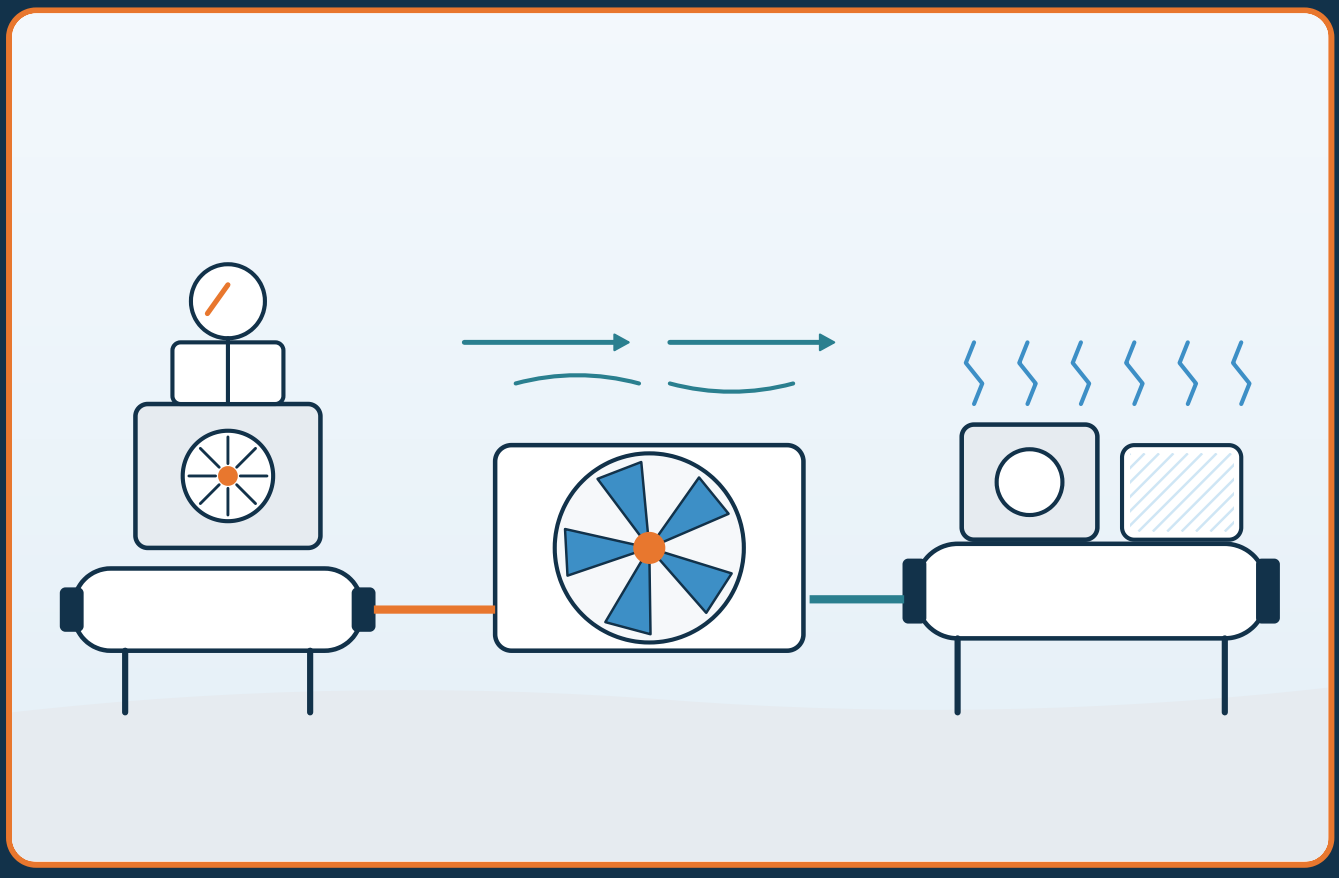
PlantCalcKit

Compressed Air, Fans and Chillers Made Simple

A field guide to plant air, fan and chiller energy

Compressed air · Leaks · Compressor specific power · Staging · Fans and the fan laws · Chiller COP and kW/TR · Part load · Psychrometrics · Energy cost



FREE SAMPLER — Chapters 1 to 3

Edition 1.0 · November 2026

PlantCalcKit

Compressed Air, Fans and Chillers Made Simple
A field guide to plant air, fan and chiller energy
Edition 1.0 · November 2026 — free sampler (Chapters 1 to 3)

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Written in our own words from published engineering sources, listed in Appendix G. All diagrams, picture pages and charts are original PlantCalcKit artwork; charts are computed from the worked examples. No equipment maker, supplier or brand is named or recommended.

Site W and all its equipment are made up. Every example value is generic; costs and prices are illustrative.

This guide is for training and engineering estimates. It does not replace your equipment maker's instructions, the advice of your own specialists, the published codes and standards, or your plant's approved procedures and safety rules. Where a method follows a code or standard, the calculation is aligned with the publicly documented method; no result in this book claims to meet a code.

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GUIDE

How to use this book

This book explains three groups of machines that sit behind almost every process plant: compressed air systems, fans and blowers, and chillers, together with the moist-air science that links them. You do not need to be an expert. If you can read a gauge and use a calculator, you can follow every example.

