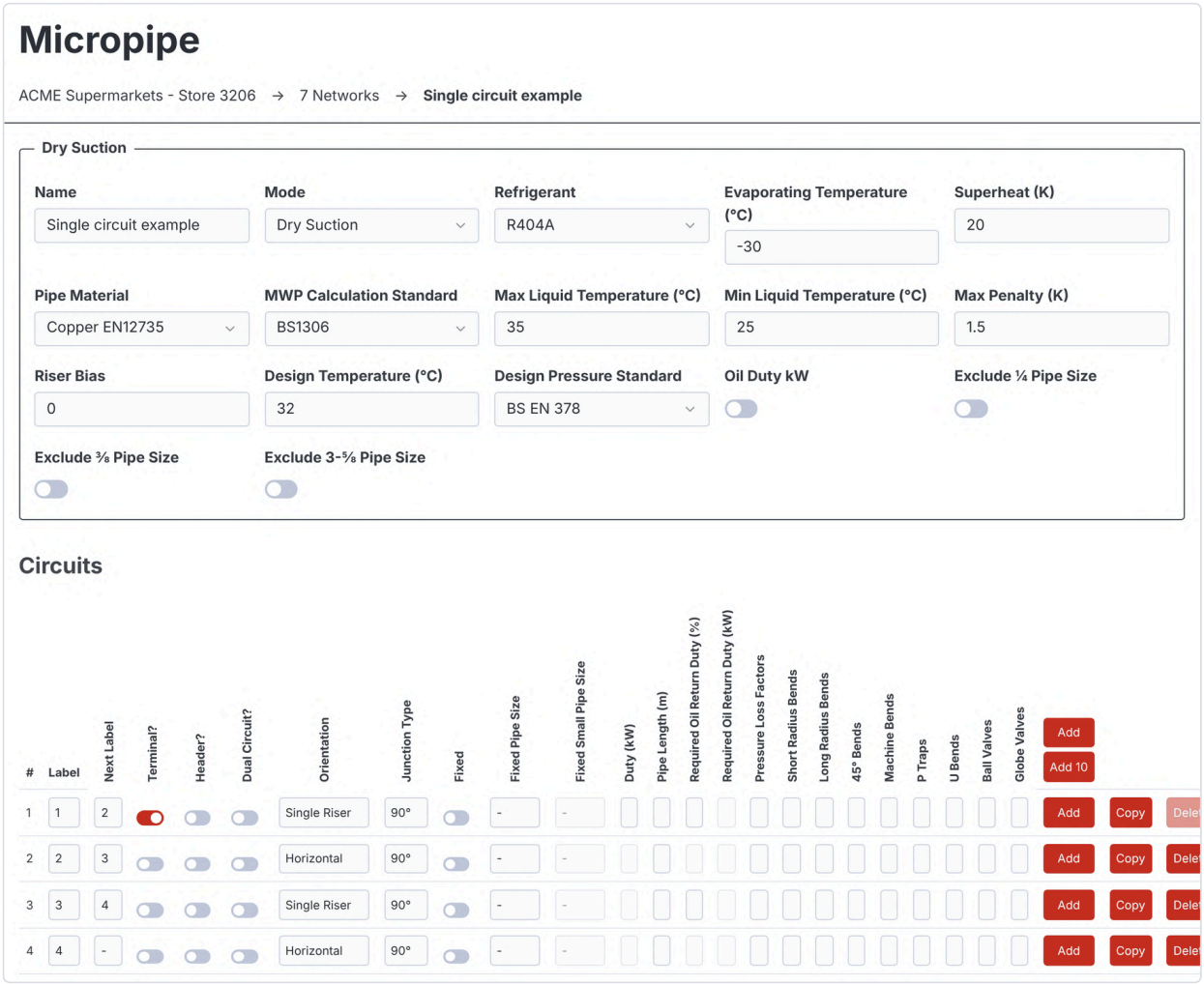


Figure 16.2 The light colour mode.

16.2 Language

MicroPipe is available in 26 languages: English, Arabic, Czech, Danish, German, Spanish, Filipino, French, Hebrew, Hindi, Indonesian, Italian, Japanese, Korean, Dutch, Norwegian, Polish, Portuguese, Russian, Slovak, Swedish, Thai, Turkish, Vietnamese, Simplified Chinese and Traditional Chinese. Choosing a language reloads the page in that language; every label, message and report heading follows, and the dates in banners are written the way the language writes them. Arabic and Hebrew lay the page out right-to-left. The values you have entered and the stored names of modes and orientations are untouched, so a project opened in another language is the same project; only the default names given to a new project, network or circuit follow the language.

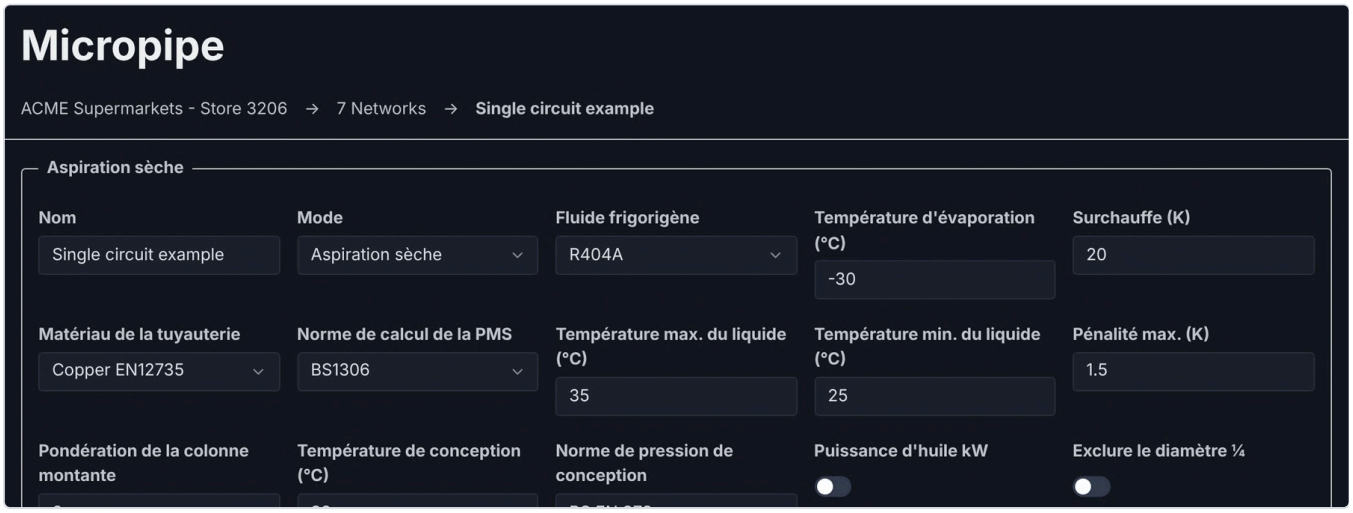


Figure 16.3 The header and the network settings in French.

16.3 Units: SI or Imperial

Every figure MicroPipe stores and calculates with is SI. The **Units** list switches the *display and entry* of every field, result and report to Imperial, with these conversions:

Quantity	SI	Imperial	Quantity	SI	Imperial
Temperature	°C	°F	Temperature difference	K	°F
Length	m	ft	Pressure	bar, bar(a), bar(g), kPa	psi, psia, psig, psi
Duty	kW	Btu/h	Mass flow	kg/s, kg/hr	lb/s, lb/hr
Volume flow	m³/s, m³/hr, l/s, lpm	ft³/s, ft³/hr, ft³/s, ft³/min	Velocity	m/s	ft/min
Density	kg/m³	lb/ft³	Mass, volume	kg, litres	lb, ft³
Weight per length	kg/m	lb/ft	Specific heat, enthalpy	kJ/kg·K, kJ/kg	Btu/lb·°F, Btu/lb
Volumetric heat capacity	kJ/m³·K	Btu/ft³·°F			

Pipe sizes, gauges, percentages, loss factors, viscosity (cP) and the compression ratio are the same in both systems. Field limits are converted with the values, rounded outward so that a value on a limit is never refused.

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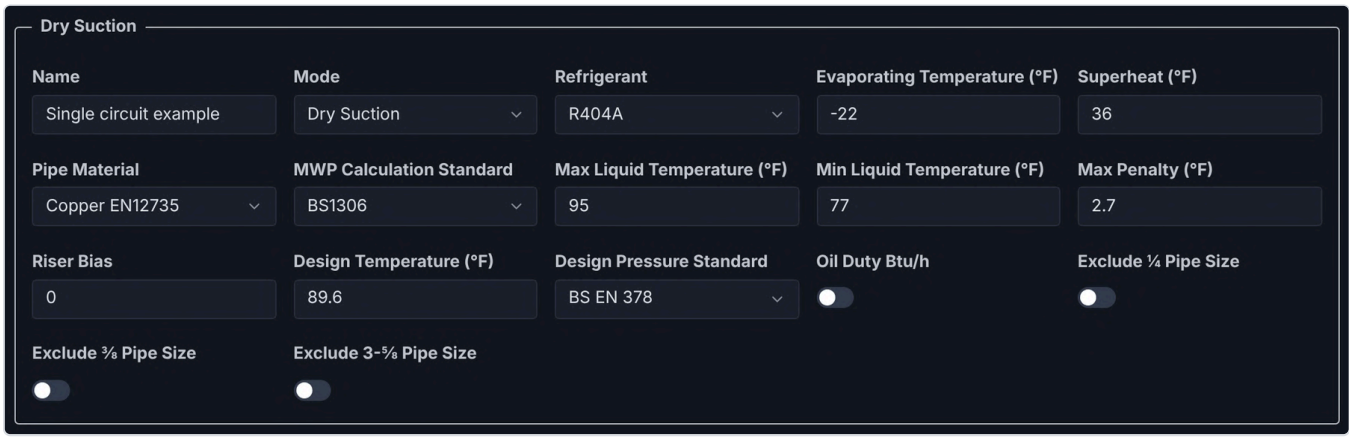


Figure 16.4 The settings panel in Imperial units.

16.4 Convert existing

The **Convert existing** switch decides what happens to the numbers already entered when you change the unit system:

- **Off** (the default): the numbers are *kept as entered* and reinterpreted in the new unit. An evaporating temperature of −10 becomes −10 °F. Use this when you are about to re-enter a network from an Imperial data sheet.
- **On**: the numbers are *converted*, so the physical quantities are preserved. −10 °C becomes 14 °F. Use this to see an existing design in the other system.

The switch applies to the open network and the tools at the moment you change the system; other networks are stored in SI regardless and simply display in whichever system is in force when they are opened. A notification confirms which happened: *Units: Imperial (existing values converted)* or *(existing values kept as entered)*. With the switch off the results are invalidated, because the inputs have changed, and must be calculated again; with it on the results stay valid and are simply shown in the new units.

> **TAKE CARE**
> Changing the unit system with **Convert existing** off changes the design conditions of the open network. If you only want to read a design in the other system, switch **Convert existing** on first.

PART C

Engineering reference

The engineering behind the inputs and the results. The physics of the online MicroPipe is the same as that of the Windows version, and the explanations that version's manual gave are carried forward here, adapted to the new fields and extended where the online edition asks for more.

- 17 The operating modes
- 18 The design data explained
- 19 Suction risers and designing for oil return
- 20 Pipe materials, sizes and pressure ratings
- 21 Refrigerants and fluids
- 22 Messages reference

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CHAPTER 17

The operating modes

A network is calculated in one of six modes. Each describes a different part of the refrigeration plant, carries a different fluid state, and is sized against a different limit.

Mode	For the design and analysis of	Sized to	Fluid state
Dry Suction	Dry suction pipe networks between the evaporators and the compressors of a direct-expansion system.	Temperature penalty (K), with every riser checked for oil return	Superheated vapour
Wet Suction	Pumped wet-suction pipe networks between the evaporators and the low-pressure receiver of a liquid-overfeed system.	Temperature penalty (K), with an allowance for liquid hold-up	Two-phase: vapour plus overfeed liquid
Liquid	High-pressure liquid pipe networks between the liquid receiver and the evaporators.	Temperature penalty (K), or pressure drop (kPa) for R744 TC	Sub-cooled liquid
Discharge	Discharge pipe networks between the compressors and the condenser system; with, optionally, the condenser liquid drain lines between the condenser outlets and the liquid receiver.	Temperature penalty (K), or pressure drop (kPa) for R744 TC; the drain to a velocity	Superheated discharge gas; liquid in the drain
Pumped Liquid	Pumped liquid pipe networks between the low-pressure receiver (pump) and the evaporators of a liquid-overfeed system.	Pressure drop (bar), plus the static lift in the pump head	Sub-cooled liquid
Fluid	Hydronic circuits for secondary refrigerants and other working fluids: chilled water, glycols, brines, steam, or a fluid you define.	Pressure drop (kPa), plus the static lift in the pump head	Single-phase liquid (or saturated steam)

17.1 Penalty or pressure drop?

Where the fluid is at saturation — a suction line, a liquid line — a pressure loss is also a loss of saturation temperature, and that is what matters to the plant: a suction-line penalty lowers the saturated suction temperature at the compressor, reducing its capacity and raising its power; a liquid-line loss brings the liquid closer to flashing. These modes are therefore sized to a *temperature penalty* in kelvin, and the equivalent pressure drop is reported alongside. Where the fluid is well away from saturation — a pumped liquid, a secondary fluid, a transcritical CO_2 high side — a pressure loss has no temperature meaning and the limit is a *pressure drop*.

17.2 How the optimiser works

The permitted penalty is first shared out along the worst flow path in proportion to each circuit's equivalent length (a riser is given a larger share when the riser bias is above zero), and every circuit starts at the smallest size whose own penalty is within its share — for a riser, the smallest size that also returns oil at its required duty. If any path still exceeds the limit, the circuit on it with the highest penalty relative to its share is enlarged one size, and this is repeated until every path is within the limit. A downsizing pass then tries each circuit one size smaller, cheapest-looking first, and keeps each reduction that leaves every path within the limit. Two rules keep the selection physically sensible: a horizontal circuit that alone feeds a riser, or alone takes its outlet, is never smaller than the riser; and horizontal circuits in series carrying the same flow are given the same size. A Dry Suction network that the standard sequence cannot size is tried once more by a second sequence that targets the worst path directly, and that result is reported if it is valid. Several passes are usually needed, which is why a large network with many risers takes longer.

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> **TIP**
> A small change in the permitted penalty can move a shared section across a size boundary and change the cost of the whole network; try two or three penalties before settling on one.

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CHAPTER 18

The design data explained

What each design entry means physically and why MicroPipe asks for it, with the entries the online edition adds explained alongside.

18.1 Evaporating temperature

The refrigerant temperature in the evaporator — not the saturated suction temperature at the compressor. MicroPipe calculates the saturated suction temperature from it by subtracting the suction-line penalty and reports it in the totals as SST. In a liquid or discharge network the evaporating temperature fixes the low-side condition of the cycle, from which the mass flow per kW of duty follows.

18.2 Suction superheat

The suction-line temperature rise above saturation between the evaporator and the compressor, expressed in K. It includes the superheat the evaporator produces and the heat gained along the line, and it determines the density of the vapour the suction pipe carries — and therefore the velocity and the pressure drop for a given mass flow. A superheat that is too low for the installation makes the line look better than it is.

18.3 Maximum liquid temperature, or liquid temperature

The highest refrigerant liquid temperature likely to be encountered during maximum design ambient conditions. It fixes the enthalpy of the liquid entering the evaporator and therefore the mass flow needed for the duty: the warmer the liquid, the less refrigerating effect per kilogram, the more mass flow for the same kW, and the higher the suction-line velocity and penalty. In a suction network the maximum liquid temperature is used for the penalty calculation and the minimum liquid temperature for the selection of risers.

18.4 Minimum liquid temperature

The minimum liquid temperature likely to be encountered during minimum design ambient conditions. Many systems are now designed to let the condensing temperature fall with the ambient. This significantly increases the efficiency of the plant but can cause problems with oil return, because of the reduction in refrigerant mass flow, so it is essential that a realistic minimum liquid temperature is entered for MicroPipe to select the correct suction risers.

Careful consideration must also be given to the system running at low load for prolonged periods in winter, when oil return is again reduced by the lower mass flow. Enter a realistic estimate of each riser's minimum capacity (its required oil-return duty), so that the risers are sized for the lowest capacity and liquid temperature likely to be experienced.

