ALUP
Kompressoren

BECAUSE IMPROVEMENT NEVER STOPS

THE COMPRESSED
AIR GUIDE

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INTRODUCTION THE AIR GUIDE

The aim for the Air Guide is to get a better understanding about air, and more important in our business compressed air. In the Air Guide you will find everything you need to know about compressed air and most of the applications that comes with it. This can range from designing a system to seeking information on how the compressor works.

The Air Guide is designed so that you, the customer, can feel confident with your purchase and know that all information is available in order to optimize you system. Another purpose with the Air Guide is that it can serve as training/ study material. The Air Guide is written in a educating and entertaining way, and is suitable to use for both company owners, sales crew, support functions and service crew, it has something for everyone.

Enjoy the Air Guide!

ALUP Kompressoren

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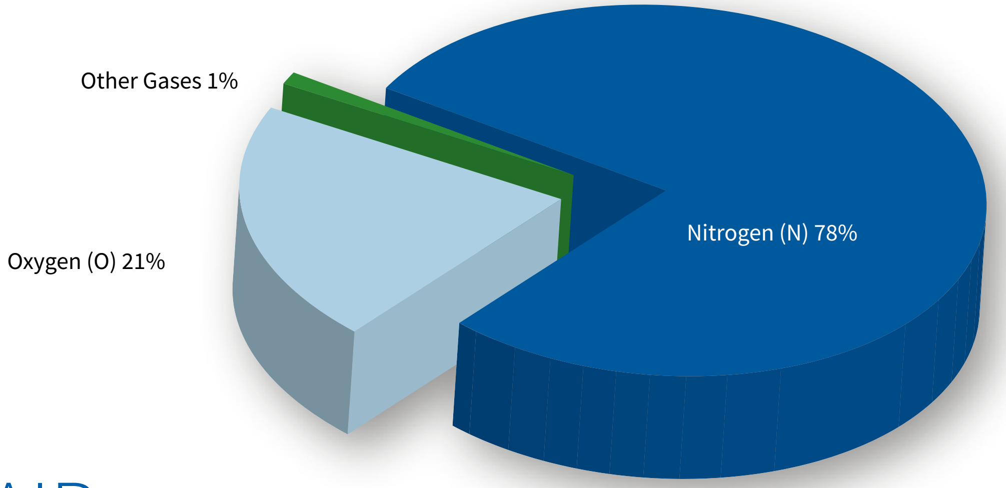
COMPRESSING AIR

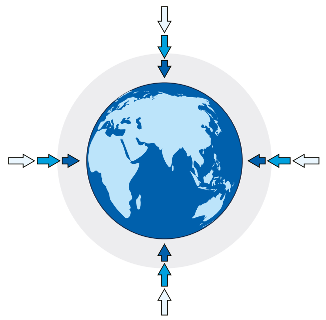
What exactly happens when we compress air? How does a compressor work? What type of compressor do I need? The Compressed Air Guide contains answers to such questions. It also explains terms and expressions that occur in connection with the compression of air, and you will gain an insight into how the different parts of a compressor system combine to supply your machines and tools with compressed air.



ABOUT AIR

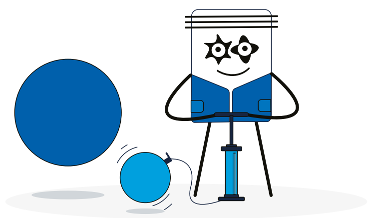
Life on earth depends on a gas bubble, the atmosphere, that surrounds our globe. This protective bubble extends approx. 1000 km into space. What we commonly call air is a gas mixture consisting mainly of nitrogen, oxygen and a larger or smaller amount of water vapor. The air also contains small amounts of inert gas and, unfortunately, a lot of pollution in the form of hydrocarbons produced by man. The air composition remains largely the same, up to about two miles altitude.

ABOUT ATMOSPHERIC PRESSURE



On the earth's surface the air has a weight of approx. 1.2 kg/m^3. This means that the earth's surface, and any objects upon it, are subjected to a pressure that we call air pressure or atmospheric pressure.

This pressure corresponds to the weight of an air column with a base of 1 cm^2 and a height of 1000 km; i.e. from the earth's surface to the atmosphere's upper limit. The air pressure decreases with increasing altitude; it is halved approximately every 5 km upwards, and we say that "the air gets thinner."



ABOUT COMPRESSED AIR

Unlike liquids, air can be compressed; i.e. a given volume of air can be reduced with increased pressure within the new volume as a result. Compression is carried out in a machine with a power source, a compressor. In its simplest form, a compressor can be a football pump with a human as the power source.

Air is drawn into the pump and compressed to about 1/4 of its original volume. The air pressure inside the football therefore rises to four times atmospheric pressure. We've put air into the ball.

THE ABSOLUTE ATMOSPHERIC PRESSURE IS ABOUT 100 kPa.

The air pressure in a football can be specified in different ways:

- As four times the absolute atmospheric pressure, 400 kPa(a),
- As excess pressure, 300 kPa(e), or
- As 300 kPa (understood as excess pressure).

(See the facts below)

UNITS

Atmospheric pressure

In the international unit system, Pa (Pascal) is the accepted basic unit of pressure.

As 1 pascal in compressed air is a very small amount of pressure we typically use the unit:

kPa (1 kilopascal = 1000 Pa)

or

MPa (1 megapascal=1000 kPa)

The general air pressure on the earth's surface can be specified in different ways, with more or less the same meaning:

1 atm (atmosfär) = 1 kp/cm² (kilopond/cm²)

100 kPa (kilopascal) = 1 bar

Compressed air

Compressed air pressure is typically specified as overpressure; i.e. pressure above normal atmospheric pressure. This is usually implicit but is sometimes clarified with an (e), kPa(e).

A compressor's operating pressure is generally specified as overpressure.

The compressor's capacity

A compressor's capacity; i.e. the amount of compressed air that can be supplied per unit of time; specified in:

l/min (liters/min), l/sec (liters/second) or m³/min (cubic meters/minute).

Capacity refers to atmospheric pressure expanded air.

An (N) before the device; e.g. (N) l/sec stands for "normal" and means that the volume specification applies to a specific ambient pressure and a specific temperature. In most practical cases, (N) l/sec is equivalent to l/sec.

WHAT DOES COMPRESSED AIR CONTAIN?

The compressed air the compressor produces naturally contains the same elements as the sucked-up ambient air. The water vapor in the air is also compressed and thus the compressed air is humid. Compressed air from an oil-lubricated compressor also contains small amounts of oil from the compressor's lubrication system.

Depending on what the compressed air is to be used for, there are different requirements for what is acceptable in terms of pollution. The compressed air's quality often needs to be improved by drying (humidity is reduced) and filtering (oil and other particles are removed). Compressed air quality can be defined in different classes according to an international system (see the Technical Information page 28).

WHAT HAPPENS WHEN AIR IS COMPRESSED?

HEAT

The power supplied to the compressor is entirely converted during the compression process into heat, regardless of the type of compressor. The total heat production is therefore always equal to the input power. A relatively small compressor with a motor power of 3 kW thus generates as much heat as a sauna unit! To improve the overall budget of a compressor system, this heat can be recovered through local heating. To prevent overheating, the compressor's cooling must be properly designed. Cooling is generally achieved using air, or in some cases with water.

WATER VAPOR

Following compression and a certain amount of cooling, the compressed air is saturated with water vapor and will have a relative humidity of 100%. As the compressed air passes through the compressed air system's coolants, this steam condenses into water. The temperature at which this occurs is called the dew point.

We then find condensate in the air and water tanks and piping. The amount of condensate depends on four factors, namely

1. The amount of water vapor in the ambient air,
2. The amount of air that is compressed,
3. The compressed air's drop in temperature after compression and
4. The compressed air's pressure.