Who it is for

- **Plant operators** who run these machines and want to know what the numbers mean.
- **Young engineers** who must check performance, find waste and write reports.
- **Senior engineers** who want a quick refresher or a training text for their team.

How the book is built

Part	What you learn	Chapters
A	Compressed air systems: anatomy, free air delivery, leaks, pressure, storage, drying	1 to 7
B	Air compressors: specific power, efficiency, control, heat recovery, staging	8 to 10
C	Fans and blowers: pressures, fan laws, system curve, flow control	11 to 13
D	Chillers and moist air: refrigeration cycle, performance, part load, psychrometrics	14 to 17
E	Energy cost of oversizing and throttling; troubleshooting	18 to 19

Each chapter is short and stands alone. At the back you will find a glossary, an FAQ, units and conversions, a formula sheet, printable checklists, answers to all exercises and quizzes, and the list of sources.

The boxes you will see

- **Field check**: a table of what you might see on the plant, what it may mean, and what to check first.
- **Engineer's calculation corner**: a worked example with every step and number, using Site W's equipment.
- **Watch out**: a common mistake or a safety point.
- **Try it**: a short exercise; answers are in Appendix F.
- **Free tools**: QR codes to the free online calculator and the matching Excel toolkit for the chapter.
- **Quick quiz**: five questions to check you have the main ideas.

Site W and the numbers

All examples follow one made-up plant, Site W (Chapter 1). Its numbers are the example cases of the matching PlantCalcKit Excel toolkits, so you can open a toolkit and see the same calculation. A few numbers are added by the book (for example the humidity of the intake air in Chapter 7, the 4,000 operating hours of the chiller in Chapter 1 and the R134a-type refrigerant of Chapter 14); the text says so each time. Every number in the worked examples was computed with a script, not typed by hand. Costs and prices are illustrative only.

Units

SI units come first, with US customary units in brackets where it helps, for example 18 m³/min (636 cfm). Pressures are marked "bar g" (gauge) or "bar a" (absolute). Appendix C has the conversions.

What this book does not do

Compressed air, refrigerants, fans and rotating machines can hurt people. This book teaches understanding and checking. It does not replace the equipment maker's instructions, the pressure-system, refrigerant and electrical rules that apply where you work, the design codes, or your plant's safe-work procedures. Where a method follows a published standard, the calculation is aligned with the publicly documented method; no result in this book claims to meet a standard. Do not open, repair or modify a pressurised system on the strength of a calculation in a book.

FREE TOOLS

Free calculators and Excel toolkits

Every chapter ends with two QR codes: a free online calculator for a quick check, and the matching PlantCalcKit Excel toolkit, which carries out the full calculation of the chapter's worked example with the same numbers. The toolkits show every formula, check every input and print a report. Shop pages are information pages; nothing is bought by scanning a code.

All free calculators
plantcalckit.com/tools/

All Excel toolkits
plantcalckit.com/shop/

Ch.	Chapter	Free calculator	Excel toolkit (does the chapter's calculation)
1	Air, fans and chillers: where the electricity goes	Process engineering unit converter plantcalckit.com/tools/unit-converter/	Utilities Cost Calculator **USD 79** plantcalckit.com/shop/utilities-cost-calculator-excel/
2	Compressed air system anatomy	Compressed air leak cost plantcalckit.com/tools/compressed-air-leaks/	Compressed Air Demand and Leakage **USD 39** plantcalckit.com/shop/compressed-air-demand-and-leakage-excel/
3	Free air delivery, reference conditions and site correction	Compressed air leak cost plantcalckit.com/tools/compressed-air-leaks/	Compressed Air Demand and Leakage **USD 39** plantcalckit.com/shop/compressed-air-demand-and-leakage-excel/

PART A

Compressed air systems

Anatomy, free air delivery, leaks, pressure, pipework and drying

CHAPTER 1

Air, fans and chillers: where the electricity goes

Walk through any process plant and listen. The hiss of a compressor, the roar of a fan, the hum of a chiller: these three machines run day and night, and together they often take a large share of the electricity bill. They are also the machines that people trust the most and check the least. This book teaches you to check them.

1.1 Three machines, one idea

Compressed air, fans and chillers look different, but they share one idea: **a motor adds energy to a gas so that the gas can do a job.**

- A **compressor** squeezes air to 6 to 8 bar so that it can drive tools, valves and cylinders and be piped everywhere.
- A **fan** or **blower** pushes a large flow of air or gas through ducts, filters, coolers and process equipment with only a small rise in pressure.
- A **chiller** uses a compressor on a refrigerant to move heat from cold water to warm water, so that process coolers and air-conditioning coils get cold water.

In every case the electricity you pay for ends up as **heat**. The compressor and the fan heat the air. The chiller heat leaves through the cooling tower. So the question for each machine is never "does it work?" but "how much energy does it use for the job it does?"

1.2 Meet Site W again

This book follows a made-up plant, **Site W**. It is generic: it is not any real plant, and every value is an example that you should replace with your own data. Figure 1.1 shows where the machines of this book sit.