18.5 Maximum permitted penalty or pressure drop

The maximum pressure drop or temperature penalty that can be tolerated, commensurate with good practice, system operating efficiency and economy of installation. A smaller penalty means larger, costlier pipes and a greater refrigerant charge; a larger penalty means lost compressor capacity and efficiency for the life of the plant. Typical practice is 1 to 1.5 K on suction lines, 0.5 to 1 K on discharge lines and a liquid-line loss that keeps the liquid sub-cooled at the expansion valve; MicroPipe's defaults are 1 K for the penalty modes, 15 kPa (liquid) and 50 kPa (discharge) in the pressure-drop forms, 0.5 bar for pumped liquid and 50 kPa for fluids.

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18.6 Liquid rise above the receiver

A value representing the height difference between the liquid refrigerant receiver and the evaporator inlet valve. Entering a value causes MicroPipe to calculate the pressure loss due to the effects of gravity (the *head penalty*), and the amount of liquid sub-cooling necessary to prevent flash-gas formation in the liquid lines (the *additional sub-cooling required*).

18.7 Discharge temperature and isentropic efficiency

The Windows version let you enter a discharge temperature or have it calculated at a built-in isentropic efficiency of 75%. The online MicroPipe always calculates it, from the suction condition, the condensing pressure and the **Isentropic Efficiency** you enter (default 75%), and reports it in the totals. If you know the actual discharge temperature, adjust the efficiency until the reported temperature matches it.

18.8 Liquid overfeed, pumped liquid temperature and lift

Pumped liquid temperature is the refrigerant temperature in the low-pressure receiver. **Liquid overfeed percentage** is the quantity of liquid overfeed leaving the evaporator expressed as a percentage of the capacity. For example, 300% liquid overfeed means that each pipe will be required to carry 100% for the system capacity plus a further 300% for liquid overfeed. In pumped liquid lines all of the refrigerant mass flow is liquid, whereas in wet-suction lines (at 300%) 25% of the mass flow is vapour and 75% liquid. **Pumped liquid lift** is the vertical distance between the refrigerant pump and the evaporator inlet; from it MicroPipe calculates the additional pumping head due to gravity and reports the system pump head.

18.9 Pressure loss factors

Occasionally a special valve or fitting will be fitted in the system. If its pressure loss is known, the temperature penalty can be found with the pressure-drop-to-temperature-penalty converter (Chapter 15). If only its loss factor is known (a K value, not a K_V), enter it in the circuit's **Pressure Loss Factors** column, where the loss is calculated as $K \times \frac{1}{2}\rho v^2$ at the circuit's velocity; several components in one circuit are entered as the sum of their factors. In Fluid mode a known loss in kPa can be entered directly in **Other Losses**.

18.10 The bias settings

Riser bias (Dry Suction). Increasing the bias value above zero increases the amount of penalty that MicroPipe allocates to suction risers. Care must be exercised in using this bias, as the higher the proportion of the available penalty expended on the risers, the larger will be the pipe sizes of the rest of the system. A riser's share of the penalty budget (section 17.2) is multiplied by 1 + bias ÷ 2: at the default of 0 a riser is treated like any other circuit, at 2 it is given twice the share, at 10 six times. The range is 0 to 10.

Liquid hold-up maximum penalty bias (Wet Suction). Sets how much the pressure drop of a wet-suction line is increased for the liquid it carries. The drops of pipe, fittings and valves are multiplied by 1 + (bias − 1) × (the liquid's share of the pipe cross-section ÷ a constant for the refrigerant), so there is no increase at 0% overfeed and the increase grows with the overfeed; a bias of 1 switches the allowance off. Adjust it from experience or measured data. The default value is 1.5; the range is 1 to 3.

18.11 Design temperature, design pressure standard and MWP standard

These three settings govern the pressure side of the design. The **design temperature** is the saturation temperature from which the design pressure is derived (section 7.2); the **design pressure standard** (BS EN 378 or ASME B31.5) sets its default and the test and relief settings derived from it (section 12.3); the **MWP calculation standard** (BS1306 or DKI) is the method by which the maximum working pressure of each copper gauge is calculated (section 20.4). A pipe

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passes when its maximum working pressure is at least the design pressure, and the thinnest gauge that passes is selected.

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CHAPTER 19

Suction risers and designing for oil return

Oil leaves the compressors with the discharge gas and must come back with the suction gas. Whether it does is decided by the suction pipe network, and above all by its risers. This chapter explains the mechanism, how MicroPipe checks for it, how to choose between single and double risers, and the design rules that keep oil moving.

19.1 Why oil return matters

To maintain maximum refrigeration system efficiency and reliable compressor oil-level control it is necessary to reduce the volume of oil circulated around the refrigeration system to a practicable minimum. This requirement makes it necessary to take positive measures to ensure that the oil will be continuously returned to the compressor system and will not be allowed to accumulate anywhere in the system.

To reduce the amount of oil carried over into the pipe network, most multi-compressor plants are fitted with an oil-level control system consisting of an oil separator, oil reservoir and oil-level controls fitted to each compressor. Single-compressor plants are normally only fitted with an oil separator. At their rated operating conditions, oil separators are normally capable of removing a fairly high percentage of the oil from the compressor discharge vapour. This still leaves a small volume of oil that will be carried over into the pipe network.

Evaporators, unless circuited incorrectly, will not normally collect oil as they are continually being flushed with liquid refrigerant, which effectively eliminates the possibility of oil accumulation. Consequently, the oil will be moved through the evaporators into the suction pipe network.

19.2 How oil moves in a suction line

Oil is transported in suction pipelines by two mechanisms. One of these is miscibility: the oil and refrigerant mix together and the oil is transported as part of the mixture. The degree of miscibility with the refrigerant can vary considerably and depends on the system operating conditions; in any event it is not the most significant mechanism. The second, and most important, mechanism is the oil being transported along the tube wall by the force (velocity pressure, or kinetic energy) of the refrigerant flow.

The driving force of any fluid stream is known as the *velocity pressure*. It is a function of the fluid density (kg/m³) and the fluid velocity (m/s) and is calculated, in Pa, as $\frac{1}{2}\rho v^2$. Naturally, as the fluid mass flow decreases the velocity will also decrease proportionally. As the velocity pressure of the fluid is proportional to the square of its velocity, even a small change in mass flow will have a marked effect on the oil transport properties. For example, a 25% reduction in mass flow will reduce the velocity pressure by 44%.

Where the velocity pressure of the refrigerant flow in a suction riser is insufficient to overcome the effects of gravity on the oil then, regardless of the height of the riser, the oil will not be transported efficiently unless the riser has been selected to be capable of doing so.

With most refrigeration systems it is not possible to accurately predict the quantity of oil carry-over at any given moment, as the efficiency of the oil separator is constantly changing with the variations in refrigerant mass flow, density and temperature. Consequently, the only methods available to the system designer to ensure efficient oil return are in the design of the suction pipe network. If the suction pipe network is designed with the correct operating parameters, pipe falls, oil traps and risers, oil will always be returned regardless of the volume of oil carry-over.

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VELOCITY IS NOT ENOUGH

The common belief that oil return is dependent on a given refrigerant velocity, for all system operating conditions, is entirely incorrect. Oil is transported in suction pipes by the forces of the refrigerant flow; as the refrigerant density varies considerably over the range of possible operating conditions it is therefore not correct to select risers solely on the basis of velocity. Fluid velocities in tubes are not uniform across the radius: the friction of the fluid on the tube wall causes a lower velocity at the wall than at the centre, and because of the parabolic-like shape of the velocity profile across the tube, larger diameter tubes require higher *average* velocities to maintain the oil-transporting velocity pressure at the tube wall.

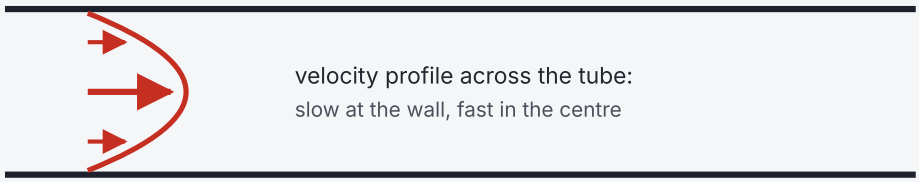


Figure 19.1 The velocity profile in a tube. The oil travels on the wall, where the velocity is lowest.

To avoid the problems associated with poor oil return it is important to fully understand the mechanisms of oil return. This understanding can then be usefully employed in the design of suction pipe networks that will not accumulate oil under any predictable circumstances.

19.3 How MicroPipe checks a riser

For every Dry Suction circuit, MicroPipe calculates the minimum load, as a percentage of the duty flowing through the circuit, at which the selected pipe still carries oil up a vertical riser — the **Oil Return %** of the results table. The check is made at both the maximum and the minimum liquid temperature, and the worse case is reported, because the lower mass flow at the lower liquid temperature is the condition that fails first. For a circuit entered as a riser, the pipe is selected so that this figure is at or below the **Required Oil Return Duty** you entered: if you require oil return down to 35% of the riser's load, the riser is sized so that it returns oil at 35% — and the optimiser reports an error if no size can satisfy both the oil-return requirement and the penalty.

For a horizontal circuit the figure is informative only, as it was in the Windows version, where percentages were shown in black for lines that would return oil and red for those that would not. A horizontal circuit whose oil-return figure exceeds 100% would not return oil if it were a riser; this is to remind you that some circuits should be treated as risers and not as horizontals, and to highlight circuits that need an oil-return slope.

19.4 Single or double riser?

Suction risers can be placed anywhere in the system by setting a circuit's **Orientation**. Before deciding whether a particular circuit is to be a single or a double riser, it is necessary to establish the minimum load for the circuit and the minimum refrigerant liquid temperature at which the system could operate during low ambient temperatures. Many refrigeration systems are now designed to take advantage of the lower condensing temperatures which are possible during the winter. During these periods, refrigeration plants consume much less energy and are able to meet their required capacity with a considerably lower refrigerant mass-flow rate. Unfortunately, the lower mass-flow rate significantly reduces the oil-return capabilities of the suction pipe network. Consequently, it becomes important to ensure that reasonably accurate estimates are made of the minimum system heat load and refrigerant liquid temperatures, to ensure that risers will be selected for continuous and reliable oil return.

If a particular circuit has not been selected to act as a riser, even a small rise in height (not necessarily vertical) can seriously reduce its oil-carrying capability and cause it to be a potential oil accumulation point. It is therefore very important to consider every circuit that rises above the horizontal as a suction riser.

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Single risers

Single suction risers can be used where the riser minimum capacity, for oil return, does not go below approximately 70%, or where higher suction riser and system penalties can be tolerated. Single risers are probably best used in situations where the minimum pipe-network duties are high and/or where higher penalties can be tolerated. It is very important to remember that having high penalties on single risers can cause the remainder of the pipe network to be increased in size to compensate for the smaller amount of penalty available for the remainder of the network after selecting the risers. In these circumstances the system could prove to be more costly than necessary, and it will probably prove more cost-effective to use double risers.

Double risers

Double risers should always be used where the minimum capacity, for oil return, could be lower than 50%, where the pipe network has to operate at low mass-flow rates for extended periods, or where penalties must be kept to a minimum. A double riser is two pipes: a small riser sized to return oil at the minimum load, and a large riser which, with the small one, carries the full load at an acceptable penalty. At low load the large riser traps oil at its foot and seals itself, so the whole flow passes up the small riser at a velocity that returns the oil; as the load rises the seal clears and both risers carry the flow.

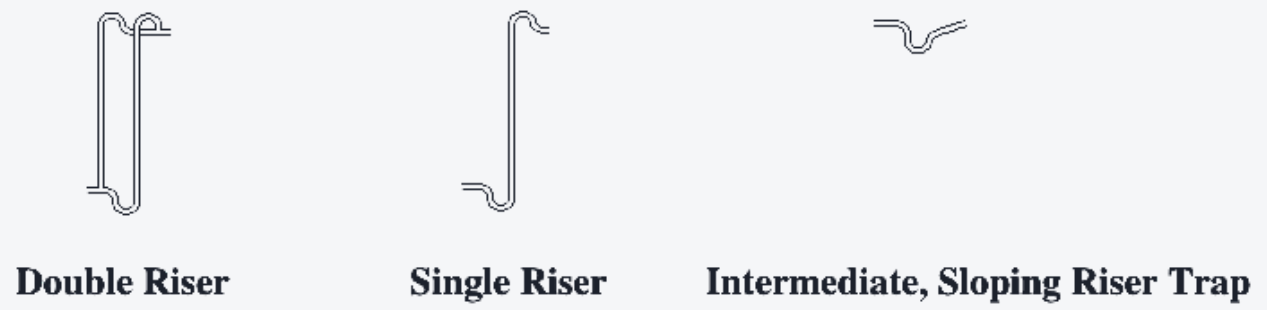


Figure 19.2 Riser configurations: a double riser with its oil trap at the foot and the two legs rejoining at the top; a single riser with its trap; and an intermediate trap on a sloping run.

> **NOTE**
>
> In addition to the minimum-capacity requirement, remember that the refrigerant minimum liquid temperature must be considered, as this can, because of the significant reduction in refrigerant mass flow, seriously affect the oil-return characteristics of the suction risers. Entering the correct minimum liquid temperature ensures that MicroPipe selects suction risers that will return oil efficiently under all operating conditions: MicroPipe selects suction riser sizes on the minimum liquid temperature and capacity, but calculates the penalty on the maximum liquid temperature. Frequently, the system configuration or operating conditions lead to the majority of the penalty being used up on the risers; when this occurs MicroPipe reports that the penalty cannot be met, and the solution is to permit a higher penalty or use double risers.

19.5 The special case: a single riser into a double riser

There are frequent occasions where the formation of a deep double-riser trap is not possible. To avoid an oil accumulation point, a combination of single and double riser can be employed. A typical example is a supermarket cabinet, which has very limited space between the floor and the underside of the case. During refits it is common practice to form a well in the floor to accommodate the oil traps; this creates problems with noise and dust, and is an extra cost and complication in what is normally a very tight programme of works.

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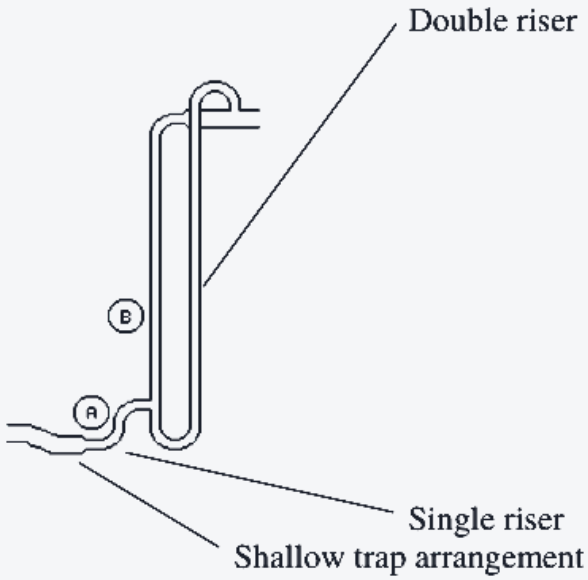


Figure 19.3 The special case. The lower horizontal line is pitched down to form a shallow trap; the short single riser A lifts the oil into the double riser B.

As the sketch indicates, the lower horizontal suction line should be pitched down to form a very shallow trap. This creates a collection point where the oil level will reach the bottom of the single riser pipe without flooding the main horizontal line with oil. Once over the bottom of the single riser tube the oil, because of the higher velocity, will be entrained and carried into the double riser. The single riser A is sized for the minimum load; because it is very short, the pressure loss is kept to a minimum. The double riser B should be sized in the normal manner.

Because this is a special case, MicroPipe detects the combination — a terminal circuit set as a single riser whose next label is a double riser — and automatically calculates and adds the additional pressure-drop penalty created by the arrangement. It is recommended that several calculations be tried to avoid unnecessary pressure drop in the riser combination. (This detection has been part of MicroPipe since December 2000.)

19.6 Design guide

Horizontal pipework

Wherever possible, all horizontal pipe runs should have a minimum fall of 1 in 500 in the direction of flow to the compressor. Of course, the more pipe fall the better the oil return. When it is necessary to slope the pipeline upward in the direction of flow, treat the circuit as a riser and provide an oil trap at the lowest point of the circuit and, if it is felt necessary, insert intermediate oil-return traps. Never permit a horizontal pipeline to lead into a riser without fitting an oil trap and a correctly sized suction riser. Large amounts of oil can and will collect in horizontal pipelines, and the only reliable means of keeping them free of oil accumulation are the gravity oil-return pipe falls, oil traps and suction risers.