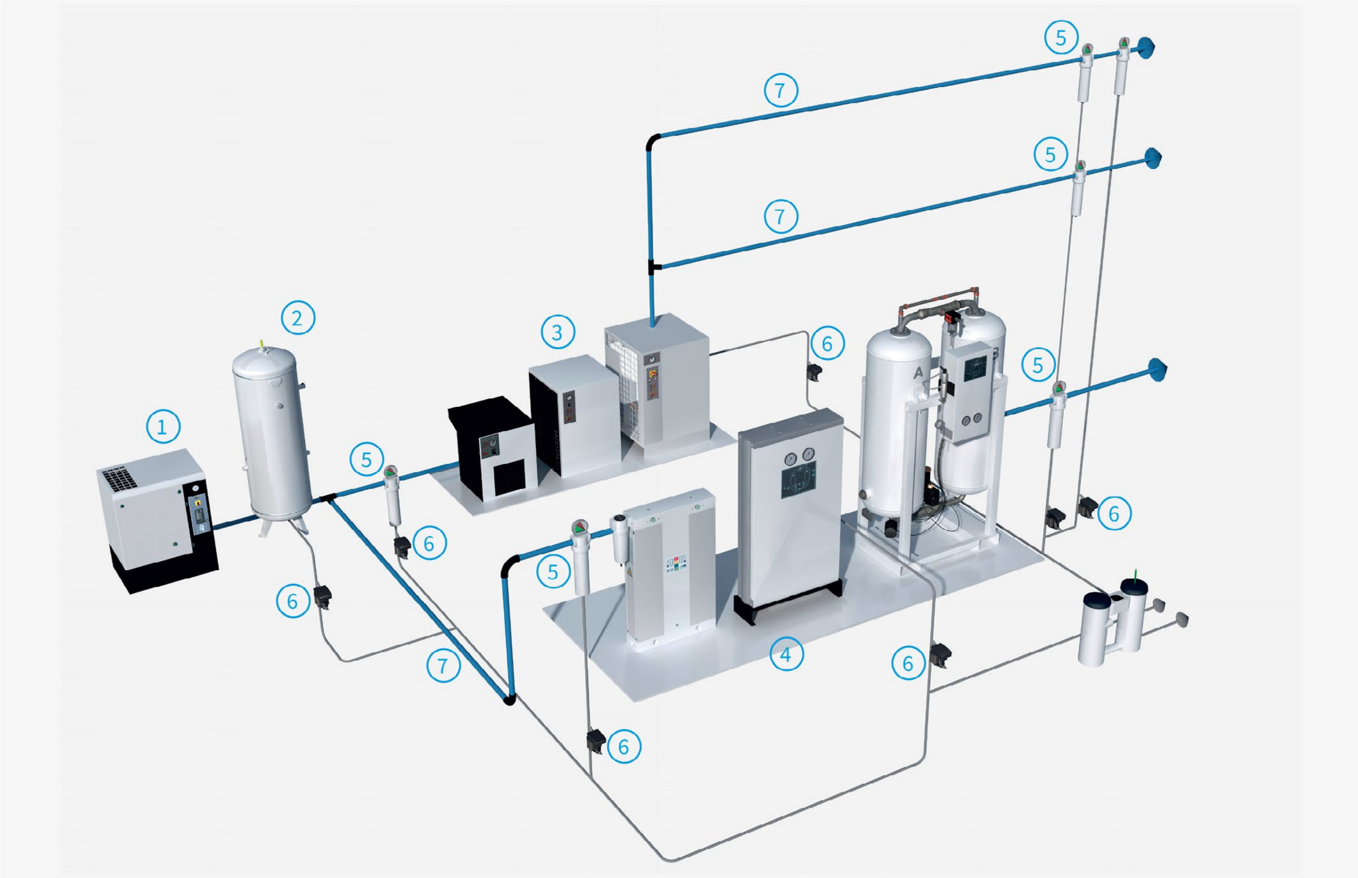
COMPRESSED AIR AS AN ENERGY MEDIUM

Extracting power from compressed air is advantageous in many aspects. Firstly, as a power source, compressed air is both clean and harmless, and secondly, it can also be used for such diverse tasks as operating tools and pistons in order to move or cool material. An external power source is required to power a compressor; typically an electric or internal-combustion engine. The power that is theoretically required to compress air to a certain volume and a certain pressure is physically fixed and cannot be changed.

There is a certain power loss during compression, which affects the system's total power needs. We will therefore discuss a compressor's specific power needs; i.e. the actual power required to compress a given volume of air to a specific pressure, plus the power loss in the compressor. For compression to 700 kPa in a modern industrial compressor, normally requires approximately 6.5 kW/m³/min of power. An increase or decrease in pressure of 100 kPa, results in a corresponding increase or decrease in power requirements of approximately 7%.

CHOOSING THE SYSTEM

The Compressed Air Guide has identified two main types of compressors: reciprocating compressors and screw compressors. A comprehensive compressed air system, which meets modern budgetary, accessibility and environmental demands, consists of the following units.



COMPRESSOR SYSTEM

1 Compressor

Positioned with at least 0.5 m service space all around. There must be at least 1 m free space in front of the electrical panel.

2 Air Tank

With fittings and automatic drainage valve. As a rule, an air tank must, by law, be inspected by an accredited body before it can be used.

3 Refrigerant Dryer

Condensation-free air for indoor use. Connected with a shut-off valve and bypass cable for easy service.

4 Adsorption Dryer

Condensation-free air for indoor use. Connected with a shut-off valve and bypass cable for easy service.

5 Filter

Removes residual oil from the compressed air for technically oil-free compressed air.

6 Condensation Treatment System

Protects the environment from oily condensate from the compressor, air tanks, refrigeration dryer and filter.

7 Airnet - Piping System

CHOOSING THE COMPRESSOR SYSTEM

In order to choose the right type of compressor and associated equipment, we need to know or determine certain conditions. An accurate assessment of the actual requirements means the selected system is used optimally, with regard to capacity and budget.

BASIC REQUIREMENTS

The following factors are essential when designing a compressor system:

- What amount of compressed air is needed to perform the proposed job?
- During which operational cycle is the compressed air used?
- What quality of water, oil and particulate content of the compressed air is required for the supporting equipment?
- Which operating pressure does the supporting equipment require?

Amount

Compressed air consumption can be estimated from past experience. The method is uncertain and requires considerable experience on the part of the assessor.

Another way is to measure an existing compressor's load; a method that works well for the expansion of an existing system.

A third method is to measure connected machines and tools' compressed air consumption. To get an accurate result, it is important to include the working time and the consumption's operational cycle in the assessment.

Working pressure

The compressor is adapted to the piece of equipment that requires the maximum working pressure. Compressed air tools within the industry are often designed to be supplied with a working pressure of 600 kPa.

The compressor will normally produce a slightly higher pressure to compensate for pressure drops in compressed air dryers, filters and ducts. In the above example, a suitable working pressure for the compressor would be 700 kPa.

Operational cycle

Is consumption continuous around the clock?

Does consumption vary during the working day?

Is there any special equipment that requires large intermittent expulsion of compressed air?

Quality

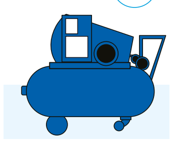
Depending on what the compressed air is to be used for, determines what is acceptable in terms of particles, oil residue and water.

RECOMMENDATIONS - THE CHOICE OF COMPRESSOR WITH EQUIPMENT

Compressed air requirements / Compressor

Intermittent operation:
(one-shift, max. 4 hours/day)
Quantity of compressed air 50-800 l/min
Operating pressure 100-800 kPa
Operating pressure 700-3,000 kPa

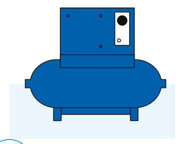
1



One-stage reciprocator compressor (with air tanks)

Several-stage reciprocator compressor (with air tanks)

(Single shift)
Quantity of compressed air 100 l/min electric.
More Operating pressure 500-1,300 kPa

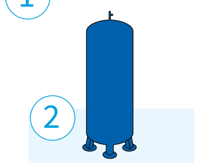


Screw compressor with air tanks

Continuous operation:
Capacity 100 l/min and more
Operating pressure 500-1,300 kPa

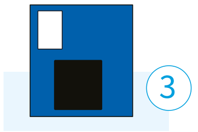
1

2



Quality requirements / Optional equipment

Operational air for pneumatic tools in heated rooms.



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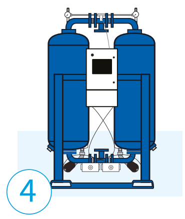
Dryer

Working air in unheated rooms or outdoor pipes. Operational air for precision mechanics and electronics up to - 70 in the dew point

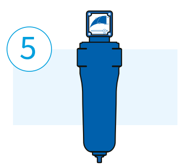


4

Adsorption dryer

When using the dryer as a post-filter. When using an adsorption dryer, and pre-filters. When spray painting, blasting and cleaning.

5



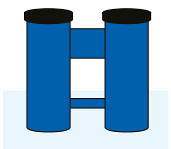
Oil Separation Filters

Breathing Air, (using cold or adsorption dryers). Laboratory Air.

Oil Separation Filters + Active carbon fi lter

Operational air for precision mechanics and electronics.

6



Oily condensate cannot be released into the sewer system.

Condensate Treatment System

For a clean compressor and a healthy environment.

RECIPROCATING COMPRESSORS

A reciprocal compressor consists of one or more cylinders with pistons driven by a motor. The air is sucked into the cylinder and then compressed, in one or more stages to the operational pressure. After compression, the compressed air passes through the after-cooler and continues on to the air tank.

THE RECIPROCATING COMPRESSOR

Oil-lubricated and oil-free?

An oil-lubricated compressor's cylinders, pistons and cranks are lubricated by oil circulating in the compressor. The compressed air from an oil lubricated reciprocal compressor contains a certain amount of residual oil, typically 10-15 mg/m^3.