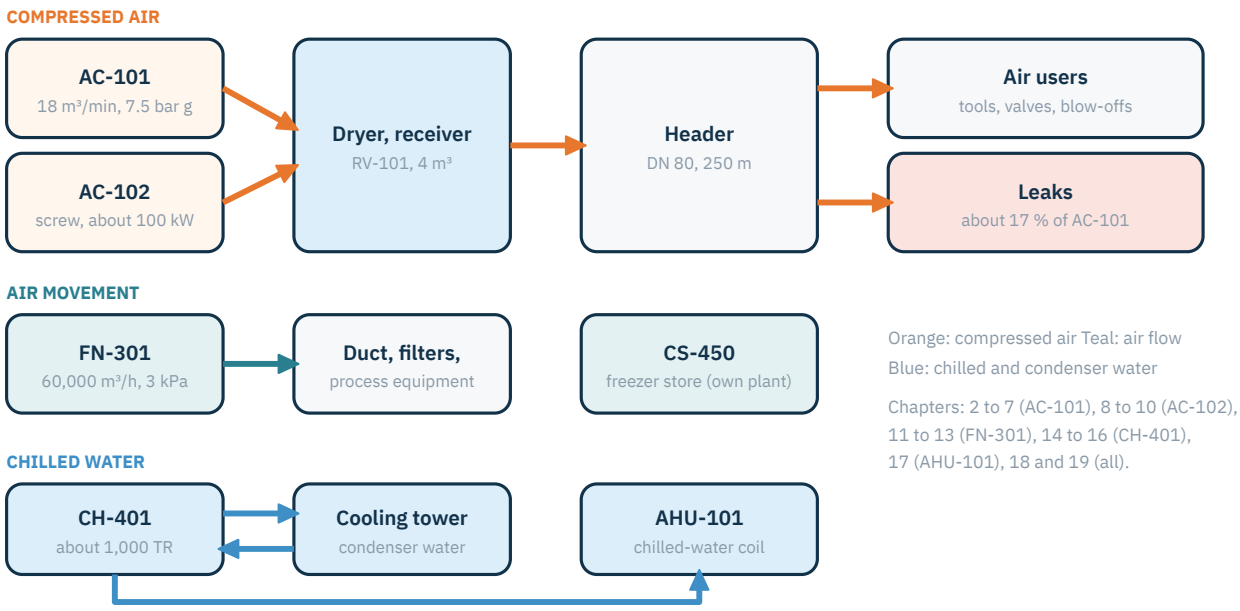


Figure 1.1 — Site W, the made-up plant used in this book. Each tag comes back in the chapter that treats it.

Tag	Equipment	Chapters
AC-101	Main air compressor, 18 m³/min rated, 7.5 bar g, with receiver RV-101 and the plant header	2 to 7
AC-102	Oil-flooded screw compressor of about 100 kW, tested in the compressor house	8 to 10
FN-301	Process air fan, 60,000 m³/h at 3 kPa, 75 kW motor	11 to 13
CH-401	Water-cooled centrifugal chiller of about 1,000 TR	14 to 16
CS-450	Freezer store (cooling load cross-reference)	14
AHU-101	Air-handling unit with a chilled-water coil	17

Each example uses the same numbers as the example case of the matching PlantCalcKit Excel toolkit, so you can open the toolkit and see every step. Where a number is added by the book (for example the humidity of the air in Chapter 7) the text says so.

1.3 Power, energy and cost

Three words cause most of the confusion in energy work.

- **Power** is a rate, measured in kilowatts (kW). A machine "draws 66 kW".
- **Energy** is power times time, measured in kilowatt-hours (kWh) or megawatt-hours (MWh). Utility bills are for energy.
- **Cost** is energy times price. In this book the price is **USD 100 per MWh** (USD 0.10 per kWh) unless a toolkit uses another value. It is an illustrative number, not a tariff.

ENGINEER'S CALCULATION CORNER **Worked example: what does a fan cost to run?**

1. Power drawn: 66 kW (the electrical input of fan FN-301).

2. Hours in a year of continuous running: 8,000 h (a round figure for a plant that stops about a month a year).
3. Energy: 66 × 8,000 = **528,000 kWh = 528 MWh**.
4. Cost at USD 100 per MWh: 528 × 100 = **USD 52,800 a year**.

A small saving on a machine like this pays for a lot of maintenance. Ten percent of that cost is more than USD 5,000 each year.

1.4 How big are the three at Site W?

Figure 1.2 puts the four machines of Site W side by side, using the example cases of the toolkits. AC-101 is shown at its average power, AC-102 at 62 % load, FN-301 with its damper, and CH-401 at the 652 kW of the toolkit example. The toolkit for the chiller does not compute annual energy, so we assumed **4,000 operating hours a year** for it. That assumption is the book's own.