Branch connections

Never connect a branch line below the centre line of the line it is joining. Inactive or low-duty branch lines can collect oil: the oil running along the bottom of the pipeline will run into the branch line and form an oil pool. If all branch lines are above the centre line of the horizontal line they are joining, oil will be prevented from accumulating, because of the pipe junction.

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Figure 19.4 Branch connections into a horizontal suction line. A branch taken off above the centre line (recommended) stays clear of the oil that runs along the bottom; one taken off below the centre line collects it; a side entry on the centre line is satisfactory. The arrows show the direction of flow into the main.

Compressor system suction headers

Compressor system suction headers should be designed to prevent oil accumulation and to be capable of returning oil only to those compressors that are running. Oil return to individual compressors should be metered in a manner that positively prevents over-feeding the compressor with oil because the suction header is incorrectly balanced.

19.7 Estimating the riser minimum load

Minimum loads of riser circuits must be considered very carefully. The type and number of refrigerated fixtures, defrost intervals and the minimum heat load of each fixture must all be taken into consideration. Generally, supermarket cabinets range from 50% to 100% of their maximum rated heat load as the surrounding ambient air temperature and humidity vary between winter and summer and night and day operation. Add to this the number and different types of fixtures that could be on or off at any given moment, and it appears to be a complex estimating problem. This is not the case. If, for example, we take a typical supermarket run of frozen-food well cabinets, we can apply a simple rationale for estimating the minimum load:

- Cabinets are usually designed for ISO 3 conditions of 25 °C, 60% RH.
- The minimum store temperature is normally permitted to fall to 12 °C at night; the RH during this period will be about 70%.
- Variations in cabinet radiant heat gain are proportional to the fourth power of the temperature difference. This reduces the cabinet radiation heat gain to approximately 84% of its maximum at 25 °C. For the example, take 25% of the maximum total heat gain to be from radiation.
- Take the heat gain through the cabinet structure to be 10% of the maximum total heat gain; this is reduced to 73% of its maximum.
- Take the fan heat gains as 10% of the maximum total; these are unchanged.
- Take the heat gain from the air ingress to be 55% of the maximum total; this is reduced to 62% of its maximum, from the air enthalpies in the table.

Condition	Air enthalpy
ISO 3 (25 °C, 60% RH)	55.95 kJ/kg
12 °C, 70% RH	27.55 kJ/kg
−23 °C frozen-food cabinet air	−19 kJ/kg

Heat gain	Share	× factor	Minimum
Radiation	25%	0.84	21.0%
Fabric	10%	0.73	7.3%
Fans	10%	1.00	10.0%
Air ingress	55%	0.62	34.1%
Total	**100%**		**72.4%**

For the example, if the cabinet run has ten sections and each has a minimum heat load of 72%, the average minimum load for the entire run would also be 72%. Because of the random nature of the load caused by the variations in control cycles and controls, the number of cabinet sections actually on at any given time could range from 0% to 100%. However, the large load variations are not important as, on average, there will be sufficient load to ensure oil return, providing the network and risers have been correctly designed and selected. If the low-load cycles are of a relatively short duration, the small amount of oil accumulated during these periods will be flushed through when the load increases. Because of this, it is not always necessary to select the risers for a very low load.

In this example, selecting a single riser for 72% minimum capacity and 5 °C minimum liquid temperature would probably lead to a riser temperature penalty that is unacceptable at full load. A more acceptable solution would be to select a double riser for a minimum oil-return capacity of 50%.

To ensure the integrity of the pipe network design regarding oil return, a minimum heat-gain estimate must be carried out for each type of fixture, taking into consideration the design ambient conditions (ISO conditions), operating temperature and the minimum ambient air temperature and humidity around the fixture. Fixtures such as cold rooms can, when turned on, be considered to be at 100% capacity, as the cooler load is a function of the fixture air temperature only and is not directly affected by the surrounding ambient air temperature. The percentage of load reduction on the pipe network will be reflected in the ratio of the cooler refrigeration on/off cycle as dictated by the heat gains from various sources. The suction risers from the individual evaporators can therefore always be considered to be at 100% load. Where multiple, individually controlled room coolers or fixture evaporators are fed into a common pipe network, careful consideration must be given to the minimum load (as described above) when sizing the risers.

Systems with a high proportion of cold rooms require extra consideration, as the minimum load can be very low for extended periods of time. Normally the room coolers are selected for 16–20 hour running with the pipe system sized to match the cooler load. When the rooms are not in use during the night or at weekends the room heat loads, due to the reduction in product throughput, door openings and lighting, will be considerably lower. If the system and risers are not designed to accommodate the load reductions, oil logging of the network will occur.

19.8 Minimum liquid temperature

Where the system condensing temperature is allowed to reduce during low ambient temperatures, it is possible for it to reach to within 5–10 K of the condenser “air on” temperature. For operational reasons, condensing temperatures are normally limited to a minimum of 5 to 15 °C for high-temperature systems and 0 to 10 °C for low-temperature systems. Because of the reduced mass flow through the condenser during these periods, the refrigerant in the condenser will have a longer dwell time, which will significantly increase the volume of liquid refrigerant in the condenser. The longer dwell time and increased flooding of the condenser tubes has a marked beneficial effect on the efficiency of the system, as the liquid is able to achieve a greater degree of sub-cooling, which increases the refrigeration effect of the refrigerant in circulation for no additional energy consumption. Liquid sub-cooling to within 3 to 5 K of the condenser air-on temperature is quite normal during these periods.

Because of the increase in refrigeration effect, the system will be able to meet the heat load with a much lower refrigerant mass-flow rate, which in turn will reduce the oil-return capabilities of the pipe network. It is therefore important that risers are selected to be capable of returning oil even when operating at the lower mass-flow rates caused by the reduced liquid temperatures and low fixture heat loads. For example, if we have a system operating with a liquid temperature of 5 °C and a heat load of 72%, the refrigerant mass-flow rate would be reduced to 44% of its value at 100% load and 40 °C liquid temperature. At these operating conditions the pipe network velocity pressures would be 20% of their full-load values.

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CHAPTER 20

Pipe materials, sizes and pressure ratings

The **Pipe Material** fixes the sizes MicroPipe can choose from, the wall thicknesses available, how the maximum working pressure of each is calculated and the weight of the pipe. This chapter lists what is built in.

20.1 Materials for refrigerant networks

Material	Sizes (nominal)	Notes
Copper EN12735	¼, ⅜, ½, ⅝, ¾, ⅞, 1⅛, 1⅜, 1⅝, 2⅛, 2⅝, 3⅛, 3⅝, 4⅛, 5⅛, 6⅛ inch	European refrigeration tube to EN 12735; several wall gauges per size (section 20.4). The default.
Copper ASTM	The same sixteen sizes	ACR tube to the ASTM series, one wall per size.
K65 Copper	⅜ to 2⅛ inch (nine sizes)	High-strength copper-iron alloy tube for CO_2 high sides; one wall per size, rated for transcritical pressures.
Reflok Aluminium	¼ to 2⅛ inch (ten sizes)	Aluminium tube with mechanical joints.
Steel SCH40	½, ¾, 1, 1¼, 1½, 2, 2½, 3, 4, 5, 6, 8, 10, 12, 14, 16, 18, 20 inch	Carbon steel, schedule 40 (nominal bore sizes). The usual choice for ammonia and large CO_2 systems.
Steel SCH80	½ to 14 inch	Carbon steel, schedule 80 (heavier wall).
Stainless Steel SCH10, SCH40	½ to 20 inch	Stainless steel, schedules 10 and 40.

Ammonia (R717) excludes the copper and aluminium series; selecting it switches the material to the first steel series and the copper materials disappear from the list. The three **Exclude ... Pipe Size** switches remove ¼″, ⅜″ and 3⅝″ from the copper and aluminium lists.

20.2 Materials for fluid networks

Material	Sizes
Steel SCH40, Steel SCH80, Stainless Steel SCH10, Stainless Steel SCH40	½ to 20 inch nominal bore (the fluid schedules carry SCH80 up to 20 inch; the refrigerant SCH80 series stops at 14)
Schedule 5 stainless steel	6 to 600 mm nominal bore (23 sizes)
BS1387 medium steel, BS1387 heavy steel, BS 1387 Heavy Galvanised Steel	6 (medium only) or 8 to 150 mm nominal bore
Copper EN12735, Copper ASTM	¼ to 6⅛ inch, as above
Table X Copper - EN1057, Table Y Copper - EN1057	6, 8, 10, 12, 15, 22, 28, 35, 42, 54, 66.7, 76.1, 108, 133, 159 mm outside diameter
ABS - ISO 15493 PN10	16 to 315 mm
ABS Class C, ABS Class C - BS5391	1 to 8 inch
ABS Class E - BS5391	⅜ to 4 inch
ABS Class T - BS5391	⅜ to 2 inch
PVCu - EN 1452-2 PN10	32 to 315 mm
PVCu - EN 1452-2 PN16	20 to 315 mm

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Each schedule carries its own bores, surface roughness, material density (for the tube weight) and pressure class, which the fluid design pressure is checked against.

20.3 Inch sizes and their outside diameters

Copper and aluminium tube sizes are the nominal outside diameters in inches; steel sizes are nominal bores. The outside diameters MicroPipe uses are:

Copper / Al	OD mm	Copper / Al	OD mm	Copper / Al	OD mm	Steel NB	OD mm	Steel NB	OD mm	Steel NB	OD mm
¼″	6.35	1⅛″	28.58	3⅝″	92.08	½″	21.34	2½″	73.03	10″	273.05
⅜″	9.53	1⅜″	34.93	4⅛″	104.78	¾″	26.67	3″	88.90	12″	323.85
½″	12.70	1⅝″	41.28	5⅛″	130.18	1″	33.40	4″	114.30	14″	355.60
⅝″	15.88	2⅛″	53.98	6⅛″	155.58	1¼″	42.16	5″	141.30	16″	406.40
¾″	19.05	2⅝″	66.68			1½″	48.26	6″	168.28	18″	457.20
⅞″	22.23	3⅛″	79.38			2″	60.33	8″	219.08	20″	508.00

20.4 Copper gauges and the maximum working pressure

EN 12735 copper tube is made in several wall thicknesses, identified by gauge number (the higher the gauge, the thinner the wall). For each size MicroPipe selects the *thinnest gauge whose maximum working pressure is at least the design pressure*, and reports it in the **Gauge(s)** column and the pipe summary. The gauges available for each size are:

Size	Gauges (wall, mm)	Size	Gauges (wall, mm)
¼″	22 (0.64), 20 (0.82)	1⅝″	18 (1.10), 16 (1.46), 14 (1.83), 12 (2.38)
⅜″	22 (0.64), 21 (0.73), 20 (0.82)	2⅛″	18 (1.10), 16 (1.46), 14 (1.83), 12 (2.38)
½″	21 (0.73), 20 (0.82)	2⅝″	18 (1.10), 16 (1.46), 14 (1.83), 12 (2.38)
⅝″	20 (0.82), 19 (0.91)	3⅛″	18 (1.10), 16 (1.46), 14 (1.83), 12 (2.38)
¾″	19 (0.91), 18 (1.10), 16 (1.46)	3⅝″	18 (1.10), 16 (1.46), 14 (1.83), 12 (2.38)
⅞″	18 (1.10), 16 (1.46)	4⅛″	16 (1.46), 14 (1.83), 12 (2.38)
1⅛″	18 (1.10), 16 (1.46), 14 (1.83)	5⅛″	16 (1.46), 14 (1.83), 12 (2.38)
1⅜″	18 (1.10), 16 (1.46), 14 (1.83), 12 (2.38)	6⅛″	16 (1.46), 14 (1.83), 12 (2.38)

The maximum working pressure of a tube is calculated from its wall thickness t, its outside diameter D and the allowable stress S of the material at the reference temperature, essentially as $MWP = 20\,S\,t\,/\,(D - t)$ with the stress in MPa and the pressure in bar. The **MWP Calculation Standard** decides where the allowable stress and the safety factors come from: **BS1306** uses the stress values of the British standard for copper refrigeration pipework; **DKI** uses those of the German copper institute's method, which are more conservative for plain copper. The reference temperature is 50 °C for every mode except Discharge, where the hot gas is taken at 150 °C and the allowable stress, and so the MWP, is lower. For K65 and aluminium the standard's own factors are applied. The maximum test pressure in the pipe summary is 1.5 times the maximum working pressure.

For **steel** there are no gauges: the schedule fixes the wall. The maximum working pressure is reported for each manufacturing method the size is available in — **Seamless** (every size), **CW** continuous-weld (up to 4″) and **ERW** electric-resistance-welded (2″ and above) — because the allowable stresses differ, and the pressure pass is given for each. Order the pipe to the method that passes. (The Windows version showed this test by colouring the maximum working pressure green or red; online it is the ✔ or ✘ in **Pressure Pass**.)

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20.5 Design pressure standards

The **Design Pressure Standard** sets the default design temperature (section 8.8) and the settings derived from the design pressure: leak-test pressure, strength-test pressure, high-pressure cut-out, relief-valve setting and rated discharge (section 12.3). The two standards offered are **BS EN 378** (the European refrigeration safety standard) and **ASME B31.5 – 2006** (the American refrigeration piping code). The factors applied to the design pressure are the same under both; the design temperatures they imply differ.

Setting	Factor on the design pressure	Notes
Leak test pressure	1.0 ×	Equal to the design pressure.
Pressure (strength) test	1.3 ×	
High pressure cut-out	0.9 ×	High side only; shown as N/A on a suction or pumped-liquid network.
Relief valve setting	1.0 ×	Equal to the design pressure.
Relief valve rated discharge	1.1 ×	
Design temperature default	–	BS EN 378: 32 °C low side, 55 °C high side. ASME B31.5: 27 and 50 °C. R744 and R23/R508B have their own defaults (section 8.8).

These are the figures for the pipework MicroPipe has sized; vessels and components may have their own, and the designer remains responsible for the relief protection of the system as a whole (Appendix D).

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CHAPTER 21

Refrigerants and fluids

21.1 Refrigerants

The refrigerant list is grouped to make it easy to find what you need. All have full property tables from −60 to 60 °C unless noted.

Group	Refrigerants	Notes
Naturals	R744 TC, R744, R717, R290, R1270, R600a	R744 is CO_2 on a subcritical high side (tables to its critical point, about 31 °C); R744 TC is CO_2 with a transcritical high side (section 8.7). R717 is ammonia and excludes copper and aluminium. R290 (propane), R1270 (propylene) and R600a (isobutane) are hydrocarbons.
Synthetics — Low GWP	R455A, R454C, R454A, R454B, R1234ze, R1234yf	HFO and HFO blends.
Synthetics — Mid GWP	R448A, R449A, R134a, R513A, R450A, R32	
Synthetics — High GWP	R407F, R407A, R410A, R407C	
Synthetics — Legacy	R404A, R507A, R502, R22, R12, R11	Kept for the analysis of existing plant.
Synthetics — ULT	R23, R508B	Ultra-low-temperature refrigerants; tables from −110 to 10 °C, and the temperature defaults and ranges are shifted to match (section 8.8).

For a zeotropic blend the saturation temperature depends on whether the refrigerant is all vapour (dew point) or all liquid (bubble point). MicroPipe uses the dew point for suction and discharge calculations and the bubble point for liquid and pumped-liquid calculations, and the converter tool lets you choose either.

> **OIL-RETURN WINDOW**
>
> The oil-return correlation is valid over a range of evaporating temperature for each refrigerant. A Dry Suction network whose evaporating temperature lies outside that range stops with *The evaporating temperature (…) is outside the oil return window for …*; the message gives the window.

21.2 Working fluids

Fluid	Temperature range	Concentration (% by mass)	Notes
Water	0 to 220 °C	–	Chilled, heating and process water.
Saturated Steam	100 to 250 °C	–	Latent fluid: duty carried by condensation; no temperature rise, no pumping power.
Propylene Glycol	−45 to 30 °C	15 to 57	Freezing point follows the concentration.
Ethylene Glycol	−45 to 30 °C	14 to 56	Freezing point follows the concentration.
Calcium Chloride	−45 to 30 °C	9 to 29.4	Brine; default 15%.
User-Defined	−60 to 300 °C	–	From the property table you enter (section 8.10).

The property correlations for ethylene glycol, propylene glycol and calcium chloride are the ones the Windows version used, which its manual records as provided by the IIR in *Thermophysical Properties of Liquid Secondary Refrigerants*; the online MicroPipe carries the same equations. Users who require other fluids can enter their properties as a user-defined fluid, or contact Omega for assistance.