Most versions of oil-free reciprocal compressors have permanently lubricated bearings. The pistons have grease-free piston rings, usually of Teflon or carbon fiber. This type of compressor typically requires more frequent replacement of bearings and piston rings than the oil-lubricated versions. In return, the compressed air is free of residual oil.

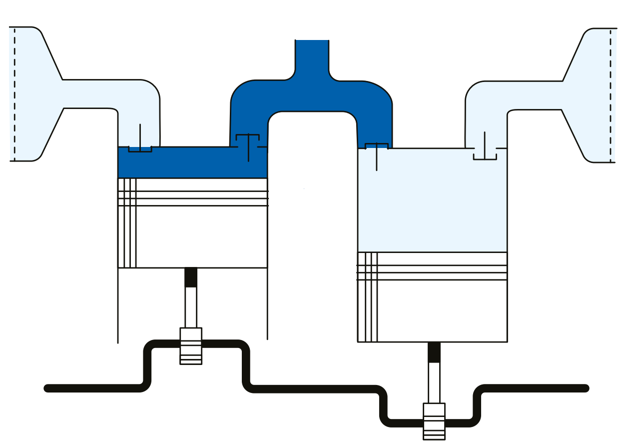
Application areas

Reciprocal compressors are mostly suitable for small compressed air requirements; one-stage compressors for pressures up to about 800 kPa, while several stage versions can produce up to 30,000 kPa.

Operation should be intermittent. An air-cooled reciprocal compressor's load level must not exceed 60%. After 2 minutes of compression, the compressor must rest for at least 1.5 minutes. The total compression time per day should be kept to a max. of approx. 4 hours.

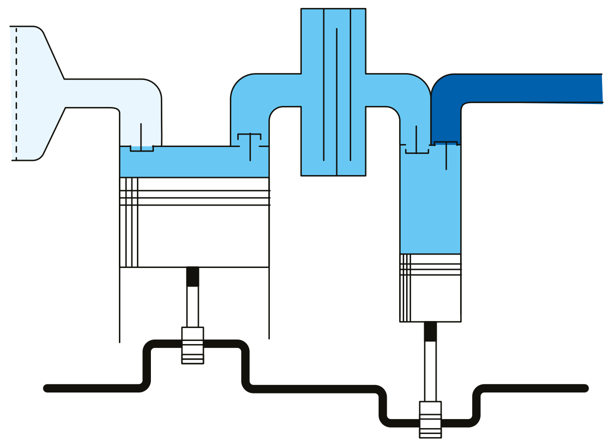
THE ONE-STAGE COMPRESSOR

A one-stage compressor has one or more cylinders, each of which compresses air from atmospheric pressure to operational pressure.



MULTI-STAGE COMPRESSOR

A multi-stage compressor has two or more cylinders connected in series in which air is gradually compressed to the final pressure. Between steps, the compressed air is cooled with air or water. Thereby improving efficiency, while achieving a much higher pressure than from the one-stage compressor.



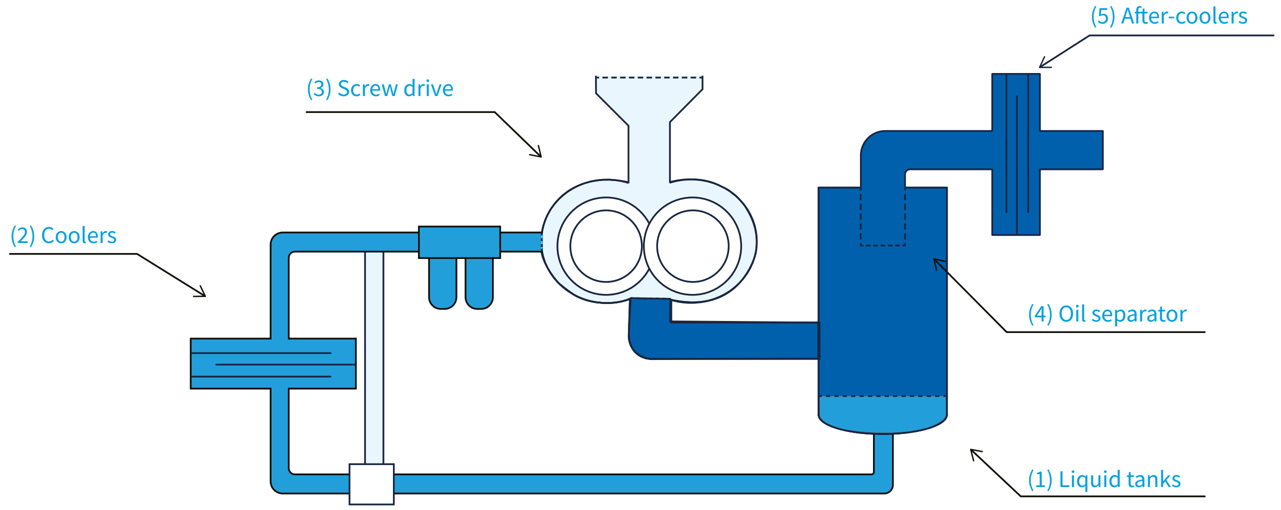
SCREW COMPRESSORS

The screw compressor compresses the air in a space formed between two opposing rotating screws. These form, together with the surrounding air compressor housing, the screw drive. A screw compressor mainly works on two premises: liquid injection or drying. Both versions come in one-and two-stage models.

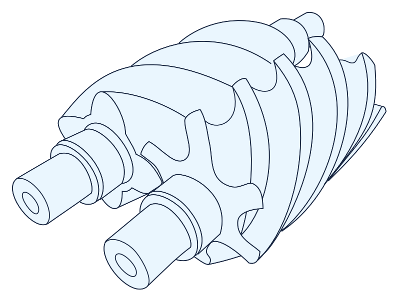
THE SCREW COMPRESSOR

Liquid-injected screw compressors

In a liquid-injected screw compressor the compressed air is cooled with a cooling liquid in the compression chamber between the screws. The coolant, usually oil, circulates in a closed system between (1) liquid tanks, (2) coolers and (3) screw units and mixed with air before compression. The compressor's operating temperature is therefore kept at around 80°C whatever the load and pressure. Immediately after compression, the coolant is separated from the compressed air in (4) the oil separator. The compressed air then goes through an (5) after-cooler and then on to the air tank.



Principle of liquid injected screw compressor



Application areas

The screw compressor is suitable for both intermittent and continuous operation. Operating budget is optimal during continuous operation at high load levels (up to 100%). With modern technology; e.g. speed control, the screw compressor's energy consumption for low or varying air requirements can be reduced significantly compared to previous methods.

Liquid-injected screw compressors in one-stage models currently dominate the industry, where operational pressures up to 1300 kPa and a capacity of up to approx. 30 m^3/min are required.

Drying compressors

The dry or "oil free" screw compressor compresses air without cooling the compression chamber. The compressor's operating temperature therefore rises to about 200°C, even at an operating pressure of 300 kPa.

For normal industrial air pressure (about 700 kPa), the drying compressor must therefore compress the air in two stages and cool the compressed air between the compression stage.

FREQUENCY DRIVEN COMPRESSORS

The piggy bank for both your wallet and the environment.

Buying a new compressor is a large investment for both large and small companies. But in fact, a compressor's investment cost is very low if you look at a compressor's life cycle. Approximately 75% of the total cost is power/ energy costs. If you are thinking of investing in a new compressor, it is this cost we will try to minimize.

This chapter describes the smart savings that can be made through minimizing power consumption. First, it can be as simple as choosing the right machine for a particular job. It has been shown in many cases that companies choose a compressor that is too big because uncertainty over the actual air demand, ,or the wrong technology due to bad knowledge of what is the most efficient for your application.

To choose the right model of compressor can be done in different kinds of ways. It can be done with a real measurement, where you measure the current value and out of that simulate potential savings. It can also be done with some of the sophisticated business tools, or just by experience. If you have done a measurement, the done a correct simulation of the previous compressor, You will not seldom experience a big saving potential with replacing your conventional load/unload compressor with frequency driven unit. If we study the illustration below. The red/blue field shows the an working pattern of a load/unload compressor. In load mode the compressor is running 100% and pressure is rising, until it reaches its max pressure value, then the compressor turns into unload mode before shutting off after a set amount of time, until the compressor unit reaches the minimum pressure value then the compressor starts up the same routine.

This leads to unnecessarily high power output and therefore higher energy costs.

A frequency driven compressor has a different work pattern, as you see in the below illustrated example, with lower peaks and a smoother air profile. The reason that the curve looks different for a frequency driven compressor is that it adjusts after the air demands and produces the amount needed for a specific moment. This is done by a pressure sensor that reports the pressure to the controller that gives a signal to the inverter about the situation. The inverter adjust the motor speed depending on the pressure settings. This technology is a real piggy bank both for the environment and for your energy bill.