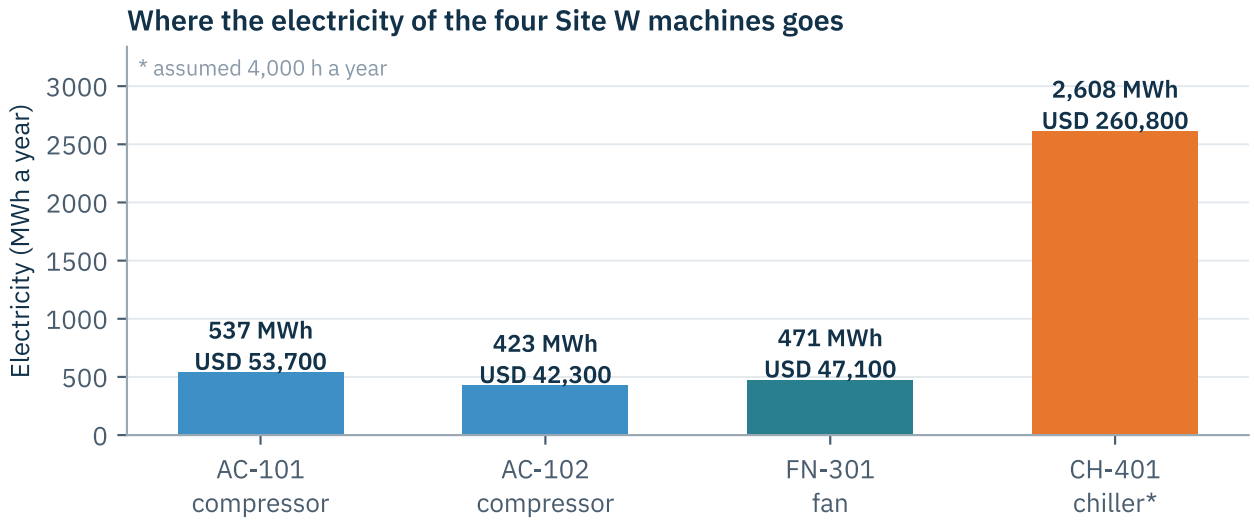


Figure 1.2 — Annual electricity of the four Site W machines, in MWh, with the cost at USD 100 per MWh (illustrative). The chiller figure uses an assumed 4,000 h a year.

The four machines together use about **4,039 MWh a year**, worth about USD 403,858 at the illustrative price. The chiller is the biggest, but the air and fan machines are not small, and (as later chapters show) they are the ones where careless operation wastes the largest share.

1.5 Five questions to ask of every machine

1. **How much does it move?** Free air delivery in m³/min, airflow in m³/h, cooling in kW or TR.
2. **At what pressure or temperature?** Discharge pressure, fan pressure, chilled-water and condenser-water temperatures.
3. **How much power does it draw?** In kW, measured, not just the nameplate.
4. **What is the ratio?** Specific power (kW per m³/min), specific fan power, kW per TR or COP.
5. **How does it compare** with its design, with last year, and with the same machine a month ago?

The ratio in question 4 is the key. Power alone goes up when the plant is busy. The ratio goes up only when something is wrong.

FIELD CHECK **What the three machines tell you when you listen and look**

What you see or hear	What it may mean	First thing to check
Compressor loaded most of the time, pressure still falls	Leaks or a demand increase	Leak test (Chapter 4)
Compressor cycling load/unload every few seconds	Receiver too small or pressure band too narrow	Control settings, receiver volume (Chapter 6)
Fan damper almost closed	Fan oversized, flow throttled	Fan curve and speed control (Chapter 13)
Chiller kW/TR higher than last summer	Fouled condenser or warm condenser water	Approach temperatures (Chapter 15)
Cooling water leaving the chiller condenser is warmer than design	Low water flow or fouled tubes	Water flow and ΔT

Watch out — this book is for understanding and checking

These chapters teach you to understand and check the performance of air, fan and chiller systems. They do not replace the equipment maker's instructions, the pressure-vessel and pressure-system rules of your site, the refrigerant safety standard or your plant's safe-work procedures. Compressed air and refrigerants store energy and can injure; never open, repair or modify a pressurised system on the strength of a calculation in a book.

TRY IT

A 110 kW air compressor runs at full power for 8,000 hours a year. How many MWh does it use, and what does that cost at USD 100 per MWh? (Answer in Appendix F.)

FREE TOOLS **Do this chapter's calculation**

Free calculator
Process engineering unit converter calculator
plantcalckit.com/tools/unit-converter/

Excel toolkit: Utilities Cost Calculator (USD 79)
plantcalckit.com/shop/utilities-cost-calculator-excel/
Topics: The whole water chain · Steam at up to six pressures · Power from every source · Fair heat-recovery credit

QUICK QUIZ

1. What happens to the electrical energy that goes into a compressor, a fan or a chiller?
2. What is the difference between power and energy? Give the units of each.
3. Why is a ratio such as specific power more useful than power alone?
4. Which of the four machines in Figure 1.2 uses the most electricity at Site W, and what assumption was made for it?
5. Name two things the equipment maker's instructions cover that a calculation in this book does not.

CHAPTER 2

Compressed air system anatomy

Compressed air is often called the "fourth utility" after electricity, water and gas. It is clean at the point of use, safe from sparks, and easy to pipe. It is also one of the most expensive forms of energy in the plant. To see why, follow the air from the intake filter to the tool, and the energy from the motor to the cooling water.

2.1 Supply side and demand side

Engineers split every compressed air system into two halves.