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CHAPTER 22

Messages reference

Every message MicroPipe can show after a calculation, with what it means and what to do. *Errors* stop the calculation; *warnings* report something about a calculation that completed, or a correction that was made. Where a message names a field, the **Show field** link takes you to it.

22.1 Errors in the description of the network

Message	Meaning and remedy
Invalid circuit label	A circuit has a blank label (an automatic calculation; a press of **Calculate** catches this before sending). Label every row.
Duplicate label ...	Two circuits share a label. Rename one; the next labels that pointed at it follow the rename.
Broken link while following load ...	A next label names a circuit that does not exist (usually after a label was edited in an export, or an old network whose labels were changed). Choose the next label again from the list.
Invalid next label: ... points to terminal/load ...	A next label names a terminal. Nothing can flow into a terminal: point it at the network circuit after the terminal, or clear the terminal flag on the row that is really a network circuit.
No loads found	No circuit is a terminal. Switch **Terminal?** on for the evaporators (or compressors) and enter their duties.
The following load bearing pipe (terminal) has a duty below the minimum of ...: ... Enter a duty of at least ... on each, then calculate again.	A terminal has no duty, or one below 0.03 kW (0.001 in Fluid). Enter the duty. With several, the message begins *The following load bearing pipes (terminals) have ...*
No end-of-line circuit found (exactly one blank Next Label is required).	Every circuit has a next label, so the paths never end. Clear the next label of the last circuit.
Multiple end-of-line circuits found (...)	More than one circuit has a blank next label; the message lists them. All but one need a next label.
Cycle detected following load ...	The next labels form a loop. Follow the path named and find the circuit pointing backwards.
Path from load ... cannot start: ...	The terminal's own next label is missing or wrong.
Flow path from load ... exceeds the BAS limit of 100 circuits. / ... exceeded max depth	A path is longer than 100 circuits, or the labels form a very long chain by mistake. Combine circuits, or look for a loop.
... has zero calculated duty; check for a broken flow path or missing terminal duty.	A network circuit has nothing flowing through it: no terminal's path reaches it. Usually a next label should point at it and does not.
Pipe ... needs to be a Header because n pipes connect to it but it was not changed because ...	Three or more circuits connect into a row that cannot be a header (it is a terminal, or not horizontal). Correct the row, or reduce the connections to two.
... has n incoming branches but is not a header	More than two circuits flow into a row whose **Header?** switch is off and could not be set automatically (see the previous message). Turn the switch on, or reduce the connections to two.
Tee junction ... cannot have two 180° incoming connections ... Use one 180° and one 90°, or two 90° junctions.	Set the junction type of one of the two entering circuits to 90°.
Double riser ... must connect to an upstream circuit; leave Next Label blank only for non-double-riser root circuits.	A double riser cannot be the end of the line. Add the horizontal run after it as a circuit.
Double riser ... cannot connect directly to header/tee circuit ...	The double riser discharges into a circuit that something else also joins. Insert a short normal circuit between the riser and the tee.

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Message	Meaning and remedy
Double riser … cannot have multiple pipes feeding directly into it; insert one normal circuit between …	Two circuits connect into the double riser. Insert a normal circuit (the horizontal run) before it and connect them to that.
Double riser … cannot connect directly to single riser / double riser … on its outlet side; insert one normal circuit between the risers.	Two risers follow each other. Insert the horizontal run between them as a circuit.
Double riser … cannot connect directly to … on its inlet side; insert one normal circuit between the risers.	As above, on the inlet side. (A *terminal* single riser feeding a double riser is allowed — section 19.5.)
The user-defined fluid property table is empty or incomplete. …	Every row of the table needs a temperature, density, viscosity and specific heat. Complete or delete the rows.

22.2 Errors in the sizing

Message	Meaning and remedy
Calculated total penalty (x K) exceeds the user input Max Penalty (y K). Please relax Max Penalty.	Even with the largest usable sizes the worst path loses more than the permitted penalty — or fixed sizes and risers are using the penalty up. Allow a larger penalty, release fixed sizes, lower the required oil-return duty of risers or use double risers, remove size exclusions, or shorten the path.
… Please relax Max Penalty and/or Required Oil Duty.	As above, where the risers' oil-return requirement is forcing small risers with a high penalty. A double riser, or a lower required oil-return duty, is usually the answer.
Calculated total pressure drop / discharge ΔP / liquid ΔP (x kPa) exceeds the user input Max Pressure Drop (y kPa). Please relax Max Pressure Drop.	The pressure-drop equivalent, in the modes sized to a pressure drop.
One or more paths cannot achieve user input constraints. Please relax …	No combination of sizes satisfies every path. Relax the constraint named.
One or more rows cannot satisfy the user input Required Oil Duty (%). Responsible row labels: …	No pipe size returns oil at the required percentage for the risers listed (typically a very low percentage at a low liquid temperature). Use a double riser, or reconsider the minimum load (section 19.7).
…: No pipe size satisfies full-flow oil return duty.	A double riser whose legs cannot be chosen to return oil. Check the duties and the minimum liquid temperature.
…: Required Oil Duty (kW) cannot exceed the total duty on the riser (x kW).	With `Oil Duty kW` on, a riser's kW requirement is more than flows through it. Reduce it.
The evaporating temperature (…) is outside the oil return window for …	The oil-return correlation does not cover this evaporating temperature for this refrigerant; the message gives the window.
The following pipe has a fixed size this network cannot use: … The size cannot meet the pressure rating for this refrigerant and design pressure. Choose a different fixed size or unfix the pipe, then calculate again.	The held size fails the pressure pass at the design pressure (or, where no gauge is offered, cannot be rated). Choose a larger size or release it. With several such pipes the message begins *The following pipes have …*
Temperature … outside table range / pressure … outside table range	R744 TC: the gas-cooler condition is outside the supercritical property table. Correct the gas-cooler temperature or pressure.
This pressure range (72.13 ↔ 73.8 bar) is not allowed. Please choose another value.	R744 TC: the minimum gas-cooler pressure is in the band between subcritical and supercritical treatment. Choose a value outside it.
The second pass cannot size every pipe in this network.	Dry Suction: the standard pass failed and the second attempt could not size every circuit either. Relax the penalty or revise the risers.
Unable to compute network totals. Please review inputs.	The totals could not be calculated from the sized network; review the settings, especially temperatures near the table limits.
An unexpected error occurred during the calculation. Please check the network and circuit inputs.	The engine met something it could not handle. Check for unusual values; if it persists, export the network and send it to Omega.

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22.3 Warnings

Message	Meaning
Pipe ... was automatically set to Header because n pipes connect to it.	Three or more circuits connect into it; the **Header?** switch has been turned on for you.
Pipe ... was automatically unset as Header because only n pipe(s) connect to it.	The switch was on but fewer than three circuits connect; it has been turned off.
Pipe ... was automatically changed to a 90° junction because it connects into header ...	Every entry into a header is a 90° entry.
Pipe ... was automatically unset as Terminal because it is marked Header / because its orientation is Double Riser / because it is marked Header and its orientation is Double Riser.	The terminal flag was cleared and the duty dropped: a terminal cannot be a header or a double riser. Check which row you meant.
Pipe ... was automatically unset as Dual Circuit because it is marked Header / because its orientation is ...	A dual circuit must be a horizontal network circuit: the switch was turned off because the row is a header, or a single or double riser.
Required Oil Duty (kW) for ... has been stored, but the total duty on this riser is not yet known. ...	Enter the terminal duties upstream; the percentage will be derived.
The condenser drain branches were ignored because ... (no branch length / number of branches is zero / a single branch is not permitted)	Enter 2 to 10 branches with a branch length, or 0 for none.
The number of drain branches was rounded down to n. Enter a whole number of branches.	Self-explanatory.
The condenser drain branch pipe is larger than the main drain pipe.	A fixed main size is smaller than the branches selected. Check the fixed size.
The fixed condenser drain main/branch pipe size (...) gives x m/s, above the 0.55 m/s drain target.	The size you held is too small for a gravity drain; the velocity is reported and the size kept.
The fixed condenser drain ... pipe size (...) is not available for this pipe material or is excluded / has no usable dimensions, so the ... was sized automatically.	Self-explanatory.
The largest available pipe size is too small for the condenser drain ... duty.	Use a larger schedule or remove a size exclusion.
The condenser drain could not be sized because the liquid density is unavailable at the condensing temperature.	Check the condensing temperature.
The condenser drain main contributes no pipe length, volume or refrigerant charge because no main drain pipe length was entered.	Enter the main drain length.

22.4 Notifications and notices outside a calculation

Message	Meaning
... Default Value ... Applied	A field was reset to its default after a change of refrigerant, mode or standard (section 8.8).
Refrigerant Changed To R744 (R744 TC Not Available In ...)	Wet Suction and Pumped Liquid use the subcritical CO_2 tables.
Fluid Temperature Clamped To ... °C	The temperature was below the fluid's freezing point at this concentration, or outside its table.
... Is Not Available For This Pipe Material And Has Been Cleared	A fixed drain size the new material does not offer.
Calculate the network before printing	**Print** or **Export CSV** needs results.

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Message	Meaning
Allow pop-ups to print this network	The browser blocked the report window.
Import failed: not a MicroPipe project/network file / file is not valid JSON / ...	The file chosen is not an export of the right kind, or has been edited.
Select one legacy project file at a time, optionally with its .wrp pipe schedule	Legacy import takes one project file per import.
Import failed: the refrigerant could not be read from the file / ...	Legacy import could not convert the file; the reason follows.
You are offline. A new project cannot be created / A project cannot be imported until you are back online.	These need the server.
Your licence has expired. New projects cannot be created.	Read-only licence.
This project was changed on another device, so this copy has been reloaded. The version you had has been kept as "... (your version)".	Section 5.6.
This project was changed elsewhere and has been reloaded.	Section 5.6: the same event, when this device held no copy of its own to keep.
This licence is no longer active. You can still open, export and print your saved projects, but calculation has stopped. Contact Omega.	The licence became read-only while the page was open (the expiry dates are shown once the page is reloaded).
This project was deleted on another device, so it has been removed here / ... has been kept here, as your only project, and saved again.	Section 5.6.
This browser will not store your work locally — its storage may be full. ...	Section 4.5. The second form of the message, ending *It exists only in this page and will be lost if you close it*, means the work is reaching neither the browser nor the server: export it now.
The tools calculate on the server and it cannot be reached	Offline; the converter tools need the server.
MicroPipe could not load its reference data. Please check your connection and reload the page.	The page could not fetch its data at start-up. Reload; if it persists, the licence check may have failed — reload from the MicroPipe address rather than a saved copy of the page.

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PART D

Worked examples

Seven complete networks, entered step by step, with the figures MicroPipe produces for them. Enter them yourself to learn the screens, and to check that your installation gives the same answers.

- 23 Example 1: a single-circuit suction line
- 24 Example 2: a supermarket LT suction network
- 25 Example 3: a pack discharge line with condenser drain
- 26 Example 4: a chilled-water secondary circuit
- 27 Further examples: liquid, pumped liquid and wet suction

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CHAPTER 23

Example 1: a single-circuit suction line

The single-circuit example from the Windows manual: one evaporator, one condensing unit, four circuits in series with two risers. It takes five minutes and exercises most of the Network view.

23.1 The system

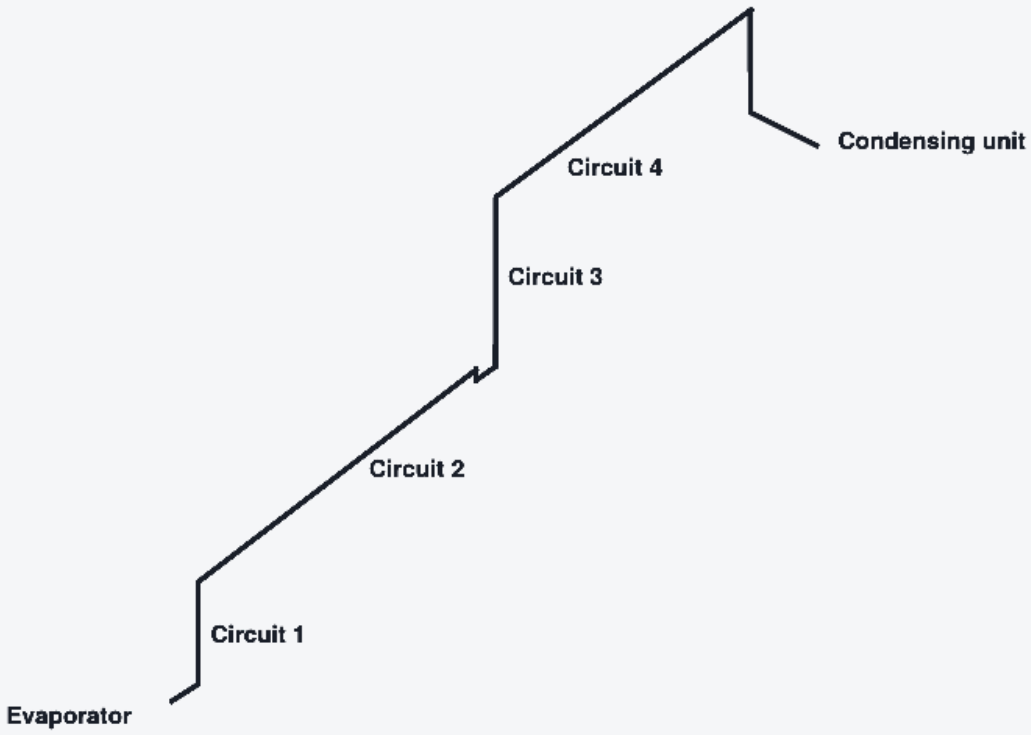


Figure 23.1 The single-circuit example: a 12.5 kW evaporator feeding a condensing unit through four circuits.

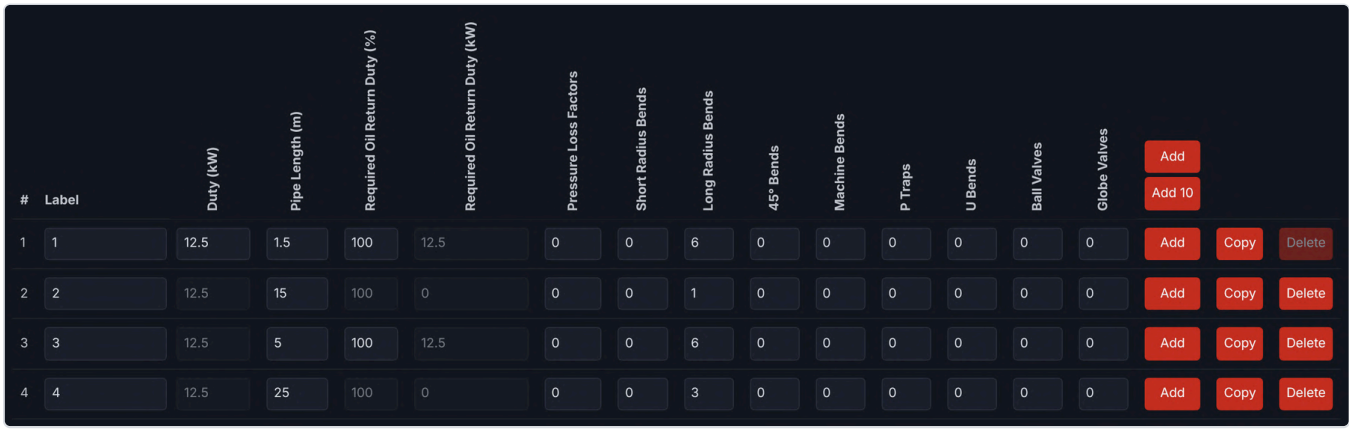
Design parameter	Value	Circuit	Details
Refrigerant	R404A, Copper EN12735	1	Terminal, 12.5 kW; single riser, 100% minimum capacity; 1.5 m; 6 long radius bends
Evaporating temperature	−30 °C	2	Horizontal; 15 m; 1 long radius bend
Suction superheat	20 K	3	Single riser, 100% minimum capacity; 5 m; 6 long radius bends
Maximum liquid temperature	35 °C	4	Horizontal; 25 m; 3 long radius bends; end of line
Minimum liquid temperature	25 °C		
Maximum permitted penalty	1.5 K		

23.2 Entering it

1. In the Networks view press **Add**, open the new network, and name it *Single circuit example*. Leave the mode as Dry Suction and the refrigerant as R404A.