Load/Unload

Frequency driven

EXAMPLES OF POTENTIAL SAVINGS

A frequency driven compressor saves in average between 25-35% in electrical cost compared to your previous compressor installation. This may not sound like a big saving, but by illustrating this with an example below, I'll show you how much money you could save by choosing a frequency driven compressor.

And remember that it is not the lowest price you should consider, it is the lowest cost that is important. Therefore, a frequency driven compressor is the obvious choice. I illustrate this with an example below.

Basic concepts:

- Load power: Is the length of time a compressor runs, while producing air.
- Unload power: Is the length of time that the compressor motor is running but no air is produced.
- After a while, however, the engine will shut off if no air is needed. It is this time we want to minimize.

Compressor 1 is a typical conventional load/unload compressor that works according to the rhythmic pattern. It has a 22 kW electric motor as a power source. In the charged mode the compressor draws 22 kW. When in the idle mode it draws 12 kW. The operating time per year is 6,000 hours. Of these 6,000 hours, the compressor spends 3,000 hours in unload mode, meaning that the engine is running but produces no air. This figure is very common in many large and small companies.

Operating cost/year charged

Compressor	Operating time load.	Charged (KW)	kWh/year	kWh (€)	**Operating costs/year**
Load	3000	22	66000	0,1	**€ 6,600**

Operating costs/year shipped

Compressor	Operating time load.	Charged (KW)	kWh/year	kWh (€)	**Operating costs/year**
Unload	3000	12	36000	0,1	**€ 3,600**

Compressor 2 is a frequency driven compressor with a 22 kW engine power source. A compressor such as this adapts itself to the production's air requirements, and it uses 65-70% of its maximum power, on average, if the compressor is properly proportioned. This is an average power of about 15.5 kW. However, this is where operating times differ slightly. Of the 3,000 hours load power the compressor above uses, the frequency driven compressor needs to run for about 4,500 hours to meet the same air requirements at 70% charge. But here's the big difference, for the remaining 1,500 hours a frequency driven compressor shuts down. When no air is needed, the frequency driven compressor runs at minimum speed for a certain time period before it shuts off. This saves 1500h of unload power, and will have a major positive impact on your electrical bill.

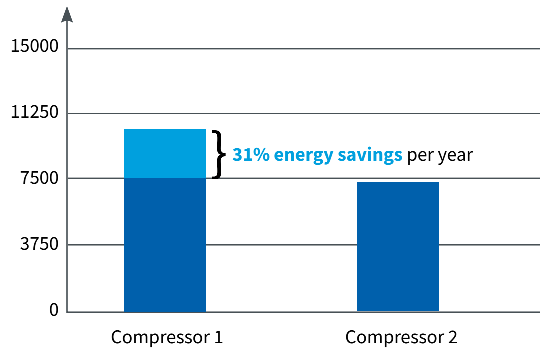
Operating costs/year

Compressor	Operating time load.	Charged (KW)	kWh/year	kWh (€)	**Operating costs/year**
Frequency driven	4500	15,5	69750	0,1	**€ 6,975**

SAVINGS POTENTIAL IN SUMMARY

Summary

The total energy consumption cost of compressor 1 is € 10,200/year.
The total energy consumption cost of compressor 2 is € 6,975/year.
This gives a difference of
€ 10,200 - € 6,975 = € 3,225/year. or € 3,225 / € 10,200
= 31% in savings per year.
You can expect to save the slightly higher investment cost in 1-2 years if you choose a frequency driven compressor. You should also think of the amount of carbon we save by selecting the speed-controlled example. If you increase the size of the air compressor to around 75 kW, the corresponding savings are significant.



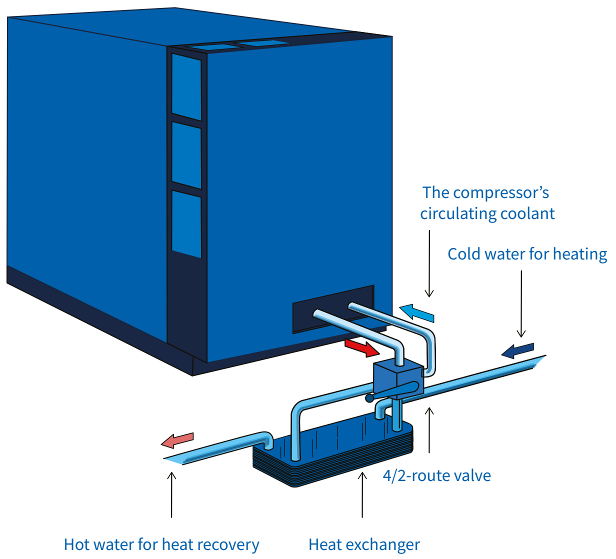
HEAT RECOVERY SYSTEM

Energy recovery from water-injected screw compressors

An air compressor is installed to provide certain types of production systems with energy in the form of compressed air. When compressing air in the compressor, energy is also created as heat. This energy is equal to the energy supplied to the compressor's motor. A small amount of the heat energy remains in the compressed air. This is noticeable, as the outgoing air has a slightly higher temperature than the ambient air sucked into the compressor. A small portion of the heat is transferred to the compressor's surroundings in the form of radiant heat. The remainder, approximately 90% of the energy supplied, consists of thermal energy, which in most cases can be extracted from the compressor and thereby significantly improving the budget for compressed air production.

Heat recovery system

Water-injected screw compressors dealt with here are equipped with two heat exchangers, in which the heat energy produced will be cooled off. A heat exchanger for cooling the expelled compressed and heated air this, must cool off approximately 10% of the energy supplied. A heat exchanger for coolant circulating in the screw compressor; in which the remaining thermal energy is cooled off by approximately 80%. The coolant to be used as a heating medium can be air or water.



Air-cooled compressor with water-based recovery system

Hydronic heat recovery

This is an option that can be of interest if the possibility exists to preheat the return water in a heating system, reheat the water in a heating system or heat the process water. A heat exchanger coolant/water is connected to the air-cooled compressor in series with the normal heat exchanger coolant/air, which in this case acts as a reserve or residual cooler. Cooling mainly takes place in the heat exchanger's coolant/water where the water can reach temperatures of up to approx. 70°C.

Ca. 80% of the energy added to the compressor can be transferred to the water as temperature increases, and can thus be recovered by this method.

AIRBORNE HEAT RECOVERY

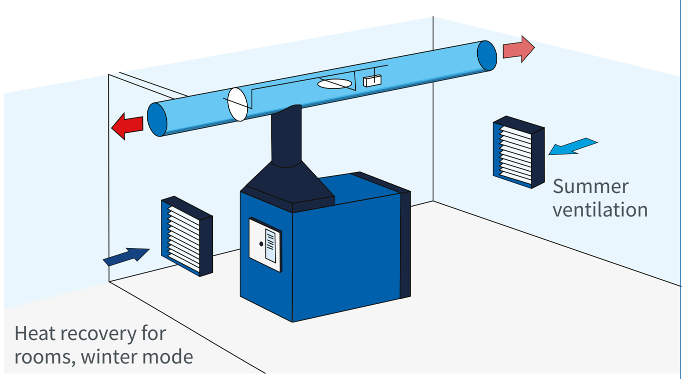
A simple and inexpensive method which, in most installations, provides rapid recovery of investment costs.

In winter, the warm air from the compressor's air outlet is fed into the adjacent chamber through a duct. The air is returned from this chamber to the compressor chamber through a valve.

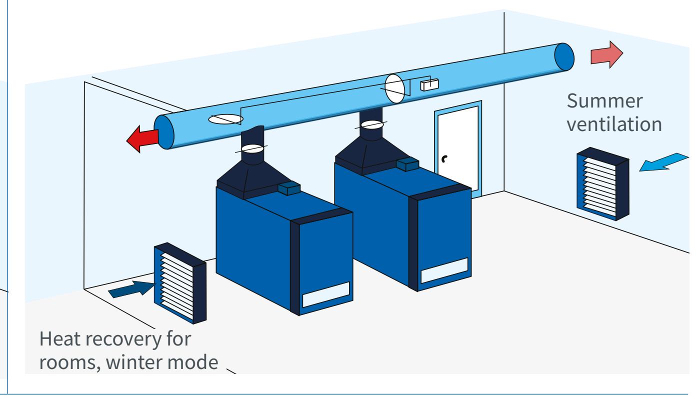
In summertime, the cooling air is fed from outdoors through a valve and back outside through the duct, which is then closed for heat recovery to an adjacent room.

In joint systems for heat recovery from dual compressors, a valve is mounted on each compressor that is interlocked with the compressor's motor. In this way hot air is prevented from being pushed back into a compressor that is idle.