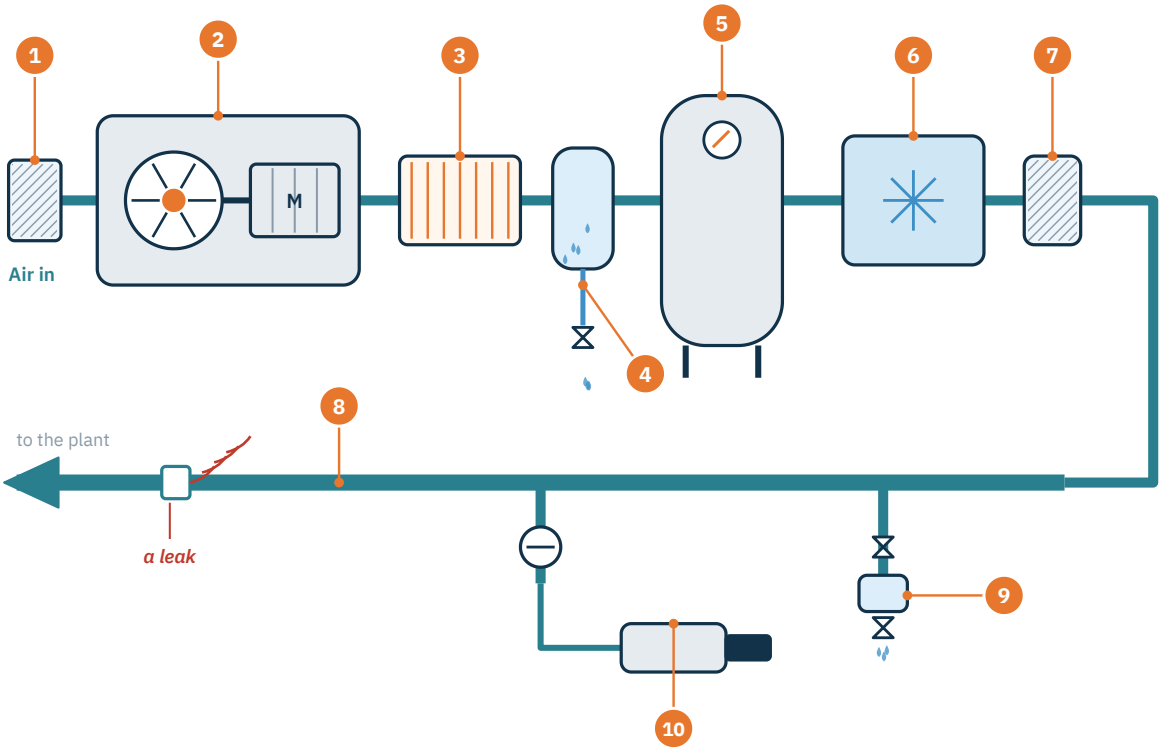
- The **supply side** makes and treats the air: intake filter, compressor, aftercooler, separator, dryer, filters, receiver and the controls that decide how many machines run.
- The **demand side** uses the air: the header, drop legs, hoses, regulators, tools, cylinders, blow-offs, and the leaks.

Many plants spend all their effort on the supply side (a bigger compressor, a new dryer) when the biggest saving is on the demand side: fewer leaks, lower pressure, no open blow-offs. The rule of thumb is simple: **fix the demand first, then size the supply.**

PICTURE PAGE 1

Compressed air system

A compressed air system, from intake to the point of use



Generic layout of a compressed air system from the intake to a tool. The red mark is a leak: every system has some.

No.	Part	What it does
1	**Intake filter**	Cleans the air before the compressor. A dirty filter makes the compressor draw more power for less air.
2	**Compressor and motor**	Compresses the air to the working pressure; most of the electricity leaves as heat (Chapter 2).
3	**Aftercooler**	Cools the hot air from the compressor so that most of the water vapour condenses.
4	**Separator and drain**	Collects the condensed water and drains it out of the air line.
5	**Receiver**	Stores air so that short peaks do not pull the pressure down (Chapter 6).
6	**Dryer**	Lowers the dew point so that no water forms in the pipes (Chapter 7).
7	**Filter**	Removes particles and oil mist after the dryer.
8	**Header**	Main distribution pipe. Size it for a small pressure drop.
9	**Drop leg and drain**	A branch from the top of the header with a drain at the bottom, so that water does not reach the tool.
10	**Point of use**	Regulator, hose and tool. Set the regulator to the pressure the tool needs, not more.

2.2 What each part does

1. **Intake filter and inlet valve.** Cleans the air and, on a load/unload machine, closes to stop the machine delivering air when the line is full.
2. **Compressor.** Raises the air to the discharge pressure. At AC-101 it is an oil-flooded screw machine, which injects oil into the compression chamber to seal and cool it.
3. **Separator.** Takes the oil out of the air leaving a screw machine.
4. **Aftercooler.** Cools the hot discharge air with cooling air or water. As the air cools, most of its water vapour condenses (Chapter 7).
5. **Dryer and filters.** Dry the air to the dew point the users need and take out oil mist and dust.
6. **Receiver.** A pressure vessel that stores air so that short peaks of demand do not make the pressure fall (Chapter 6).
7. **Header and branches.** The distribution piping. Its size sets the pressure drop between the compressor house and the farthest user.
8. **Controls.** Decide when machines load, unload, modulate or change speed (Chapter 9).

2.3 Where the energy goes

A compressor does not "use up" air; it uses energy. The energy chain is the first thing to understand, because it explains why leaks and extra pressure cost so much.