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2. Set **Evaporating Temperature** to −30, **Superheat** to 20, **Max Liquid Temperature** to 35, **Min Liquid Temperature** to 25 and **Max Penalty** to 1.5. Leave the pipe material, standards, design temperature (32 °C) and riser bias at their defaults.
3. Press **Add** three times so that there are four circuit rows, and label them 1, 2, 3 and 4.
4. Set the next labels: 1→2, 2→3, 3→4, and leave circuit 4's blank.
5. Switch **Terminal?** on for circuit 1 and enter its duty, 12.5.
6. Set the orientations: circuits 1 and 3 to Single Riser (their required oil-return duty defaults to 100%), 2 and 4 Horizontal.
7. Enter the lengths (1.5, 15, 5, 25) and the long radius bends (6, 1, 6, 3).
8. Press **Calculate**.



#	Label	Duty (kW)	Pipe Length (m)	Required Oil Return Duty (%)	Required Oil Return Duty (kW)	Pressure Loss Factors	Short Radius Bends	Long Radius Bends	45° Bends	Machine Bends	P Traps	U Bends	Ball Valves	Globe Valves			
1	1	12.5	1.5	100	12.5	0	0	6	0	0	0	0	0	0	Add	Copy	Delete
2	2	12.5	15	100	0	0	0	1	0	0	0	0	0	0	Add	Copy	Delete
3	3	12.5	5	100	12.5	0	0	6	0	0	0	0	0	0	Add	Copy	Delete
4	4	12.5	25	100	0	0	0	3	0	0	0	0	0	0	Add	Copy	Delete

Figure 23.2 The duty, length, oil-return and fittings columns of the circuits table as entered (the connection and orientation columns are shown in Figure 9.1). Circuits 2, 3 and 4 show the summed duty of 12.5 kW in their greyed duty boxes.

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23.3 The results

Label	Type	Next	Duty kW	Orientation	Size(s)	Fixed	Length m	Bends	Valves	Oil Return %
1	Terminal	2	12.50	Single Riser	1-3/8	✘	1.50	6	0	34.5
2	Network	3	12.50	Horizontal	2-1/8	✘	15.00	1	0	108.7
3	Network	4	12.50	Single Riser	1-5/8	✘	5.00	6	0	53.8
4	Network		12.50	Horizontal	1-5/8	✘	25.00	3	0	53.8

Label	Velocity m/s	Penalty K	Penalty kPa	Pipe kPa	Fittings kPa	Valves kPa	Flowpath K	Flowpath kPa	Gauge(s)	MWP bar(g)	Pressure Pass
1	15.89	0.39	3.30	0.77	2.53	0.00	1.47	12.25	18	26.60	✓
2	6.35	0.12	1.04	0.82	0.21	0.00	-	-	18	17.02	✓
3	11.14	0.24	2.04	1.08	0.97	0.00	-	-	18	22.39	✓
4	11.14	0.71	5.87	5.39	0.48	0.00	-	-	18	22.39	✓

Total Duty **12.50 kW**	Total Penalty **12.25 kPa**	Total Penalty **1.47 K**	SST **-31.47 °C**	Evaporating Pressure **2.02 bar(a)**
Suction Pressure **1.90 bar(a)**	Suction Density **9.59 kg/m³**	Mass Flow Rate **0.12826 kg/s**	Volumetric Flow Rate **0.01337 m³/s**	Pipe-System Volume **68.84 litres**
Pipe-System Contents **0.66 kg**	Design Pressure **13.85 bar(g)**	Leak Test Pressure **13.85 bar(g)**	Pressure Test **18.01 bar(g)**	High Pressure Cut-out **N/A**
Relief Valve Setting **13.85 bar(g)**	Relief Valve Rated Discharge **15.24 bar(g)**			

Figure 23.3 The results: the table in two halves (Label column repeated) and the totals.

Circuit	Type	Size	Velocity m/s	Penalty K	Penalty kPa	Oil return %	Gauge	MWP bar(g)
1	Terminal, single riser	1⅜″	15.89	0.39	3.30	34.5	18	26.60
2	Network, horizontal	2⅛″	6.35	0.12	1.04	108.7	18	17.02
3	Network, single riser	1⅝″	11.14	0.24	2.04	53.8	18	22.39
4	Network, horizontal	1⅝″	11.14	0.71	5.87	53.8	18	22.39

Total penalty **1.47 K · 12.25 kPa**	SST at the unit **−31.47 °C**	Mass flow **0.128 kg/s**
Pipe-system volume / contents **68.8 litres · 0.66 kg**	Design pressure (32 °C) **13.85 bar(g)**	Pressure test / relief discharge **18.01 · 15.24 bar(g)**

Reading it

- The penalty budget of 1.5 K is almost fully used (1.47 K), which is what the optimiser aims for.
- Both risers are sized for oil return at 100% of load, and they return oil down to 34.5% and 53.8% of load respectively — comfortably below the requirement. The risers are smaller than the horizontal run between them (1⅜″ and 1⅝″ against 2⅛″), and run at 16 and 11 m/s, which is where most of the penalty goes.
- Circuit 2, the horizontal between the risers, has an oil-return figure of 108.7%: at 2⅛″ it would not return oil if it rose. It must fall towards circuit 3, with a trap at the foot of riser 3 — which is how the system was drawn.

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- Every pipe passes the design pressure of 13.85 bar(g) in gauge 18.

TRY THIS

Change **Min Liquid Temperature** to 5 °C and calculate again. The sizes do not change, but every Oil Return % figure rises (the risers to 43.3% and 67.4%): colder liquid means less mass flow per kilowatt, so a larger share of the load is needed to carry oil up a riser. Set it back to 25 °C and instead set the required oil-return duty of circuit 3 to 50%. The riser must now return oil with half the load running and drops to 1⅜″ (34.5%, 0.61 K). Because that uses more of the penalty budget, the optimiser re-balances the rest of the network — circuit 1 grows to 1⅝″, circuit 2 falls to 1⅛″ and circuit 4 grows to 2⅛″ — and the total comes to 1.37 K. A constraint on one circuit can change the sizes of the others; this is the trade-off Chapter 19 describes.

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CHAPTER 24

Example 2: a supermarket LT suction network

The 28-circuit EXAMPLE1 of the Windows manual: a run of frozen-food display cases and two freezer rooms on a low-temperature pack, with single and double risers. It shows how a real network is described and what MicroPipe makes of it.

24.1 The system

ACME Supermarkets, store 3206, LT suction. R404A, copper EN12735. Evaporating temperature −35 °C, suction superheat 30 K, maximum liquid temperature 38 °C, minimum liquid temperature 10 °C, maximum penalty 1.5 K. Eight display-case evaporators (1–8) tee into a main that rises through a double riser (16) to the ceiling; two freezer rooms, each with two coolers on single risers (18–19 and 21–23), join it; the common main (26) drops through a second double riser (27) to the compressor pack (28).

#	Type	Duty kW	Length m	LR bends	SR bends	Ball valves	Next	Oil return %	#	Type	Duty kW	Length m	LR bends	SR bends	Ball valves	Next	Oil return %
1	T	1.5	2	2		1	9		15	N		20	2			16	
2	T	2.5	1	1		1	9		16	N DR		4		6		17	35
3	T	2.5	1	1		1	11		17	N		5			1	26	
4	T	2.5	1	1		1	13		18	T SR	4.5	2		7	1	20	100
5	T	2.5	1	1		1	12		19	T SR	4.5	1		6	1	20	100
6	T	2.5	1	1		1	12		20	N		10	1			25	
7	T	2.5	1	1		1	14		21	T SR	3.2	1		6	1	22	100
8	T	1.5	2	2		1	10		22	N		4				24	
9	N		3				10		23	T SR	3.2	1		6	1	24	100
10	N		0.5				11		24	N		6				25	
11	N		1.5				15		25	N		3			1	26	
12	N		3				13		26	N		28	1			27	
13	N		0.5				14		27	N DR		4		6		28	35
14	N		1.5				15		28	N		2				–	

T terminal · N network circuit · SR single riser · DR double riser (35% required oil-return duty). Every junction is 90°. The double risers carry no valves.

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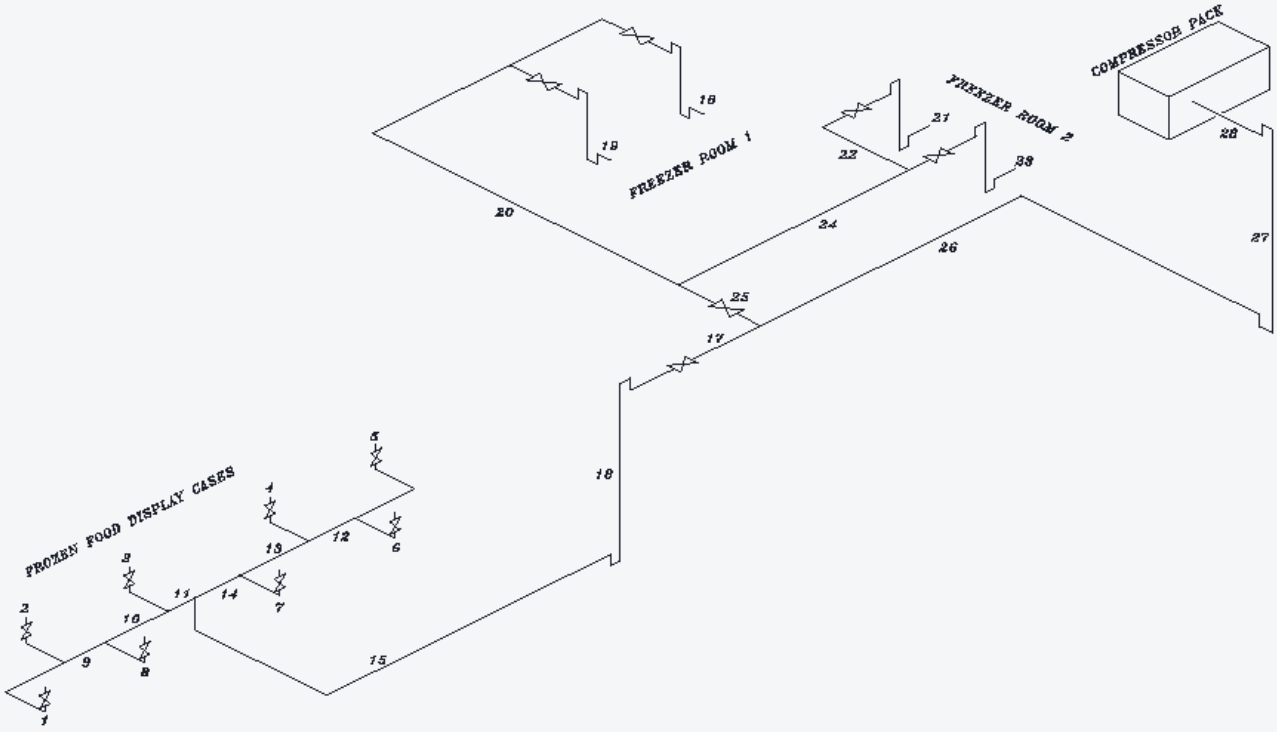


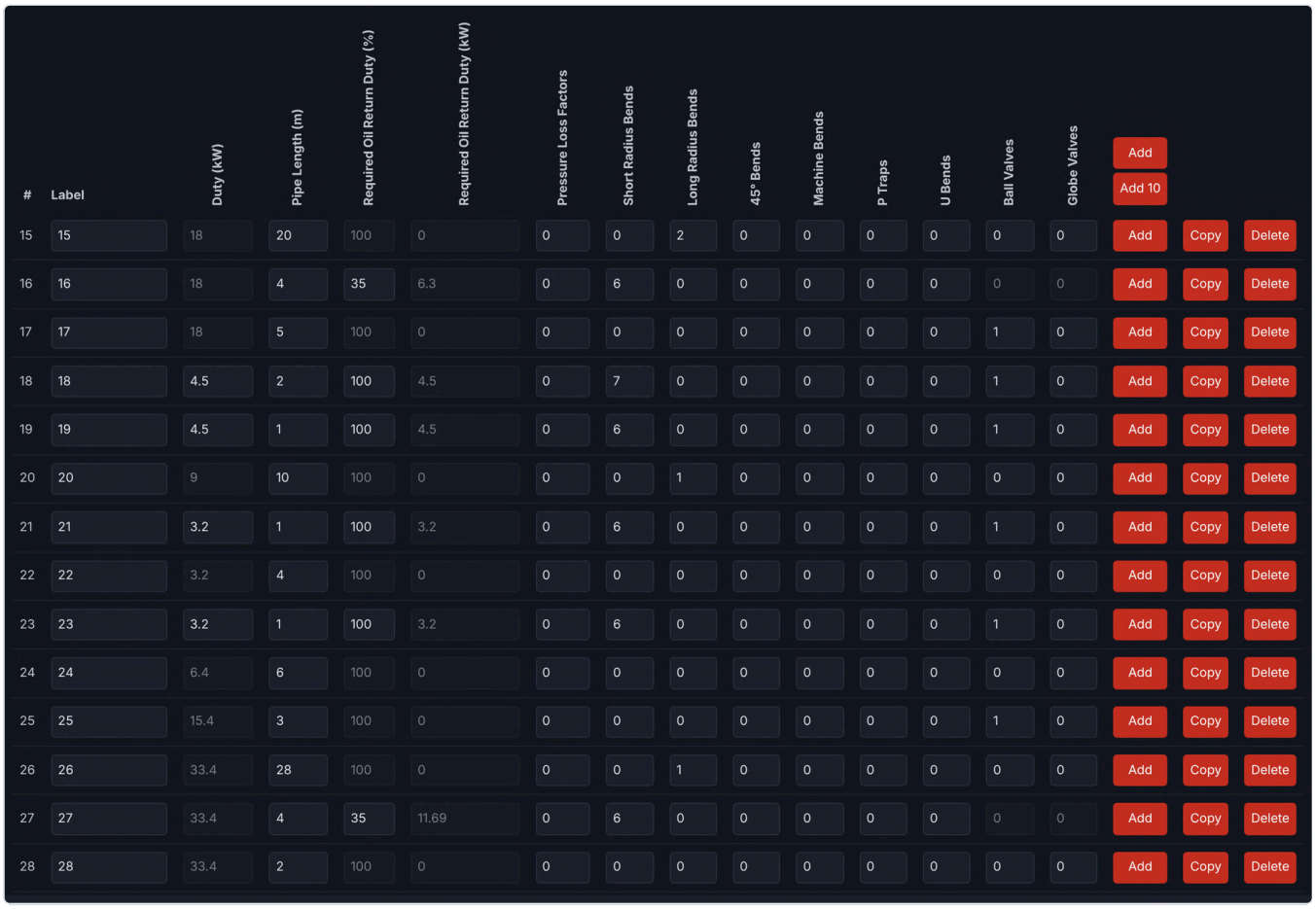
Figure 24.1 The network drawn as an isometric (from the Windows manual): the frozen-food display cases, the two freezer rooms and the compressor pack. The circuit numbers are the ones used throughout this chapter.

24.2 Entering it

1. Add a network, name it *ACME LT suction*, and set the design conditions: evaporating −35, superheat 30, max liquid 38, min liquid 10, max penalty 1.5.
2. Press **Add 10** twice and **Add** seven times for 28 rows (or **Add 10** three times and delete three, since a new network starts with one row).
3. Label the rows 1 to 28 and set the next labels from the table. The end-of-line circuit, 28, has none.
4. Switch **Terminal?** on for 1–8, 18, 19, 21 and 23 and enter their duties.
5. Set the orientation of 16 and 27 to Double Riser with 35% required oil-return duty, and of 18, 19, 21 and 23 to Single Riser (100%).
6. Enter the lengths, bends and valves. Note the ball valves: one on each case tail and freezer cooler, one on 17 and one on 25.
7. Press **Calculate**. The network takes a second or two because of the two double risers.

EXERCISE

The Windows manual's version of this example carried a deliberate error for the reader to find. The table above calculates cleanly — no errors and no warnings — so if you want the exercise, make these changes one at a time, calculate, and read what MicroPipe reports before restoring the table. Make 16 a single riser at the same 35%: it is chosen at 1⅜″ to return oil, the rest of the path cannot recover the penalty, and the calculation stops with *Calculated total penalty (3.31 K) exceeds the user input max penalty (1.50 K)*. Make 17 a single riser: *Double riser 16 cannot connect directly to single riser 17 on its outlet side; insert one normal circuit between the risers*. Point circuit 2 at 10 instead of 9: the network still calculates, with the warning *Pipe 10 was automatically set to Header because 3 pipes connect to it*. Chapter 22 explains each message.