SINGLE COMPRESSOR INSTALLATION



DOUBLE COMPRESSOR INSTALLATION



Examples of water flow through heat exchangers for different temperature ranges for the water-energy recovery:

Power added to compressor

kW	30	45	75	110	160

Recovered power, kW

kW	24	36	60	88	128

Water flow, l/h at water temperature degrees °C

°C in/°C, out	l/h				
10/70	340	520	860	1 260	1830
40/70	690	1 030	1 720	2 520	3670
55/70	1 380	2 060	4 130	5 050	7340

DRYING COMPRESSED AIR

The drying process removes moisture from the compressed air. Dry compressed air reduces the risk of corrosion damage to the compressed air system and improves the operational budget of connected machinery and tools. Drying mainly takes place by two methods, cold drying or adsorption drying.

COMPRESSED AIR DRYER

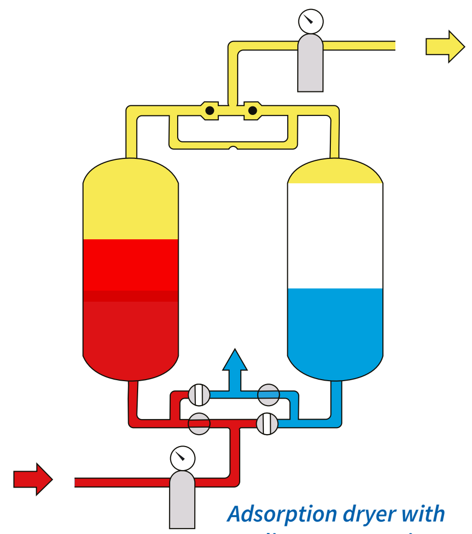
Adsorption dryer

The Adsorption dryer consists of two pressure tanks which both contain a desiccant; usually aluminium oxide, silicon gel or a mixture of these.

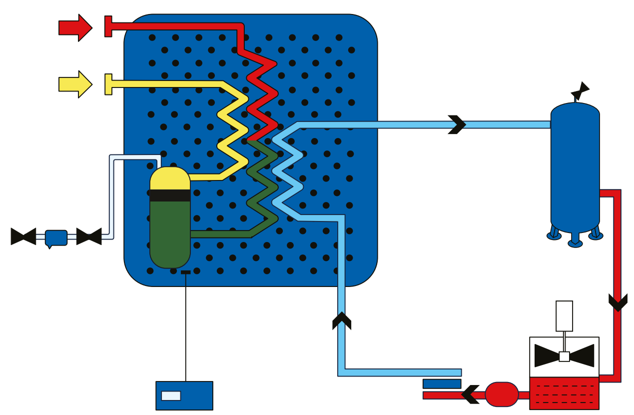
The compressed air passes through one chamber and is dried as a result of contact with the desiccant to a dew point of -25oC or lower. Most of the dry compressed air then passes directly into the compressed air system. The remainder, 3-15%, is led into the second tank, where it expands to atmospheric pressure. The dry, expanded air then absorbs the moisture from this container's desiccant and then, together with the moisture, is released into the environment.

After a certain time, the containers switch functions and we thus have a continuous-drying process.

The adsorption dryer is sensitive to oil and water in the compressed air and must always be preceded by an oil and water separation filter.



Adsorption dryer with cooling regeneration.



Refrigerated dryer

The cold dryer contains a cooling machine with a refrigerated compressor, heat exchanger and a cooling medium. The compressed air is cooled to between ± 0 and +6°C, the condensed water is precipitated and separated automatically.

The dryer gives the compressed air a dew point of +3 to 10°C, which is enough to achieve condensation-free compressed air for use in heated rooms.

The dryer is easy to install, requires little energy input and is relatively insensitive to oil in the compressed air. An oil separating fi lter should be installed after the dryer to reduce any residual oil in compressed air.

Proportioning the compressed air dryer

To select the right capacity of the compressed air dryer, the following factors must be considered:

- What is the temperature and pressure of the compressed air before drying?
- How high is the fl ow rate through the dryer?
- What dew point is required after the drying process?
- What temperature is the ambient air?

FILTERING COMPRESSED AIR

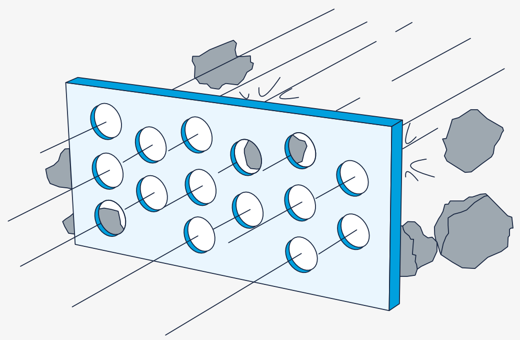
By installing filters in the compressed air system, the levels of pollutants can be minimized to an acceptable level for operational air, or completely eliminated if necessary. We primarily use three different methods for filtration of compressed air and gases; surface filtration, depth filtration and filtration with active carbon.

COMPRESSED AIR FILTERED

Surface filtering

A surface filter acts as a sieve. Particulates that are larger than the holes in the filter element stick to the surface while smaller particles pass through. By adjusting the filter material's orifice, the filter's ability to separate particles down to a certain size can be determined.

When the filter's orifice is clogged, the pressure drops and the filter element must be cleaned or replaced. The material in a surface filter may be cellulose fibers, polyethylene or sintered metal.



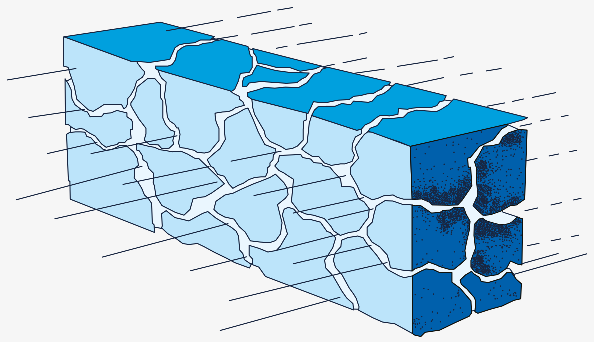
Surface filtration separates particles

Filtration with active carbon

When filtering through a bed of active carbon both oil vapors and certain gases are absorbed. The compressed air is thus odorless and tasteless.

Normally, the active carbon in a filter element soaks up oil to approximately 15% of the amount of carbon weight before it is saturated. When the carbon is saturated, the filter element is replaced.

This type of filter should always be preceded by a depth filter in which any oil drops are separated. The compressed air should also be dried by air-drying prior to filtration through active carbon.



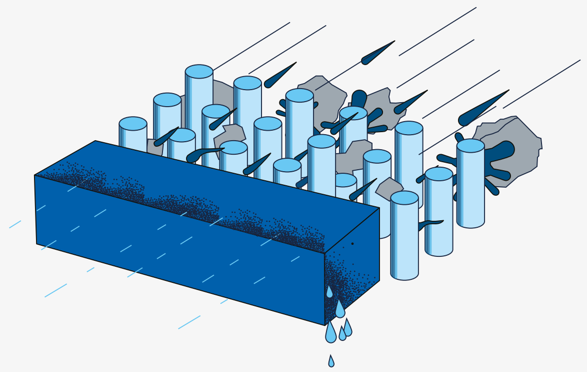
Carbon filters remove oil vapor and gases

Depth filtration

Depth filtration separates oil and particulates from compressed air through a filter of glass fibers. Oil droplets become trapped on the fibers, the oil is pressed through them and eventually drained via a drainage valve at the bottom of the filter housing.

Solid particulates are caught between the fibers.

When the filter material has been saturated by pollution, the pressure across the filter falls and the filter element must be replaced. The filter separates the oil most efficiently when the air pressure has a low temperature (+20°C or less) and when the air velocity through the filter is correct.



Depth filters remove oil and particulates

TECHNICAL INFORMATION

This chapter deals with several types of technical information which will further guide you in understanding compressed air principles and technologies. Moreover, also some financial aspects are dealt with and we close with a FAQ section to answer the most common issues.

COMPRESSED AIR BUDGETS

Correct pressure is important

Compressed air-powered tools within the industry are generally constructed for an operating pressure of 600 kPa. The compressor's operating pressure should be slightly higher to compensate for pressure losses along the way to the tool.

Falling pressure has a major impact on tool performance. If the pressure, which supplies, for example, a drill, is reduced from 600 to 500 kPa, output is reduced by about 25%, which of course makes working with the drilling machine slower.

Feeding tools with pressure which is too high is not good either. An increase in pressure from 600 to 900 kPa makes a power wrench 50 percent stronger, but also 50 percent overloaded. Overloading leads to damage and shortens the life of the tool.

Increasing the operational pressure also increases compressed air consumption and thus energy costs.

Compressed air consumption

The compressed air consumption of a compressed air machine increases with pressure in accordance with the following.

Operational pressure kPa	Correction factor
500	0,8
600	1
700	1,2
800	1,4
900	1,6
1000	1,8

Example:

A grinding machine which, according to the supplier consumes 700 l/min at 600 kPa will consume
700 x 1.6 = 1,120 l/min at 900 kPa.