ENGINEER'S CALCULATION CORNER **Worked example: where do the 98.5 kW of AC-102 go?**

AC-102 is the screw compressor of Chapters 8 and 9. Its toolkit example case gives an electrical input of 98.5 kW.

1. **Motor and drive loss.** With a motor and drive efficiency of 93 % (a generic allowance in the toolkit), the shaft power is 98.5 × 0.93 = **91.6 kW**, and the loss is 6.9 kW. That heat stays in the machine room.
2. **Heat in the compressed air.** The air leaves at 38 °C after the cooler. Its heat gain from 30 °C is the mass flow (18.07 kg/min of dry air) × 1.03 kJ/kg·K × 8 K = **2.49 kW**.
3. **Heat taken away by the oil and air coolers.** Shaft power less the heat in the air: 91.6 − 2.49 = **89.1 kW**.
4. Adding up: 6.9 + 2.49 + 89.1 = 98.5 kW. **About 100 % of the electricity becomes heat.** 90.5 % of it leaves through the coolers, where it can be recovered (Chapter 9).

The ideal minimum work to compress the same air at constant temperature is the isothermal power, 56.3 kW (Chapter 8), which is only 57 % of the electricity. The rest is the price of real machines: friction, heat and leakage inside the compressor, and motor losses.

AC-102: where every kilowatt of electricity goes



Check: 6.9 + 89.1 + 2.49 = 98.5 kW. The ideal isothermal work is only 56.3 kW (57 % of the input).

Figure 2.1 — Energy chain of AC-102: every kilowatt of electricity ends as heat, and most of it leaves through the coolers.

2.4 The control that sets the system

There are three families of control, and they decide how the compressor behaves when the plant uses less air than the machine can make:

Control	What it does	Typical problem
Load/unload	Machine runs loaded until the pressure reaches an upper limit, then the inlet valve closes and the machine runs unloaded (idling)	Idling power is still a large share of full power (25 % for the screw machine of Chapter 9); short cycles if the receiver is small
Modulation	An inlet valve throttles the air as the pressure rises	Poor efficiency at part load: the machine works against a closed valve
Variable speed (VSD)	Motor speed follows demand	Small extra loss at full load; needs a pressure band set properly

The percentages in this table are generic allowances used in the PlantCalcKit compressor toolkit for an oil-flooded screw machine. Your machine's data sheet or a short power test gives the true values. Chapter 9 compares the three controls with numbers.

2.5 Five signs the system is healthy

- The compressor spends a fair share of its time **unloaded** or at part speed (it is not running flat out).
- The **pressure drop** from the compressor house to the farthest user is small, a common design guide being less than about 10 % of the discharge pressure.
- The **discharge pressure** is only as high as the users need plus the drop in the dryer, filters and piping.
- **Condensate** is drained automatically and the drains do not blow air.
- Someone knows the **leak rate** and has a plan to reduce it.

FIELD CHECK **Reading the air system from the compressor house**

What you see	What it may mean	First thing to check
Compressor at full load all day, pressure still dips	Not enough supply, or leaks have grown	Leak test, then demand profile
Several compressors running, all lightly loaded	Poor sequencing	Pressure setpoints of each machine
High discharge temperature	Cooler fouled, low oil level or poor ventilation	Cooler fins, oil level, room temperature
Water at the end of lines	Dryer not working or bypassed	Dryer outlet dew point, drains
Very high pressure setpoint "to be safe"	One far-away user with a restriction	Pressure at the user, not at the compressor

Watch out — compressed air is not a toy

Air at 7 bar can push a particle through skin and can whip a loose hose. Never use compressed air to blow dust from clothes or skin, and never point it at a person. Pressure vessels (receivers, separators, dryers) have inspection rules in every country; follow them.

TRY IT

A compressor takes 80 kW of electricity and has a motor and drive efficiency of 92 %. How much heat does the motor and drive release into the machine room? (Answer in Appendix F.)

FREE TOOLS **Do this chapter's calculation**

Free calculator
Compressed air leak cost calculator
plantcalckit.com/tools/compressed-air-leaks/

Excel toolkit: Compressed Air Demand and Leakage (USD 39)
plantcalckit.com/shop/compressed-air-demand-and-leakage-excel/
Topics: Free air delivery · Leak flow · Energy and cost of leaks · Artificial demand

QUICK QUIZ

1. Name the two halves of a compressed air system and give one example in each.
2. What does the aftercooler do to the water vapour in the air?
3. Why is "fix the demand first" good advice?
4. How much of the electricity going into AC-102 becomes heat?
5. Name the three families of compressor control.

CHAPTER 3

Free air delivery, reference conditions and site correction

"How much air does the compressor make?" It sounds like a simple question, and it is the source of many arguments. Air is squeezed, so its volume depends on pressure and temperature. A compressor that is "18 m³/min" in the catalogue may deliver less on a hot day on a hill. To compare machines, check leaks and size receivers, you need one agreed way of counting air.

3.1 Free air delivery

Free air delivery (FAD) is the volume of air the compressor delivers, expressed as if that air were back at the **reference conditions** at the intake. It is the "free" air, before compression. Two machines are comparable only when their FAD is stated at the same reference state.