#	Label	Duty (kW)	Pipe Length (m)	Required Oil Return Duty (%)	Required Oil Return Duty (kW)	Pressure Loss Factors	Short Radius Bends	Long Radius Bends	45° Bends	Machine Bends	P Traps	U Bends	Ball Valves	Globe Valves	Add / Add 10		
15	15	18	20	100	0	0	0	2	0	0	0	0	0	0	Add	Copy	Delete
16	16	18	4	35	6.3	0	6	0	0	0	0	0	0	0	Add	Copy	Delete
17	17	18	5	100	0	0	0	0	0	0	0	0	1	0	Add	Copy	Delete
18	18	4.5	2	100	4.5	0	7	0	0	0	0	0	1	0	Add	Copy	Delete
19	19	4.5	1	100	4.5	0	6	0	0	0	0	0	1	0	Add	Copy	Delete
20	20	9	10	100	0	0	0	1	0	0	0	0	0	0	Add	Copy	Delete
21	21	3.2	1	100	3.2	0	6	0	0	0	0	0	1	0	Add	Copy	Delete
22	22	3.2	4	100	0	0	0	0	0	0	0	0	0	0	Add	Copy	Delete
23	23	3.2	1	100	3.2	0	6	0	0	0	0	0	1	0	Add	Copy	Delete
24	24	6.4	6	100	0	0	0	0	0	0	0	0	0	0	Add	Copy	Delete
25	25	15.4	3	100	0	0	0	0	0	0	0	0	1	0	Add	Copy	Delete
26	26	33.4	28	100	0	0	0	1	0	0	0	0	0	0	Add	Copy	Delete
27	27	33.4	4	35	11.69	0	6	0	0	0	0	0	0	0	Add	Copy	Delete
28	28	33.4	2	100	0	0	0	0	0	0	0	0	0	0	Add	Copy	Delete

Figure 24.2 Rows 15 to 28 of the circuits table as entered (the duty, length, oil-return and fittings columns). The greyed duty boxes show the summed duties: 18 kW through the display-case main (15, 16, 17), 15.4 kW through 25, and the full 33.4 kW through 26, 27 and 28. The derived oil-return duties of the double risers (6.3 and 11.69 kW) are shown beside their 35%, and the valve boxes of the double risers are disabled.

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24.3 The results

Label	Type	Next	Duty kW	Orientation	Size(s)	Fixed	Length m	Bends	Valves	Oil Return %
15	Network	16	18.00	Horizontal	2-5/8	✘	20.00	2	0	136.1
16	Network	17	18.00	Double Riser	1-5/8 + 1-3/8	✘	4.00	6	0	25.7
17	Network	26	18.00	Horizontal	2-5/8	✘	5.00	0	1	136.1
18	Terminal	20	4.50	Single Riser	1-1/8	✘	2.00	7	1	60.0
19	Terminal	20	4.50	Single Riser	1-1/8	✘	1.00	6	1	60.0
20	Network	25	9.00	Horizontal	1-5/8	✘	10.00	1	0	80.1
21	Terminal	22	3.20	Single Riser	7/8	✘	1.00	6	1	42.4
22	Network	24	3.20	Horizontal	1-1/8	✘	4.00	0	0	84.3
23	Terminal	24	3.20	Single Riser	7/8	✘	1.00	6	1	42.4
24	Network	25	6.40	Horizontal	1-5/8	✘	6.00	0	0	112.6
25	Network	26	15.40	Horizontal	2-5/8	✘	3.00	0	1	159.1
26	Network	27	33.40	Horizontal	3-1/8	✘	28.00	1	0	115.5
27	Network	28	33.40	Double Riser	2-5/8 + 1-5/8	✘	4.00	6	0	21.6
28	Network		33.40	Horizontal	2-5/8	✘	2.00	0	0	73.3

Label	Velocity m/s	Penalty K	Penalty kPa	Pipe kPa	Fittings kPa	Valves kPa	Flowpath K	Flowpath kPa	Gauge(s)	MWP bar(g)	Pressure Pass
15	8.25	0.22	1.54	1.14	0.39	0.00	-	-	16	18.40	✔
16	13.21	0.40	2.82	1.02	1.80	0.00	-	-	18 + 18	22.39 + 26.60	✔ + ✔
17	8.25	0.09	0.67	0.29	0.25	0.13	-	-	16	18.40	✔
18	12.04	0.48	3.40	0.66	2.46	0.28	1.46	10.31	18	32.75	✔
19	12.04	0.40	2.82	0.33	2.21	0.28	1.38	9.73	18	32.75	✔
20	10.97	0.35	2.44	1.73	0.71	0.00	-	-	18	22.39	✔
21	14.85	0.53	3.71	0.67	2.61	0.43	1.43	10.08	18	42.59	✔
22	8.56	0.15	1.05	0.70	0.35	0.00	-	-	18	32.75	✔
23	14.85	0.70	4.87	0.67	3.77	0.43	1.45	10.20	18	42.59	✔
24	7.80	0.12	0.85	0.56	0.30	0.00	-	-	18	22.39	✔
25	7.06	0.06	0.41	0.13	0.18	0.10	-	-	16	18.40	✔
26	10.64	0.32	2.23	2.06	0.17	0.00	-	-	16	15.40	✔
27	11.58	0.21	1.47	0.50	0.97	0.00	-	-	16 + 18	18.40 + 22.39	✔ + ✔
28	15.30	0.05	0.36	0.36	0.00	0.00	-	-	16	18.40	✔

Figure 24.3 Rows 15 to 28 of the results table — the display-case main, the freezer rooms and the common main — in two halves with the Label column repeated. The double risers 16 and 27 show both sizes, both gauges and both pressure checks.



Figure 24.4 The totals.

1 → 9 → 10 → 11 → 15 → 16 → 17 → 26 → 27 → 28

Path Totals

Terminal	Path	Total Penalty K	Total Penalty kPa	Total Duty kW
1	1 → 9 → 10 → 11 → 15 → 16 → 17 → 26 → 27 → 28	1.49	10.52	33.40
2	2 → 9 → 10 → 11 → 15 → 16 → 17 → 26 → 27 → 28	1.44	10.14	33.40
3	3 → 11 → 15 → 16 → 17 → 26 → 27 → 28	1.38	9.77	33.40
4	4 → 13 → 14 → 15 → 16 → 17 → 26 → 27 → 28	1.45	10.22	33.40
5	5 → 12 → 13 → 14 → 15 → 16 → 17 → 26 → 27 → 28	1.49	10.53	33.40
6	6 → 12 → 13 → 14 → 15 → 16 → 17 → 26 → 27 → 28	1.49	10.53	33.40
7	7 → 14 → 15 → 16 → 17 → 26 → 27 → 28	1.40	9.87	33.40
8	8 → 10 → 11 → 15 → 16 → 17 → 26 → 27 → 28	1.46	10.32	33.40
18	18 → 20 → 25 → 26 → 27 → 28	1.46	10.31	33.40
19	19 → 20 → 25 → 26 → 27 → 28	1.38	9.73	33.40
21	21 → 22 → 24 → 25 → 26 → 27 → 28	1.43	10.08	33.40
23	23 → 24 → 25 → 26 → 27 → 28	1.45	10.20	33.40

Pipe Summary

Metric	7/8	1-1/8	1-3/8	1-5/8	2-1/8	2-5/8	3-1/8
Length (m)	6.0	13.0	4.0	31.0	3.0	34.0	28.0
Gauge	18	18	18	18	18	16	16
Maximum Working Pressure (bar(g))	42.59	32.75	26.60	22.39	17.02	18.40	15.40
Maximum Test Pressure (bar(g))	63.88	49.12	39.90	33.59	25.52	27.60	23.10
Tube Weight (kg/m)	0.648	0.843	1.037	1.232	1.622	2.666	3.186
Refrigerant Weight (kg/m)	0.002	0.004	0.006	0.009	0.016	0.024	0.035
Total Weight (kg/m)	0.650	0.847	1.044	1.241	1.638	2.691	3.221

Figure 24.5 The worst path, the path totals and the pipe summary.

Size	⅞″	1⅛″	1⅜″	1⅝″	2⅛″	2⅝″	3⅛″
Length (m)	6.0	13.0	4.0	31.0	3.0	34.0	28.0
Gauge	18	18	18	18	18	16	16
Maximum working pressure (bar(g))	42.59	32.75	26.60	22.39	17.02	18.40	15.40

Total duty **33.40 kW**	Worst-path penalty **1.49 K · 10.53 kPa**	SST at the pack **−36.49 °C**
Mass flow **0.373 kg/s**	Pipe-system volume / contents **284.8 litres · 2.17 kg**	Design pressure · test **13.85 · 18.01 bar(g)**

Reading it

- The worst path is case 1 — *1 → 9 → 10 → 11 → 15 → 16 → 17 → 26 → 27 → 28* — at 1.49 K; every other path is between 1.38 and 1.49 K, so the network is well balanced.
- The double riser 16 (18 kW) is 1⅝″ + 1⅜″ and returns oil down to 25.7% of its load against the 35% required; double riser 27 (33.4 kW) is 2⅝″ + 1⅝″ at 21.6%. The freezer-room single risers at 100% requirement return oil down to 60% (1⅛″ at 4.5 kW) and 42% (⅞″ at 3.2 kW).
- The risers take the largest share of the penalty: 0.40 K in 16, 0.48 K in 18, 0.70 K in 23. That is why the long horizontal mains (15, 26) are generous, at 2⅝″ and 3⅛″.
- The display-case mains 9–14 show oil-return figures of 96 to 182%: as designed they are horizontal and must fall towards 15; none of them could be allowed to rise.
- Gauge 16 is needed from 2⅝″ up to meet 13.85 bar(g); the smaller sizes pass in gauge 18.

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CHAPTER 25

Example 3: a pack discharge line with condenser drain

Three compressors discharging through a header and a common main to a remote air-cooled condenser, with the condenser drain sized in the same calculation.

25.1 The system and its entry

R448A, copper EN12735, evaporating −10 °C, superheat 10 K, isentropic efficiency 75%, condensing 43 °C, liquid 40 °C, max penalty 1 K, design temperature 55 °C (BS EN 378). Three 40 kW compressors C1, C2 and C3 each have a 2 m tail with 3 long radius bends and a ball valve into the header H (3 m), which feeds the main M: 30 m, 4 long radius bends and a ball valve to the condenser. The condenser drain: 150 kW (the condenser's own rating, entered as an override), 6 m main with 2 long radius bends, and two branches of 3 m with 2 bends each.

1. Add a network named *Pack discharge*; set **Mode** to Discharge and **Refrigerant** to R448A. The design temperature becomes 55 °C by itself.
2. Set the temperatures and the penalty as above. Switch **Condenser Drain** on and fill the drain fields (Figure 8.2): drain duty 150, drain length 6, 2 long radius bends, 2 branches, branch length 3, 2 long radius bends.
3. Enter five circuits: C1, C2, C3 (terminals, 40 kW, next H), H (next M) and M (end of line). Leave **Header?** off on H: MicroPipe sets it because three circuits connect, and tells you so.
4. Calculate.

25.2 The results

Total Duty **120.00 kW**	Total Penalty **23.48 kPa**	Total Penalty **0.52 K**	Discharge Temperature **78.98 (°C)**	Evaporating Pressure **3.62 bar(a)**
Condensing Pressure **18.05 bar(a)**	Discharge Density **64.03 kg/m³**	Mass Flow Rate **0.89087 kg/s**	Volumetric Flow Rate **0.01391 m³/s**	Pipe-System Volume **87.76 litres**
Pipe-System Contents **23.75 kg**	Compression Ratio **4.99**	Design Pressure **23.12 bar(g)**	Leak Test Pressure **23.12 bar(g)**	Pressure Test **30.06 bar(g)**
High Pressure Cut-out **20.81 bar(g)**	Relief Valve Setting **23.12 bar(g)**	Relief Valve Rated Discharge **25.44 bar(g)**		

Condenser Liquid Drain Details

Drain Duty **150.00 kW**	Main Drain Size **2-1/8"**	Main Drain Velocity **0.55 m/s**	Drain Branch Size **1-5/8"**	Drain Branch Velocity **0.47 m/s**
Drain Duty Source **Override**	Number Of Branches **2**	Main Drain Length **6.00 m**	Drain Branch Length, each **3.00 m**	Drain Branch Length, total **6.00 m**
Main Drain Pressure Check ✔	Drain Branch Pressure Check ✔	Drain Liquid Density **1025.16 kg/m³**	Drain Volume **18.86 litres**	Included In System Totals **Yes**

Figure 25.1 The discharge totals — with the discharge temperature, compression ratio and the high-side pressure settings — and the *Condenser Liquid Drain Details* group beneath them.

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Pipe Summary

Metric	1-1/8	1-5/8	2-1/8
Length, Discharge (m)	6.0		33.0
Length, Drain (m)		6.0	6.0
Gauge	18	16	14
Maximum Working Pressure, Discharge (bar(g))	27.15		23.85
Maximum Working Pressure, Drain (bar(g))		30.13	28.76
Maximum Test Pressure, Discharge (bar(g))	40.73		35.77
Maximum Test Pressure, Drain (bar(g))		45.20	43.14
Tube Weight (kg/m)	0.843	1.628	2.665
Refrigerant Weight, Discharge (kg/m)	0.035		0.127
Refrigerant Weight, Drain (kg/m)		1.184	2.039
Total Weight, Discharge (kg/m)	0.878		2.793
Total Weight, Drain (kg/m)		2.812	4.704

Figure 25.2 The pipe summary of a discharge network with a drain: the discharge and drain lengths, pressures and weights are reported in separate rows.

Circuit	Type	Size	Velocity m/s	Penalty K	Penalty kPa	Gauge	MWP bar(g)
C1, C2, C3	Terminal	1⅛″	8.48	0.20	9.09	18	27.15
H	Header	2⅛″	7.00	0.02	1.09	14	23.85
M	Network	2⅛″	7.00	0.29	13.30	14	23.85

Worst-path penalty
0.52 K · 23.48 kPa

Discharge temperature
78.98 °C

Compression ratio
4.99

Design pressure (55 °C)
23.12 bar(g)

HP cut-out · relief setting
20.81 · 23.12 bar(g)

Drain main / branches
2⅛″ at 0.55 · 1⅝″ at 0.47 m/s

Reading it

- The three compressor tails are identical, so their paths are identical: 0.52 K each against the 1 K allowed. The penalty is not fully used because the next size down for the main would overshoot: the pipe summary and velocity (7 m/s in the main) show a conservative line.
- The design pressure at 55 °C is 23.12 bar(g), and the 2⅛″ main needs gauge 14 to pass it — a heavier wall than the suction side of the same plant. The MWP is calculated with the copper at 150 °C for a discharge line.
- The drain main is 2⅛″ at 0.55 m/s, the target for a gravity drain; the two branches, each carrying half the 150 kW, are 1⅝″. The drain is included in the totals, which is why the pipe-system contents (23.75 kg) are large: 18.86 litres of liquid in the drain.

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CHAPTER 26

Example 4: a chilled-water secondary circuit

A Fluid network: three fan-coil loads on a chilled-water circuit in schedule 40 steel, sized to 50 kPa, with the pump head and pumping power reported.

26.1 The system and its entry

Water at 7 °C, 5 K rise across each coil, duties in kW, pump efficiency 65%, maximum pressure drop 50 kPa, 4 m static lift, design pressure 10 bar(g). FC1 (40 kW, 12 m, 4 bends, 2 ball valves) and FC2 (60 kW, 8 m, 4 bends, 2 ball valves) tee into main M1 (25 m, 2 bends); FC3 (80 kW, 10 m, 4 bends, 2 ball valves) joins at M2 (40 m, 6 bends, 2 gate valves), which returns to the plant.

1. Add a network named *Chilled water secondary*, set **Mode** to Fluid. The working fluid defaults to Water at 7 °C.
2. Set **Pipe Material** to Steel SCH40, **Liquid Lift** to 4 and leave the duty units as kW, the pump efficiency at 65%, the maximum pressure drop at 50 kPa and the design pressure at 10 bar(g). The properties panel shows water at 7 °C: 999.9 kg/m³, 1.427 cP, 4.201 kJ/kg·K.
3. Enter the five circuits: FC1, FC2 (terminals, next M1), M1 (next M2), FC3 (terminal, next M2) and M2 (end of line), with their duties, 5 K temperature rise, lengths and fittings.
4. Calculate.