Dry compressed air is economical compressed air!

A compressor plant without a compressed air dryer supplies the pipeline with compressed air with a relative humidity of 100% and consequently a dew point which is the same as the compressed air's temperature.

For each degree of temperature drop in the piping system, the condensation water will precipitate and cause corrosion in pipes and associated tools and machinery.

Water in the piping system also requires continuous maintenance of the water separator and filters. In addition, the wear on pneumatic tools will increase. A compressor's air dryer in the system eliminates these problems and the additional costs they incur.

For larger facilities, a centrally located compressor system is preferable to having compressors at each work unit. The benefits are many:

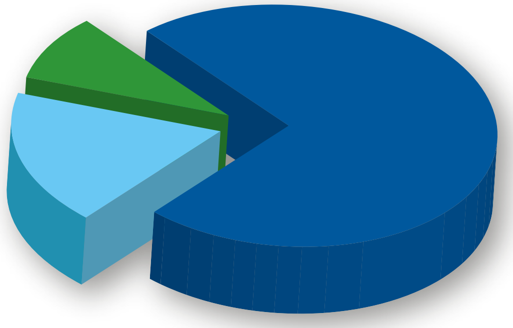
- It is easier to optimize a compressor system's capacity, which affords lower energy and investment costs.
- Interconnection of several compressors provides better operating budgets.
- Easier monitoring results in lower maintenance costs.
- Ventilation and heat recovery can be made more efficient by reducing energy costs as a result.

The compressor's location

Generally, the compressor is placed as close to the workplace as possible.

The cost of compressed air

During a compressor's technical lifetime of 10 years, the cost of compressed air is roughly divided as follows:



The total energy cost is thus the first thing we'll look at. Each unit in the compressed air system consumes energy either directly or indirectly through the loss of pressure. This must be compensated with a higher compressor pressure, which results in a higher power consumption. For every 10 kPa (0.1 bar) increase in compressor pressure, the power demand is increased by approximately 0.7%.

To achieve as low an energy consumption as possible, consider the following:

- Choose as large an air tank as possible. The compressor's control system can then work optimally for the lowest energy consumption.
- Set the compressor's operating pressure as low as possible.
- Dimension the supporting equipment, such as compressed air dryers and filters, in view of low pressure drops.
- Dimension the compressed air pipes for low pressure drop (see pages 30-31).
- Change filters regularly to minimize pressure losses.
- Check the compressed air system regularly for leaks. Immediately repair leaking pipes, hoses and fittings.
- Take advantage of any possible heat recovery from the compressor (see chapter about energy recovery).
- Invest in modern interconnection automation that adapts the compressor's operational cycle according to swings in the compressed air requirements.
- Reduce compressed air consumption by installing an automatic saver to the adsorption dryer if there is one in the system.

Requirements for air to be compressed

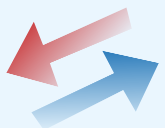
The compressor's intake air must be free of particulate and gaseous pollutants.

Remember that hydrocarbons; e.g. vehicle exhaust fumes, may be present in the ambient air. When these are compressed with the air in the compressor, the concentration of toxic gases is deadly if the compressed air is used as breathing air.

Therefore, make sure that the compressor chamber's air intake is positioned where clean air is available, and equip it with a dust filter!

The intake air must be as cold as possible for the compressor and its function.

Heat recovery



In principle, 100% of the energy supplied to the compressor motor is recovered in the form of heat.

The heat from an air-cooled compressor is recovered in the form of heated ventilation air for room heating.

A water-cooled compressor, primarily affords heated cooling water, which can be used directly or indirectly as process or tap water. Thermal energy in the cooling water can be converted into hot air for room heating in a so-called Aerotemper (temp. control).

Adapting the compressor for heat recovery is relatively easy and in many cases pays for itself quickly.

EXAMPLES OF COMPRESSED AIR CONSUMPTION FOR SOME COMMON MACHINES

Equipment	Compressed air consumption l/min	Utilization factor* of the company	
		Manufacturing	Service center
Drill 10 mm	500	0,2	0,1
Angle grinders"	900	0,2	0,2
Angle grinder 7"	1 600	0,1	0,1
Polishing Machine	900	0,1	0,2
Impact Wrench 1/2"	450	0,2	0,1
Impact Wrench 1"	800	0,2	0,1
Chipping hammer	400	0,1	0,05
Varnishing machine	500	0,2	0,3
Pressure cleaner	350	0,05	0,05
Paint Gun	300	0,6	0,1
Small pressure cleaner	300	0,1	0,2
Free-jet blaster 6 mm	2 000	0,6	0,1
Free-jet blaster 8 mm	3 500	0,6	0,1
Breathing mask, light work	50	0,6	0,2
Breathing mask heavy work	200	0,6	0,2

* The utilization factor can vary greatly in different applications. The stated value can only be used as a guideline.

Example of a calculation of a garage's average compressed air requirements:

2 drills	2 x 500 x 0,1 =	100
2 impact wrenches 1/2"	2 x 450 x 0,1 =	90
1 polishing machine	900 x 0,2 =	180
1 buffing machine	500 x 0,3 =	150
1 paint gun	300 x 0,1 =	30
3 pressure cleaners	3 x 350 x 0,05 =	53
Consumption:		**603 l/min**
Addition for leakage 10%:		60
Reserve for future needs 300/o:		180
Basis for choosing the compressor:		**843 l/min**

When selecting the compressor, the compressor's level of utilization must be considered. For screw compressors, 70% utilization rate can be selected, which in this case means a suitable compressor capacity of about 1200 l/min.

The calculation must also take into account how many machines may be operating simultaneously. The formula for a rough estimate of the compressed air consumption of a pneumatic cylinder:

$$x \, S \, x \, P \, x \, A \, x \, F = L \quad \frac{D \, x \, D \, x \, 3.14}{4}$$

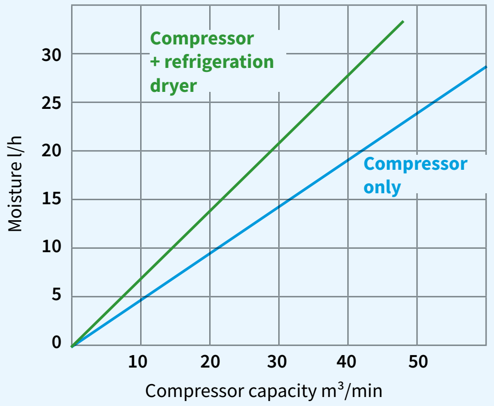
S = stroke length in dm
D = piston diameter in dm
P = operational pressure in bars
A = behavior: dual-action = 2, single-action = 1
F = frequency, number of strokes/min
L = air consumption in l/min

The calculation formula does not take account of the piston's volume, allowing a slightly higher value than the theoretical accuracy to be achieved. However, this can be a marginal in a practical calculation.

HOW MUCH CONDENSATION DOES THE COMPRESSOR SYSTEM PRODUCE?

Prerequisites for the table:
The condensation amount is calculated at 20°C air temperature entering the compressor, 70% RH and 800 kPa operational pressure.

Example:
Compressor capacity: 20 m³/min (with subsequent refrigerated drying).
Production time: 10 hours/day, 20 days/month.
Condensate volume produced: 13.5 l/h, which means 135 liters/day, or 2700 l/month.



CLASSIFICATION OF COMPRESSED AIR QUALITY

ISO standard 8573.1 for the classification of compressed air quality

The European cooperative organization for suppliers of pneumatic equipment, PNEUROP, has developed an ISO standard for the classification of compressed air content in terms of solid particulates, water and oil.