The publicly documented method for displacement compressors is ISO 1217 (the edition is named in Appendix G). It fixes a reference pressure and temperature for stating FAD. The PlantCalcKit toolkits let you choose the reference; the leakage toolkit example uses **1 bar a and 20 °C** and dry air, so we use the same here.

Quantity	Unit	Meaning
Rated FAD	m³/min (cfm)	The maker's figure at the rated conditions
Delivered capacity	m³/min	Rated FAD corrected to site conditions, times the share of the rating you can actually use
Specific power	kW per m³/min	Electrical power divided by FAD (Chapter 8)

Many catalogues use cfm (cubic feet a minute): 1 m³/min = 35.3 cfm. Use the same unit throughout a comparison.

3.2 Why altitude and heat matter

A compressor sucks in a fixed **volume** of air at its intake. If the air is thinner (high altitude) or hotter, each cubic metre has less mass, and so the machine delivers less air in terms of reference conditions. The site correction is

C = (P_site ÷ P_ref) × (T_ref ÷ T_site)

with absolute pressure and absolute temperature (kelvin). The site pressure comes from the standard atmosphere, ISO 2533 / US Standard Atmosphere 1976, in which pressure falls about 11 % for the first 1,000 m. Figure 3.1 shows the effect for AC-101.

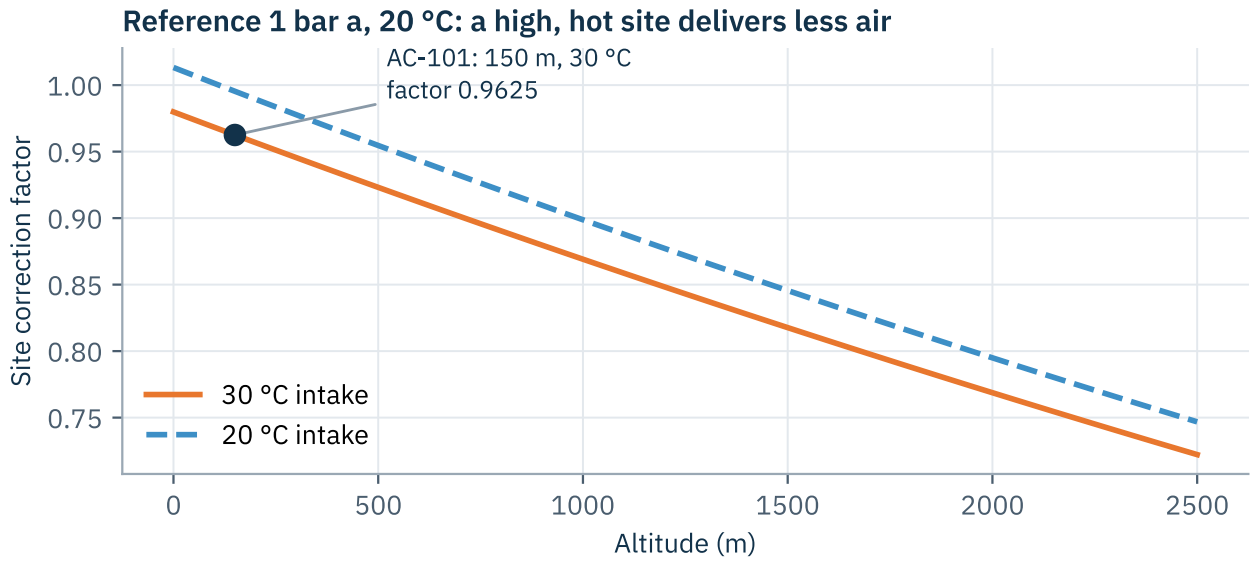


Figure 3.1 — Site correction factor against altitude for a 30 °C intake (solid) and a 20 °C intake (dashed). AC-101 is at 150 m, 30 °C.

ENGINEER'S CALCULATION CORNER **Worked example: how much air does AC-101 really deliver?**

AC-101 is rated 18 m³/min FAD at 1 bar a and 20 °C. It is installed at an altitude of 150 m, and the intake air is at 30 °C.

1. **Site pressure.** P = 1.01325 × (1 − 0.0065 × 150 ÷ 288.15)^5.2559 = **0.9954 bar a** (99.54 kPa), where 0.0065 K/m is the temperature lapse rate and the exponent is g ÷ (R × lapse rate) for air.
2. **Site correction.** C = (0.9954 ÷ 1.0) × (293.15 ÷ 303.15) = **0.9625**. Heat and altitude together cost 3.7 % of the rating.
3. **Delivered capacity.** 18 × 0.9625 = **17.325 m³/min** (612 cfm). The toolkit calls this the capacity on load.
4. **Air density at the reference state.** ρ = P ÷ (R T) = 100,000 ÷ (287.05 × 293.15) = **1.1884 kg/m³**.
5. **Mass flow.** 17.325 × 1.1884 = 20.59 kg/min = **0.3431 kg/s** of dry air.
6. **Specific power at site conditions.** The toolkit takes the specific power at the rating, 6.1 kW per m³/min, and divides by C: 6.1 ÷ 0.9625 = **6.337 kW per m³/min**. Full-load electrical power at the rating is 6.1 × 18 = 109.8 kW.

3.3 Air at the pressure it is used

FAD is a quantity at the intake. At the discharge pressure the same mass of air takes up far less space.