26.2 The results

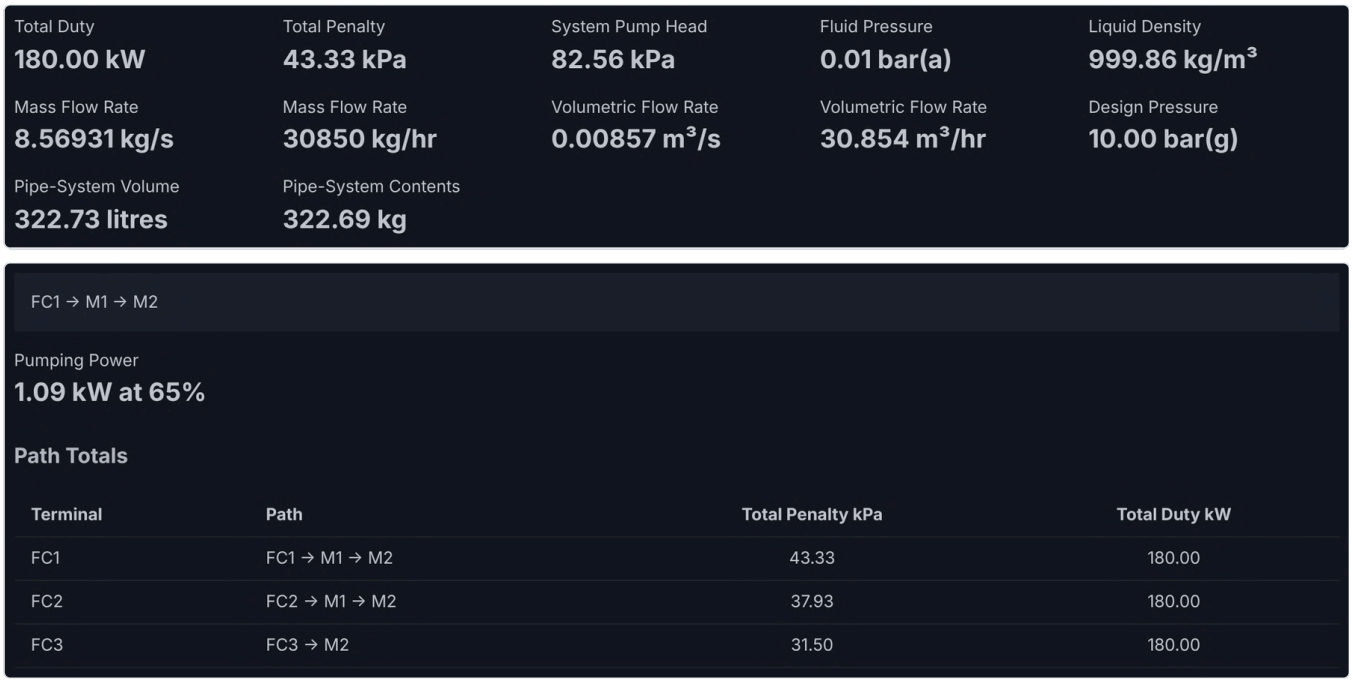


Figure 26.1 The totals of a Fluid network — the worst-path pressure drop, the system pump head, the mass and volume flows — then the worst path, the pumping power line and the path totals.

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Circuit	Type	Duty kW	Mass flow kg/s	Size	Velocity m/s	Pressure drop kPa	Path kPa
FC1	Terminal	40	1.904	1½″	1.45	11.18	43.33
FC2	Terminal	60	2.856	2″	1.32	5.78	37.93
M1	Network	100	4.761	2½″	1.54	12.30	–
FC3	Terminal	80	3.809	2″	1.76	11.65	31.50
M2	Network	180	8.569	3″	1.80	19.85	–

Total duty · flow
180 kW · 30.85 m³/h

Worst path (FC1 → M1 → M2)
43.33 kPa

System pump head
82.56 kPa

Pumping power
1.09 kW at 65%

Pipe-system volume / contents
322.7 litres · 322.7 kg

Design pressure
10.00 bar(g)

Reading it

- The mass flows follow from the duties and the 5 K rise: 40 kW ÷ (4.201 kJ/kg·K × 5 K) = 1.904 kg/s, and so on. With flow units instead of kW you would enter these directly.
- Velocities are between 1.3 and 1.8 m/s, as expected for steel chilled-water mains sized to a modest pressure drop.
- The pump head is the worst-path friction (43.3 kPa) plus the 4 m lift (39.2 kPa): 82.6 kPa. The pumping power, 8.57 kg/s against 82.6 kPa at 65% efficiency, is 1.09 kW.
- The pipe summary gives the tube weight and the water weight per metre of each size, for the pipe supports.

TRY THIS

Change the working fluid to Propylene Glycol and calculate again. The concentration field becomes active at its default of 30% (the tabulated range is 15–57%), the properties panel shows a freezing point of −13.1 °C and the fluid temperature can no longer be set below it. The same duties now need 9.22 kg/s instead of 8.57 because of the lower specific heat, M1 goes up a size to 3″, and the pump head rises to 87.4 kPa for 1.24 kW of pumping power. Ethylene glycol at 30% behaves similarly (−14.6 °C, 9.74 kg/s, 89.2 kPa).

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CHAPTER 27

Further examples: liquid, pumped liquid and wet suction

Three shorter networks that show the remaining modes. Their inputs are given in full so that you can reproduce the figures.

27.1 An MT liquid line

R448A, copper EN12735, Liquid mode. Evaporating −10 °C, condensing 43 °C, liquid 40 °C, liquid line rise 5 m, max penalty 1 K, design temperature 55 °C. Three evaporators: E1 and E2 (15 kW each, 6 m, 4 LR bends, 1 ball valve) tee into L1 (20 m, 2 LR bends); E3 (20 kW, 8 m, 4 LR bends, 1 ball valve) joins at L2 (35 m, 6 LR bends, 1 ball valve), the end of the line at the receiver.

Total Duty **50.00 kW**	Total Penalty **38.70 kPa**	Total Penalty **0.85 K**	Head Penalty **1.12 K**	Additional Subcooling Required **0.00 K**
Evaporating Pressure **3.62 bar(a)**	Condensing Pressure **18.05 bar(a)**	Liquid Density **1025.16 kg/m³**	Mass Flow Rate **0.37120 kg/s**	Volumetric Flow Rate **0.00036 m³/s**
Pipe-System Volume **17.67 litres**	Pipe-System Contents **18.12 kg**	Compression Ratio **4.99**	Design Pressure **25.49 bar(g)**	Leak Test Pressure **25.49 bar(g)**
Pressure Test **33.14 bar(g)**	High Pressure Cut-out **22.94 bar(g)**	Relief Valve Setting **25.49 bar(g)**	Relief Valve Rated Discharge **28.04 bar(g)**	

Figure 27.1 The liquid-line totals: the head penalty of the 5 m rise, the additional sub-cooling required, and the high-side pressure settings.

E1 and E2 are sized at ½″ (1.10 m/s), L1 at ¾″, E3 at ½″ (1.46 m/s) and L2 at ⅞″ (1.15 m/s). The worst path loses 38.7 kPa, 0.85 K; the 5 m rise costs a further 1.12 K of head penalty; and because the liquid is 3 K sub-cooled (43 − 40 °C) the additional sub-cooling required is reported as 0.00 K — the available sub-cooling covers both losses. The gauges are 21 and 19 for the small sizes: the liquid line is checked against 25.49 bar(g), the bubble-point pressure at 55 °C.

27.2 An ammonia pumped-liquid feed and its wet-suction return

R717 in Steel SCH40. Pumped Liquid mode: pumped liquid temperature −33 °C, liquid lift 6 m, liquid overfeed 300% (a 4:1 circulation ratio), max pressure drop 0.5 bar. Two 100 kW evaporators EV1 and EV2 (15 m, 4 LR bends, 1 globe valve each) on a common feed P1 (60 m, 8 LR bends, 1 globe valve). The Wet Suction network is the mirror image: the same two evaporators returning through S1 with the same lengths and fittings, max penalty 1 K, hold-up bias 1.5.

Total Duty **200.00 kW**	Total Penalty **36.05 kPa**	System Pump Head **0.762 bar**	Evaporating Pressure **1.03 bar(a)**	Liquid Density **681.56 kg/m³**
Mass Flow Rate **0.58456 kg/s**	Mass Flow Rate **2104 kg/hr**	Volumetric Flow Rate **0.00086 m³/s**	Volumetric Flow Rate **3.088 m³/hr**	Volumetric Flow Rate **51.46 lpm**
Pipe-System Volume **68.22 litres**	Pipe-System Contents **46.50 kg**	Design Pressure **11.35 bar(g)**	Leak Test Pressure **11.35 bar(g)**	Pressure Test **14.75 bar(g)**
High Pressure Cut-out **N/A**	Relief Valve Setting **11.35 bar(g)**	Relief Valve Rated Discharge **12.48 bar(g)**		

Figure 27.2 The pumped-liquid totals: the worst-path pressure drop and the system pump head, which includes the 6 m lift.

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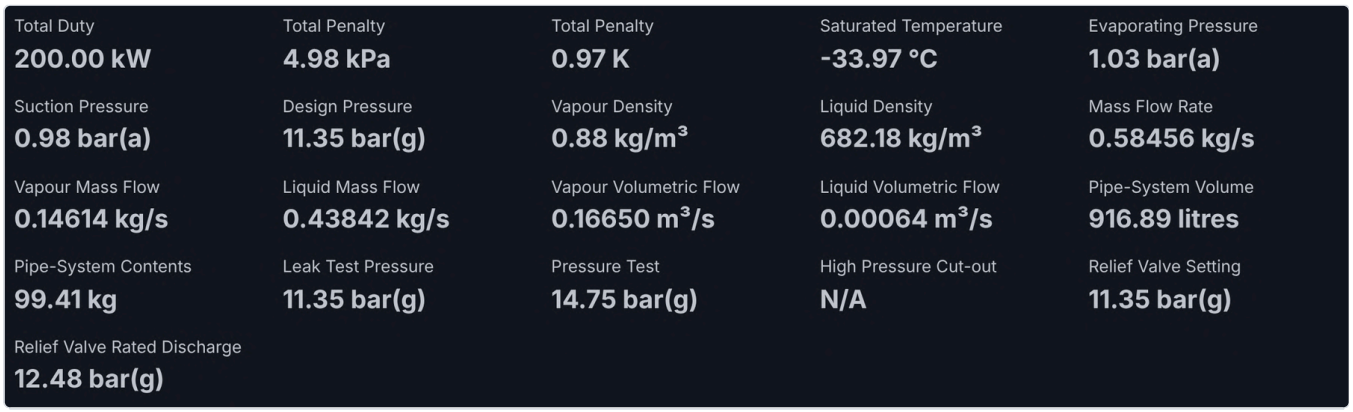


Figure 27.3 The wet-suction totals: the vapour and liquid mass flows are reported separately, and the saturated temperature at the receiver follows the penalty.

- Pumped liquid: EV1 and EV2 at ¾″ (1.25 m/s) and P1 at 1¼″ (0.89 m/s). The friction loss on the worst path is 36 kPa; with the 6 m lift of ammonia at 682 kg/m³ the system pump head is 0.762 bar. The mass flow is 0.585 kg/s — four times the 0.146 kg/s that evaporates — and the volume flow 3.09 m³/h, which sizes the pump.
- Wet suction: the same mass flow returns as 0.146 kg/s of vapour and 0.438 kg/s of liquid. The evaporator returns are 3″ (20.7 m/s vapour velocity) and the common return 5″ (15.3 m/s), for a penalty of 0.97 K against the 1 K allowed. Steel of this size is available seamless or ERW; both pass the 11.35 bar(g) low-side design pressure.

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APPENDICES

Reference material

A blank data sheet for recording a system before it is entered, the keys and habits that make MicroPipe quicker to use, a glossary of the terms used in this manual and on the screen, and the notices that apply to MicroPipe and to this manual.

- A — Data sheet
- B — Keyboard and efficiency tips
- C — Glossary
- D — Notices
- E — About this edition

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APPENDIX A

Data sheet

The two sheets that follow have the same columns as the circuits table, so that a system can be written down on site or taken off a drawing in the order MicroPipe will ask for it. Photocopy them, or print these pages from the PDF of this manual.

A.1 Using the sheet

- Fill in the design block first: the mode decides which of the other boxes matter (Chapter 8 lists the fields of each mode), and the refrigerant and pipe material decide the sizes MicroPipe can choose from.
- Number the circuits as they are numbered on the drawing and give each one its label and the label of the circuit it flows into. Walk every flow path from its terminal to the end of the line before you leave site; a circuit nobody flows into, or a next label that does not exist, is the commonest reason a network will not calculate (Chapter 10).
- Measure pipe lengths along the pipe, including the vertical runs, and count the fittings in each circuit. Risers are circuits in their own right: give each one its own row, its height as its length, and its orientation.
- Record the duty of every terminal in kilowatts; the duties of the network circuits are summed by MicroPipe and need not be written down.
- Use the *Fixed size* column for pipes that already exist or have been decided, and leave it blank where MicroPipe is to choose.

A.2 Column key

Column	Meaning	Where it goes in MicroPipe
Label, Next label	The circuit's name and the name of the circuit it discharges into. The end of the line has no next label.	**Label**, **Next Label** (Chapter 9)
Term.	Tick for a terminal: a circuit that starts a flow path and carries a duty of its own.	**Terminal?**
Duty kW	The terminal's duty. In Fluid mode the duty may instead be a mass or volume flow (Chapter 8).	**Duty**
Length m	Developed length of the circuit's pipe.	**Pipe Length**
Orient.	H horizontal (or falling), SR single riser, DR double riser. Dry Suction only.	**Orientation**
Oil return	For a riser, the lowest duty at which it must still carry oil: a percentage of its duty, or a figure in kW with **Oil Duty kW** on.	**Required Oil Return Duty**
Bends and traps	Counts of long radius, short radius, 45° and machine bends, P-traps and U-bends. In Fluid mode: short 90° elbows.	The fittings columns
Valves	Counts of ball and globe valves; in Fluid mode also 90° globe, gate and butterfly valves.	The valve columns
PLF	Any additional loss, in velocity heads, for fittings the columns do not cover (section 18.9).	**Pressure Loss Factors**
Dual, Hdr	Two identical pipes in parallel; a header into which several circuits discharge.	**Dual Circuit?**, **Header?**
Fixed size	A size to impose instead of letting the optimiser choose; for a double riser, both sizes.	**Fixed**, **Fixed Pipe Size** (Chapter 13)

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MicroPipe network data sheet

MicroPipe · NOW SELECT · Omega Solutions Sheet 1 of ___

Project	
Reference / drawing	
Date & surveyed by	
Network name	
Mode	DS · LQ · DC · PL · WS · FL
Refrigerant / fluid & conc.	
Pipe material	

Evaporating temperature	°C
Condensing temperature	°C
Max liquid temperature	°C
Min liquid temperature	°C
Superheat	K
Pumped / wet: liquid overfeed	%
Pumped liquid lift	m

Max penalty	K
Max pressure drop	kPa / bar
Design temperature	°C
Design pressure standard	BS EN 378 / ASME B31.5
Liquid line rise (+) / fall (–)	m
Discharge: isentropic efficiency	%
Fluid: temperature & pump efficiency	°C / %

#	Label	Next label	Term.	Circuit details (room, case, run ...)	Duty kW	Length m	Orient. H / SR / DR	Oil return % or kW	LR bends	SR bends	45° bends	Mach. bends	P-traps	U-bends	Ball valves	Globe valves	PLF	Dual	Hdr	Fixed size
1																				
2																				
3																				
4																				
5																				
6																				
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Term. = terminal (a load: evaporator, cabinet, cooler, fan coil). Orient. = Horizontal, Single Riser or Double Riser (Dry Suction only). Oil return = required oil-return duty of a riser, as % of its duty (default 100) or in kW. LR/SR = long/short radius bends; Mach. = machine bends. PLF = pressure loss factors in velocity heads. Dual = two pipes in parallel; Hdr = header. Fluid mode: use the bend columns for short 90° elbows, the valve columns for straight and 90° globe, gate and butterfly valves, and note the temperature rise/drop (K) and other losses (kPa) under Circuit details.