Quality class	Solid particle content		Water content		Oil content
	Max. size mu	Max. amount mg/m³	Dew point °C	Amount g/m³	Max. amount mg/m³
1	0,1	0,1	– 70	0,003	0,01
2	1	1	– 40	0,11	0,1
3	5	5	– 20	0,88	1,0
4	40	10	+ 3	6,0	5
5	–	–	+ 7	7,8	25
6	–	–	+ 10	9,4	–

Typical requirements for compressed air quality classes according to ISO 8573.1 for some uses

Application areas	Quality class		
	Solid particle content	Water content	Oil content
Air stirring	3	6	3
Air motors, large	4	5-2	5
Air motors, miniature	3	4-2	3
Air turbines	2	3	3
Transportation of granulates	3	5	3
Transportation of powder	2	4	2
Fluidistors	2	3-2	2
Foundry machinery	4	5	5
Contact with provisions	2	4	1
Pneumatic tools, industrial	4	6-5	4
Mining Machinery	4	6	5
Packaging machines	4	4	3
Textile machinery	4	4	3
Pneumatic cylinders	3	4	5
Film Handling	1	2	1
Precision Regulators	3	3	3
Process Instruments	2	3	3
Sand blasting	-	4	3
Spray Painting	3	4-3	3
Welding machines	4	5	5
Workshop air, general	5	4	5

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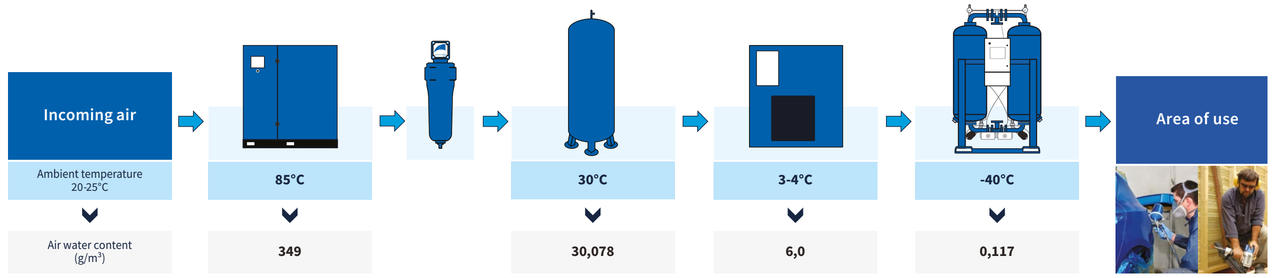
The air's water content at different dew points

Dew Point °C	g/m³	Dew Point °C	g/m³	Dew Point °C	g/m³	Dew Point °C	g/m³
+ 100	588,208	58	118,199	16	13,531	-26	0,51
98	550,375	56	108,2	14	11,987	-28	0,41
96	514,401	54	98,883	12	10,611	-30	0,33
94	480,394	52	90,247	10	9,356	-32	0,271
92	448,308	50	82,257	8	8,243	-34	0,219
90	417,935	48	74,871	6	7,246	-36	0,178
88	389,225	46	68,056	4	6,356	-38	0,144
86	362,124	44	61,772	2	5,571	-40	0,117
84	336,661	42	55,989	±0	4,868	-42	0,093
82	311,616	40	50,672	-2	4,135	-44	0,075
80	290,017	38	45,593	-4	3,513	-46	0,061
78	268,806	36	41,322	-8	2,984	-48	0,048
76	248,841	34	37,229	-12	2,156	-52	0,031
72	212,648	30	30,078	-14	1,81	-54	0,024
70	196,213	28	26,97	-16	1,51	-56	0,019
68	180,855	26	24,143	-18	1,27	-58	0,015
66	166,507	24	21,587	-19	1,05	-60	0,011
64	153,103	22	19,252	-20	0,88	-70	0,0033
62	140,659	20	17,148	-22	0,73	-80	0,0006
60	129,02	18	15,246	-24	0,61	-90	0,0001



COMPRESSED AIR FLOWS THROUGH PIPES AND NOZZLES

Maximum recommended compressed air flow through pipes (The flow measured in l/s)

Pressure		Nominal inner pipe diameter										
bar	kPa	6 mm	8 mm	10 mm	15 mm	20 mm	25 mm	32 mm	40 mm	50 mm	65 mm	80 mm
0,4	40	0,3	0,6	1,4	2,6	4	7	15	125	45	69	120
0,6	60	0,4	0,9	1,9	3,5	5	10	20	30	60	90	160
1,0	100	0,5	1,2	2,8	4,9	7	14	28	45	80	130	230
1,6	160	0,8	1,7	3,8	7,1	11	20	40	60	120	185	330
2,5	250	1,1	2,5	5,5	10,2	15	28	57	85	170	265	470
4,0	400	1,7	3,7	8,3	15,4	23	44	89	135	260	410	725
6,3	630	2,5	5,7	12,6	23,4	35	65	133	200	390	620	1 085
8,0	800	3,1	7,1	15,8	29,3	44	83	168	255	490	780	1 375
10,0	1 000	3,9	8,8	19,5	36,2	54	102	208	315	605	965	1 695
12,5	1 250	4,8	10,9	24,1	44,8	67	127	258	390	755	1 195	2 110
16,0	1 600	6,1	13,8	30,6	56,8	85	160	327	495	955	1 515	2 665
20,0	2 000	7,6	17,1	38	70,6	105	199	406	615	1 185	1 880	3 315

Comment
The flow value is calculated using the following pressure fall: 10% of the starting pressure per 30 m of piping with a diameter of 6-15 mm, 5% of the initial pressure per 30 m cable with a diameter of 20-80 mm.

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Smallest recommended inner diameter for original piping in mm (At 700 kPa and a pressure drop of 10 kPa)

Airflow	Piping length in meters								
l/s	25	50	75	100	150	200	300	400	500
10	16	18	20	21					
20	21	24	26	27	30				
30	24	28	30	32	34	36	39		
50	29	33	38	41	44	47	51		
75	33	39	42	41	48	51	55	58	61
100	37	43	46	49	53	56	61	65	68
125	41	47	50	53	58	61	67	70	74
150	43	50	54	62	66	71	75	79	83
200	48	55	60	64	69	73	79	84	88
300	56	64	70	74	80	85	92	97	102
400	62	71	77	82	89	94	102	108	113
500	68	78	83	89	97	102	111	117	123
600	72	83	90	95	103	109	119	126	131

Choose the next largest standard size of pipes than what the table shows.

Airflow through the nozzle at different pressures and expansion to atmospheric pressure at the nozzle. (Table values in l/min at +15°C air temperature)

Nozzle	Pressure kPa						
Diameter mm	200	300	500	700	900	1 200	1 500
1,0	17	26	44	61	79	105	132
1,5	39	59	99	138	178	238	297
2,0	70	105	176	246	317	423	529
3	158	238	396	555	714	952	1 190
4	282	426	705	987	1 270	1 694	2 116
5	441	661	1 100	1 543	1 984	2 646	3 308
6	634	952	1 588	2 223	2 857	3 810	4 763
8	1 129	1 693	2 822	3 951	5 080	6 771	8 464

The values according to the table refers to air flow through a well done nozzle with a rounded inlet edge. For nozzles with sharp inlet edges, the values are multiplied by 0.9.

NB! The values are approximate, since the airflow is highly influenced by the nozzle design.

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VENTILATION REQUIREMENTS/ HEAT RECOVERY

Ventilation requirements for the compressor chamber with Air-cooled compressors and free discharge of the compressor's Cooling air into the room

Compressor motor power	The required fan capacity*	The appropriate size of the air intake**
kW	m³/s	W x H mm
3	0,30	300 x 300
4	0,40	300 x 300
5,5	0,55	400 x 400
7,5	0,75	500 x 500
11,0	1,10	500 x 500
15,0	1,15	600 x 600
18,5	1,85	700 x 700
22	2,20	800 x 800
30	3,0	900 x 900
37	3,7	1 000 x 1 000
45	4,5	1 000 x 1 000
55	5,5	1 200 x 1 200
75	7,5	1 400 x 1 400
90	9,0	1 500 x 1 500

* In the event of a +8oC temperature rise of the ventilation air. The fan should be thermostatically controlled for the temperature in the compressor room.
** Corresponding to an air velocity through the air intake of approx. 4 m/s.

Ventilation requirements for the compressor chamber with air-cooled screw compressors and duct connection of the compressor's exhaust

Compressor motor power	The required air injection*	The appropriate size of the air intake**
kW	m³/s	W x H mm
4	0,22	300 x 300
5,5	0,32	400 x 400
7,5	0,45	400 x 400
11,0	0,53	500 x 500
15,0	0,70	500 x 500
18,5	0,75	600 x 600
22	0,80	600 x 600
30	1,34	700 x 700
37	1,40	700 x 700
45	1,80	800 x 800
75	2,80	1 000 x 1 000
90	3,40	1 100 x 1 100
75	7,5	1 400 x 1 400
90	9,0	1 500 x 1 500

* Allowable max. pressure drop in the compressor's outlet duct: 30 Pa If there is a risk of a large pressure drop, a fan must be installed.
** Corresponds to an air velocity of approx. 3 m/s. The temperature rise of cooling air at the duct connection of the compressor is approximately 20°C.

SOME USEFUL FORMULAS AND RULES OF THUMB FOR CALCULATING HEAT RECOVERY

Water heating: $\dfrac{\text{Power in kW x 860}}{\text{Water flow l/h}}$ = Temperature increase in °C

Air heating: $\dfrac{\text{Power in kW}}{\text{1.25 x airflow in m}^3\text{/sec}}$ = Temperature increase in °C

The energy needs for heating normally insulated workshop: about 1 kW/day/m³ (volume of air in the room).
The heating oil's heat content at normal level of efficiency in the air heater: about 8 kW/l oil.