ENGINEER'S CALCULATION CORNER **Worked example: how big is 17.3 m³/min of free air at 7.5 bar g?**

Take the delivered capacity of 17.325 m³/min FAD. The discharge is 7.5 bar g, which is 0.9954 + 7.5 = 8.5 bar a, and the delivered air is 35 °C (308.15 K).

V = 17.325 × (1.0 ÷ 8.50) × (308.15 ÷ 293.15) = **2.144 m³/min**

The compressed air is about 8.1 times smaller in volume. This is why pipes can be small, and also why a hole of a few millimetres loses so much air.

3.4 Humid air: a short note

Atmospheric air carries water vapour, and warm humid air has a smaller share of dry air in each cubic metre. The compressor toolkit treats the intake as a mixture of dry air and water vapour; the leakage toolkit example uses dry air. In Chapters 7, 8 and 17 we put humidity in properly. For now, remember that a "dry" FAD and a "moist" FAD can differ by a few percent on a humid day, so state which one you mean.

3.5 Quick altitude table

Altitude (m)	Pressure (bar a)	Site correction at 30 °C intake
0	1.013	0.980
500	0.955	0.923
1,000	0.899	0.869
1,500	0.846	0.818
2,000	0.795	0.769

At 1,500 m the 18 m³/min machine delivers only 14.72 m³/min. A plant at altitude that buys compressors by catalogue number will always find them too small.

FIELD CHECK **Quantities that disagree**

What you see	What it may mean	First thing to check
Measured air is less than the rating	Site correction, inlet filter drop, wear	Inlet pressure and temperature; FAD test
Two datasheets differ by 5 %	Different reference conditions	The reference state in each
Flow meter reads high or low	Meter reads actual flow, not FAD	Meter basis and correction
FAD falls on hot afternoons	Intake air from a hot machine room	Intake duct, room ventilation

Watch out — "Nm³" and "m³" are not the same

Several reference states are in use (0 °C, 15 °C or 20 °C; 1.01325 or 1.0 bar a). A figure labelled "Nm³/h" can differ from FAD by 7 % or more. Always write the reference state next to the number.

TRY IT

A compressor is rated 12 m³/min FAD at 1 bar a and 20 °C. It is installed at 500 m altitude (use the table above) and takes in air at 25 °C. What is its site correction and delivered capacity? (Answer in Appendix F.)

FREE TOOLS **Do this chapter's calculation**

Free calculator
Compressed air leak cost calculator
plantcalckit.com/tools/compressed-air-leaks/

Excel toolkit: Compressed Air Demand and Leakage (USD 39)
plantcalckit.com/shop/compressed-air-demand-and-leakage-excel/
Topics: Free air delivery · Leak flow · Energy and cost of leaks · Artificial demand

QUICK QUIZ

1. What is free air delivery, and why does it need a reference state?
2. Write the site correction formula in words.
3. Why does a compressor deliver less air on a hot day?
4. AC-101 is rated 18 m³/min. What capacity does it have at Site W?
5. How much smaller in volume is the air at 7.5 bar g than at the intake?

APPENDIX G

Sources

Every chapter was written in our own words from the published references below. No text, tables or figures were copied; all diagrams and charts are original PlantCalcKit artwork, and the charts were computed from the worked examples. Where a method follows a code or standard, the calculation is aligned with the publicly documented method; that is not a claim that any result meets the code. Book citations give title, edition and chapter. **Edition note:** the standards, handbooks and sourcebooks below are listed with the edition that the matching PlantCalcKit toolkit documents. Editions change and the section numbers move; check the edition you have before you rely on a number. Method names (Darcy, Colebrook, Swamee–Jain, Carnot and so on) are the usual names of published equations.

General (all chapters)

- *Thermodynamics: An Engineering Approach* (Cengel and Boles), 9th ed. — ideal gas, compression, refrigeration cycles, psychrometric processes.
- *Fundamentals of Engineering Thermodynamics* (Moran and Shapiro) — compression work and refrigeration cycles.
- IAPWS-IF97 Industrial Formulation for the thermodynamic properties of water and steam (revised release 2007) and the IAPWS release on the sublimation pressure of ordinary water substance (2011) — saturation pressures and water enthalpy.
- NIST Special Publication 811, *Guide for the Use of the International System of Units* (2008 edition) — unit conversions, ton of refrigeration.
- ISO 2533, *Standard Atmosphere* (1975), and the *US Standard Atmosphere 1976* — pressure and temperature with altitude.

Chapter 3 — Free air delivery and site correction

- ISO 1217, *Displacement compressors — Acceptance tests* (2009 edition) — definition of free air delivery and the reference conditions (worded "aligned with the publicly documented" method).
- ISO 2533 and the US Standard Atmosphere 1976 — site pressure.

Enjoyed the free sample?

The full book has 19 chapters, 9 picture pages and more than 30 figures: leak surveys, pressure and pipework, drying, compressor specific power, part load and heat recovery, staging and intercooling, fan laws and flow control, chiller COP, part load and condenser water, psychrometrics, and a method for troubleshooting, every one with a worked example, field checks, exercises and a quiz. Get the full book and the matching Excel toolkits at **plantcalckit.com/shop/**.

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