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MicroPipe network data sheet — continuation

Project _____ Network _____ Sheet ___ of ___

#	Label	Next label	Term.	Circuit details (room, case, run ...)	Duty kW	Length m	Orient. H / SR / DR	Oil return % or kW	LR bends	SR bends	45° bends	Mach. bends	P-traps	U-bends	Ball valves	Globe valves	PLF	Dual	Hdr	Fixed size
18																				
19																				
20																				
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41																				

Columns as on sheet 1. Every circuit needs a label, and every circuit except the end of the line needs a next label. Count the fittings in the circuit itself; the entry into a tee or header is allowed for automatically from the junction type (0.5 velocity heads plus a short-radius bend for a 90° branch, 0.2 for a straight-through connection), as is any change of size at the connection.

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APPENDIX B

Keyboard and efficiency tips

MicroPipe runs in the browser and uses the browser's own controls, so the keys you already use in web forms work here. These are the ones worth knowing, with a few habits that save time on a large network.

B.1 Keys in the fields

Key	What it does
`Tab` / `Shift`+`Tab`	Moves to the next or previous control: along a row of the circuits table from left to right, then on to the next row, switches and list boxes included. A value is taken when you leave its field.
`Enter`	Takes the value typed and leaves the cursor in the field. It does not calculate and does not submit anything; press **Calculate** when the network is ready.
`↑` `↓` and the spinner arrows	Step the value by the field's step, counted from the field's minimum rather than from a round number: a duty of 13 steps to 13.03 (its minimum is 0.03) and a length of 1.5 steps to 2.1. The stepped value is taken at once. Typing the value is quicker and gives the figure you intend.
`Space`	Turns a switch (**Terminal?** , **Fixed** , **Dual Circuit?** ...) on or off, or opens a list box.
Letters in a list box	Select the first option beginning with those letters: `D` for Double Riser in **Orientation** , `R` `4` `4` for R448A in **Refrigerant** , or the first characters of a label in **Next Label** .
`Ctrl`+`Z`	Undoes typing within the field you are in, as in any web form. There is no undo for a deleted row, a cleared table or a deleted network or project — the *Are you sure?* question is the only safeguard — so export a project (Chapter 5) before a major re-arrangement.
`Ctrl`+`F`	The browser's find. Searching for a label is the quickest way to reach one row of a long circuits table or results table.
`Ctrl`+`+` / `Ctrl`+`−`	Browser zoom. On a laptop screen the Dry Suction circuits table is wide; zooming out to 80 or 90% brings every column into view without sideways scrolling, and the setting is remembered for the site.
`Ctrl`+`P`	Prints the browser page, which is not the report. Use the **Print** button (Chapter 14), which produces the formatted inputs-and-results report in its own window and opens the print dialogue for it.
`F5`	Reloads the page. Nothing is lost: every change is saved as it is made, and the open project and network are reopened. A reload is also how a renewed licence takes effect (section 2.7).

On a Mac the `Cmd` key takes the place of `Ctrl`.

B.2 Building a network

- Work down the columns, not across the rows (section 9.5): add all the rows with **Add 10** , type every label, then set every next label — the **Next Label** list only offers labels that already exist — then the terminal switches, the duties, the lengths and the fittings.
- Rename freely. When you change a label, every next label that pointed at it follows the change and the lists are rebuilt, so a network can be relabelled to match a revised drawing without re-connecting it.

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- A copied row keeps its label; change the label on the copy straight away, before the duplicate is forgotten and reported at the next calculation.
- Calculate early and often. The error list after a calculation is the best check that the connections are right, and an unconnected or mislabelled circuit is far easier to find among twelve rows than among forty.
- Describe the network in the mode it is drawn for and let the other networks of the job share the project: a suction network, its liquid line and its discharge line are three networks of one project, each with its own settings.
- Fix sizes last. Once the network calculates cleanly, use **Fix All** to hold the result and then release and change only the pipes you intend to alter (Chapter 13).

B.3 Working habits

- **Export what matters.** Projects are saved to the server as you work, but an exported project file (Chapter 5) is the copy you control: keep one with the job records at each issue, together with the printed report, which carries the date and time the figures were calculated.
- **One device at a time.** A licence runs on one device. Moving it is a deliberate step with a limit on how often it can be done (section 2.6), so pick the machine you will design on and leave the licence there.
- **Watch the banner.** A licence change or a lost connection is announced in a banner or a notification at the top of the page, not in a dialogue you must dismiss. Glance at it before relying on a figure.
- **Record the conditions with the result.** The reference data MicroPipe holds is maintained and occasionally corrected, and a correction can change the result of a saved project when it is recalculated. The printed report and the CSV carry the inputs and the calculation time; file them with the design.
- **Keep the browser current.** MicroPipe requires a current version of a mainstream desktop or mobile browser with JavaScript, cookies and local storage enabled. Private or incognito windows discard the device's activation when they close (section 2.1).

B.4 If something looks wrong

Symptom	Where to look
Calculate is greyed out	The licence is read-only: expired, a failed renewal payment, or suspended. The banner says which (section 2.7).
The results have disappeared, and Print is greyed out	An input changed since the last calculation, so the results no longer describe the network; calculate again (section 11.4).
"Path from load … cannot start" or "Broken link …"	A next label names a circuit that does not exist — typically in an imported file, or an old network whose labels were changed. Choose the next label again from the list. Chapter 22 lists every message.
A duty box is greyed out	The circuit is not a terminal; the greyed figure is the sum of the terminals upstream. Switch **Terminal?** on if it should carry its own duty.
The sizes are far larger than expected	Check the penalty limit and the units (Chapter 16), the duty units in Fluid mode, and whether a riser's oil-return duty or a fixed size is forcing the rest of the path (section 17.2, Chapter 23).
A figure differs from the Windows version	The methods are the same (section 1.2). Differences come from the reference data in use, which is maintained and corrected over time, from the rounding of displayed figures, and from the few settings an imported Windows file does not carry over (section 6.6). Compare the inputs first.
The page says you are offline	The working copy is in the browser and keeps every change; it is pushed to the server when the connection returns (section 4.5). Calculating needs the server.

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APPENDIX C

Glossary

The terms used on the MicroPipe screen and in this manual. Chapter references point to where each is explained.

Activation code
The six-digit code e-mailed to the licence holder when a key is activated on a device, proving that the e-mail address is theirs (section 2.5).

Bias (riser)
A setting from 0 to 10 that increases the share of the penalty budget the optimiser allows the suction risers (section 18.10).

Bubble point, dew point
For a zeotropic blend at a given pressure, the temperatures at which the liquid starts to evaporate and at which the last of it has evaporated. MicroPipe takes saturated suction temperatures at the dew point and liquid-line temperatures at the bubble point (section 12.3, Chapter 21).

Circuit
One length of pipe between junctions, with its own length, fittings and orientation; one row of the circuits table (Chapter 9).

Compression ratio
Absolute condensing pressure divided by absolute suction pressure, reported in Discharge mode (Chapter 12).

Condenser drain
The gravity liquid line from a condenser to the receiver, sized in Discharge mode to a target velocity of 0.55 m/s (section 8.4).

Design pressure
The saturation pressure, in bar gauge, at the design temperature; the pressure the pipework is checked against and from which the test and relief pressures are derived (sections 12.3 and 18.11).

Design temperature
The temperature at which the design pressure is taken, with a default for each mode and refrigerant group (Chapter 8).

Double riser
Two risers in parallel, the smaller carrying the oil at low load while the larger is trapped out of service (Chapter 19).

Dual circuit
A circuit installed as two identical pipes in parallel, each carrying half the flow (section 10.6).

End of line
The circuit with no next label: the last circuit of every flow path, at the compressor, receiver or pump (Chapter 10).

Fixed size
A pipe size you impose on a circuit instead of letting the optimiser choose it; the rest of the path is sized around it (Chapter 13).

Flow path
The sequence of circuits from a terminal to the end of the line, followed through the next labels. The penalty limit applies to each path (Chapter 4).

Gauge
The wall-thickness designation of a copper tube size; MicroPipe selects the lightest gauge whose maximum working pressure meets the design pressure (Chapter 20).

Header
A circuit into which several others discharge — a suction or discharge manifold. MicroPipe marks a circuit as a header automatically when more than two circuits join it (section 10.5).

Isentropic efficiency
The compressor efficiency, in per cent, from which Discharge mode estimates the discharge temperature (sections 8.3 and 18.7).

Junction type
How a circuit enters a tee or header: as a 90° branch, or straight through (180°). It sets the junction allowance added to the circuit's fittings loss (section 10.4).

Label, next label
A circuit's name, and the name of the circuit it flows into (Chapter 9).

Licence key
The twelve-character key, in three groups of four, that identifies a licence. One key runs on one device at a time (Chapter 2).

Liquid lift
The vertical rise from the refrigerant pump to the highest evaporator (Pumped Liquid), or the static lift a fluid pump must overcome (Fluid) (section 18.8).

Liquid overfeed
In pumped and wet-suction systems, the liquid leaving the evaporators as a percentage of the liquid evaporated: 300% overfeed means each line carries four times the evaporated mass flow, a circulation ratio of 4 to 1 (sections 8.5 and 18.8).

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Maximum working pressure (MWP)
The pressure a tube size and gauge may carry at the reference temperature, calculated by BS 1306 or DKI rules; the basis of the pressure pass (Chapter 20).

Mode
The kind of line a network is: Dry Suction, Liquid, Discharge, Pumped Liquid, Wet Suction or Fluid (Chapter 17).

Network
One pipe system of one mode, with its own settings, circuits and results; a project holds several (Chapter 4).

Oil return duty (required)
The lowest duty, as a percentage of the riser's duty or in kW, at which the riser must still carry oil upwards; the constraint that sizes a riser (sections 9.4 and 19.7).

Oil Return % (result)
The lowest share of the circuit's duty at which the size chosen will return oil, worked out at the worse of the maximum and minimum liquid temperatures. At or below the required duty it is satisfactory; above 100% the pipe would not return oil at full load if it rose (Chapter 12).

Optimiser
The routine that shares the permitted penalty along the worst path, starts every circuit at the smallest size within its share, enlarges circuits until every path is within the limit, and then tries each one a size smaller (section 17.2).

Orientation
Horizontal, Single Riser or Double Riser: how a Dry Suction circuit runs, and therefore whether it is checked for oil return (Chapter 19).

Penalty
The fall in saturated temperature between the evaporator and the compressor caused by the pressure drop in the suction line, in kelvin; the measure in which suction and wet-suction limits are set (section 17.1).

Pressure loss factor (PLF)
An additional loss for a circuit, expressed in velocity heads (K values summed), for fittings the standard columns do not cover (section 18.9).

Project
A named job holding one or more networks; the unit that is saved, exported and listed in the Projects view (Chapter 5).

Read-only
The state of an expired, unpaid or suspended licence: saved projects can be opened, exported and printed but not calculated or added to (section 2.7).

Retention period
The ninety days after a licence expires during which its projects remain available read-only before they are deleted (section 2.7).

Riser
A vertical suction circuit in which the gas must carry the oil upwards (Chapter 19).

Saturated suction temperature (SST)
The saturation temperature at the suction pressure the compressor sees: the evaporating temperature less the total penalty of the worst path (Chapter 12).

Stale results
Results that no longer correspond to the inputs because something has changed since the calculation. MicroPipe removes them, rather than mark them, until the network is calculated again (section 11.4).

Sync
The automatic saving of the working copy to the server and the reconciliation of the copies on the device and the server when they differ (sections 4.5 and 5.6).

Terminal
A circuit that starts a flow path and carries a duty of its own: an evaporator, cabinet, cooler or fan coil connection (Chapter 9).

Trial
The seven-day free period on an annual licence, after which the licence is charged and begins (section 2.4).

Velocity head
$\frac{1}{2}\rho v^2$, the dynamic pressure of the flow; loss factors (K values) are multiples of it (section 18.9).

Wet suction
A suction line carrying both vapour and the unevaporated liquid returned from overfed or flooded evaporators (Chapter 17).

Worst path
The flow path with the largest total penalty or pressure drop; the one that sets the saturated suction temperature and the pump head (Chapter 12).

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APPENDIX D

Notices

MicroPipe is supplied under published terms. This appendix points to them and summarises the parts that bear on everyday use. Where this summary and the published documents differ, the published documents apply.

D.1 The governing documents

Terms of Sale and Licence	https://now-select.com/micropipe/terms — what a licence is, how it renews, how saved work is kept, support, engineering responsibility, warranties and liability.
Refund Policy	https://now-select.com/micropipe/refunds — withdrawal and refunds, handled by Paddle as reseller and merchant of record.
Privacy Notice	https://now-select.com/micropipe/privacy — what personal data is held about purchasers, licence holders and visitors, and why.

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D.2 Engineering responsibility

The terms describe MicroPipe as a calculation aid, not a substitute for engineering judgement. It performs pipe-sizing and related calculations from the inputs you give it and the reference data it holds, and its output depends on the accuracy and completeness of those inputs, on the selections you make, and on whether its methods and data apply to your system.

You, or the competent and suitably qualified person you work under, remain responsible for the design: for checking MicroPipe's output before relying on it, for deciding whether its results suit the installation in question, and for ensuring that the design, specification and installation comply with the laws, regulations, codes of practice and standards that apply. MicroPipe does not certify compliance with any standard. It is not designed for use as the sole means of determining safety-critical parameters, such as pressure-relief protection, without independent verification by a competent person.

The refrigerant, fluid and pipe data are maintained with care and updated from time to time. Published data varies between sources and editions, and a correction can change the results of a saved project when it is recalculated. Where a result matters, keep the printed report, which records when the figures were calculated.

D.3 Warranties and liability

Omega undertakes to provide MicroPipe with reasonable care and skill and substantially as described on its public page and in the terms. For business customers all other warranties are excluded so far as the law allows: MicroPipe is not warranted to be uninterrupted or error-free, to meet particular requirements, or to give a result suitable for a particular installation, and Omega is not liable for loss arising from a design, specification, installation or decision made in reliance on its output. Consumers have the statutory rights the terms summarise, which nothing in the terms limits. The full wording, including the limit on liability to business customers, is in clause 16 of the terms.

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D.4 Your saved work

- Projects are stored on Omega’s server in the United Kingdom, on the record of the person who created them, and are yours. They can be exported at any time (Chapter 5).
- The server stores the inputs needed to reproduce a calculation, not the results.
- Ninety days after a licence expires without renewal, its projects are deleted, with warnings thirty and seven days beforehand.
- To support you or to resolve a problem with the service, Omega’s staff can open and edit your projects; every opening and every save is logged.
- Anything you type into a project name or description is held as part of the project, so personal data placed there is your responsibility.

D.5 Intellectual property and trade marks

MicroPipe, its calculation methods, its reference data and everything in it except your projects belong to Omega Solutions Cross Hills Limited and its licensors and are protected by copyright, database right and other intellectual property laws. Nothing in the licence transfers any of them to you.

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D.6 Support

Support for MicroPipe itself — using it, your licence and your saved work — is given by Omega by e-mail at support@omega-solutions.co.uk and by telephone on +44 (0)1535 322111, Monday to Friday 09:00–17:00 UK time, with a reply by the next working day. Support covers using MicroPipe and your licence; it does not include engineering advice on your designs. Billing questions, receipts and refunds are handled by Paddle. There is no out-of-hours service and no promise of any particular level of availability.

APPENDIX E

About this edition

Edition	1, November 2026
Describes	The online MicroPipe at https://now-select.com/micropipe, with calculation engine 1.4 (21 October 2026) and the Terms of Sale and Licence published 3 October 2026.
Replaces	The manual for MicroPipe for Windows, written by White Rose Software, whose engineering chapters this edition carries forward.
Worked examples	Chapters 23 to 27 were calculated with engine 1.4 and the reference data current at that date. Later corrections to the data may move the figures slightly; the inputs are given in full so that any difference can be seen.
Screenshots	Taken from the online MicroPipe in its default dark theme at desktop window widths, with example projects created for this manual. Your screen will differ in the project names and in any language or unit setting you have chosen.

What changed from the Windows manual

- Installation, copy control and registration have gone; Chapter 2 describes licences, activation and the licence states instead.
- The toolbar-by-toolbar descriptions have been replaced by the views, forms and tables of the online edition (Chapters 3 to 16), with a mapping from the old controls in section 3.7.
- The engineering material — the design data, the suction riser and oil-return guidance, the heat-gain and condenser-drain notes, and the pipe material and pressure data — is carried over with the wording revised and the figures checked against the online calculation (Part C).
- The worked example of the Windows manual is reproduced as Chapter 24, with the figures the online MicroPipe gives for it, and five further examples cover the other modes.
- A messages reference (Chapter 22), the glossary and the data sheet are new.

Comments on this manual are welcome at support@omega-solutions.co.uk.

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