ELECTRIC MOTORS, GENERAL INFORMATION

Pop-up table

Electric Motor Data		Min. cable area according to SIND-FS Article 21 A-extension Cu cable	Recommended slow-blow fuse on start-up	
Power	Nominal current at 400V		Direct	Y-D
kW	A	mm²	A	A
0,37	1,1	1,5	4	
0,55	1,7	1,5	6	
0,75	2,1	1,5	10	
1,1	2,7	1,5	10	
1,5	3,7	1,5	10	
2,2	5,3	1,5	10	
3,0	7,1	2,5	16	
4,0	9,5	2,5	20	16
5,5	12	2,5		25
7,5	16	6		25
11	22	6		35
15	30	10		50
18,5	36	10		50
22	44	10		63
30	60	16		80
37	72	25		100
45	85	35		100
55	106	50		125
75	145	70		200
90	175	95		200
110	210	150		250
131	255	185		315
160	290	240		355

The values in the table are for guidance concerning three-phase, 2-pole, totally enclosed standard motors. The table is only a recommendation. Consult your electrician for detailed information for each particular case.

Nominal current

is the current an electrical motor draws from the grid when 100% charged and at a given voltage.

Motor shield

recommended installation of a 3-phase motor shield.

Main fuse

It is recommended that compressors use a conventional type of main fuse with a value of at least 1.5 x the motor's nominal current. So-called circuit breakers are not recommended. If this type is used, the fuse class must be "C", but even this may be too little to handle the motor's starting current.

The starting current

is the current an electrical motor uses when it starts. The starting current is directly proportional to the electric motor's nominal current. As a general rule, the starting current, during direct starting, is estimated at approximately 7 times the nominal current.

For a Y-D start, the start current is estimated at approximately 2.5 times the nominal current. The maximum start current lasts only a fraction of a second, then the current dissipates to the value of the nominal current as the engine's speed increases.

Idle running current

can, as a rule of thumb, can be calculated at approx. 40% of the nominal current. This means that the engine's efficiency drops sharply if the engine is nat full shaft power.

Insulation class

describes the electric motor's ability to withstand temperature increases in the windings. The most common insulation classes are B and F.

B can withstand a temperature in the windings of +130°C, while F withstands +155°C.

B and F are designed for +40°C ambient temperature.

Cladding class or protective types

for an electric motor or equipment are specified with the letters IP followed by two digits. Common cladding classes for motors and electrical equipment are IP23, IP54, IP55 and IP65. The first number indicates protection against foreign objects, the second number indicates protection against water.

Grade of protection 1: a digit:

2. Protection against solid objects greater than 12 mm,
5. Dust-proof,
6. Dust-proof.

Grade of protection 2: a digit:

3. Splash-proof,
4. Spray-proof,
5. Flush-proof.

CONVERSION FACTORS

Length		1 in = 0,0254 m		39,3701 in
SI unit	**m**	1 ft = 0,3048 m	**1 m**	3,28084 ft
		1 yd = 0,9144 m		1,09361 yd
		1 mile = 1609,344 m		0,000621371 mile
Area		1 in^2 = 645,16 mm^2		1550 in^2
SI unit	**m^2**	1 ft^2 = 0,092903 m^2	**1 m^2**	10,7639 ft^2
		1 yd^2 = 0,836127 m^2		1,19599 yd^2
		1 acre = 4046,86 m^2		0,247105 x 10-3 acre
Volume		1 in^3 = 16,3871 ml		61,0237 in^3
SI unit	**m^3**	1 ft^3 = 28,3168 l	**1 l**	35,3147 x 10-3ft^3
		1 yd^3 = 0,764555 m^3		1,30795 x 10-3yd^3
		1 UK gal = 4,54609 l		0,219969 UK gal
		1 US gal = 3,78541 l		0,264172 US gal
Mass		1 lb = 0,453592 kg		2,20462 lb
SI unit	**kg**	1 oz = 28,3495 g	**1 kg**	35,274 oz
		ton UK = 1016,5 kg		0,984207 x 10-3 ton UK
		ton US = 907,185 kg		1,10231 x 10-3 ton US
Power		1 kp = 9,80665 N		0,101972 kp
SI unit	**N**	1 lbf = 4,44822 N	**1 N**	0,224809 lbf
Power torque		1 kpm = 9,80665 Nm		0,101972 kpm
SI unit	**Nm**	1 lbf ft = 1,35582 Nm	**1 Nm**	0,737562 lbf ft
Pressure		1 bar = 100 kPa		0,01 bar
SI unit	**Pa**	1 kp/cm^2(at) = 98,0665 kPa	**1 kPa**	0,0101972 kp/cm^2(at)
		1 psi = 6,89476 kPa		0,145038 psi
Energy		1 kWh = 3,6 MJ		0,277778 x 10-3 kWh
SI unit	**J**	1 kpm = 9,80665 J	**1 kj**	101,972 kpm
		1 kcal = 4,1868		0,238846 kcal
		1 hkh = 2,6478 MJ		0,377673 x 10-3 hkh
Power		1 kpm/s = 9,80665		101,972 kpm/s
SI unit	**W**	1 kcal/s = 4,1868 kW	**1 kW**	0,238846 kcal/s
		1 kcal/h = 1,163 W		859,845 kcal/h
		1 hk = 735,499 W		1,35962 hk
		1 hp = 745,7 W		1,34102 hp
Volume flow		1 m^3/min = 16,6667 l/s		60 m^3/min
SI unit	**m^3/s**	1 cfm = 0,471947 l/s	**1 m^3/s**	2118,88 cfm
Supplementary units	**l/s**	1 m^3/h = 0,277778 l/s		3600 m^3/h
Density		1 lb/ft^3 = 16,0185 kg/m^3		0,0624278 lb/ft^3
SI unit	**kg/m^3**	1 lb/in^3 = 27679,9 kg/m^3	**1 kg/m^3**	36,127 x 10-6 lb/in^3
Specification Energy		1 hpmin/m^3 = 44,1299 J/l		22,6604 x 10-3 hpmin/m^3
SI unit	**J/m^3**	1 kWh/m^3 = 3600J/l		0,277778 x 10-3 kWh/m^3
Supplementary units	**J/l**	1 hp/cfm = 1580,05 J/l	**1 J/l**	0,632891 x 10-3 hp/cfm
		1 kWh/ft^3 = 127133 J/l		7,86578 x 10-6 kWh/ft^3
Temperature				
SI unit	**K**	1° C = 1 K	**1 K**	1° C
Supplementary units	**°C**	1° F = 0,555556 K		1,8° F
Absolute zero		0 K		
		–273,15° C		
		–459,67° F		
Ice's melting point		273,15 K		
		0° C		
		32° F		
Pipe connections		connection 6 = 1/8”		connection 25 = 1”
		connection 8 = 1/4”		connection 32 = 1 1/4”
		connection 10 = 3/8”		connection 40 = 1 1/2”
		connection 15 = 1/2”		connection 50 = 2”
		connection 20 = 3/4”		connection 65 = 2 1/2”

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FAQ SHEET PISTONS

Q: Is it possible to buy service kits for all pistons?

A: Yes, there is from this year kits available for most of the models, it contains special piston oil, air intake filter, oil filter and gaskets. For order write down the serial number of the piston and search at the MBP for the proper kit or call your spare part ordering representative at customer center.

Q: What is the availability (lead time)?

A: It varies depending on your regions geographical position. Usually your customer center has a stock set up with the most frequent sold compressors, but some of the customer centers has chosen not to. To secure your sales we recommend to keep a few pistons in stock to offer quick delivery. Often customers expects you to keep some pistons in stock.

Q: Where can I find technical datasheets and maintenance instructions?

A: All available material can be found at the MBP portal > Marketing > Pistons > model > Instruction books. Here you will also find a lot of sales and marketing material to help you boost sales.

Q: Is a vessel is necessary for piston compressors?

A: For the most applications you need a vessel. The reasons for that is a more calm flow to the end use, this means less start and stops for the piston compressor. Which means less wear of the compressor and less service.

Q: Is it possible to adapt an automatic drain under a vessel? And is that on option on pistons compressors?

A: This is something we recommend, in order to keep the receiver and your compressor system efficient you need to drain the receiver after every use. This can always be done manually, but also with an automatic drain which can ordered separately.

Q: Is it necessarily to have filters after the piston compressor when you use a piston with a normally low free air delivery? And when read the filter leaflet we only offer filters from 1000 l/min?

A: That is true that the smallest max capacity filters are 1000 l/min. But it doesn't matters if the flow is 300, 500 or 700 liters per minute, the only regulation is the max capacity of 1000 l/min. But it is still as important with filters on a piston compressor as on a screw compressor. You still have the need of:

- remove dirt particles from compressed air that Could damage the final tools/equipment
- remove the presence of oil in the compressed air that could damage the final product.

Q: What the difference is between piston displacement and real air flow delivered? (technical data in the leaflet)

A: When you read a piston sales catalogue of any brand you read the piston displacement flow. This is the amount of air that gets sucked in to the compressor before its compressed. When the air is pressurized you will have the free air delivery, this flow is always set at an certain pressure.

Q: I see sometimes the term professional and industrial pistons, what are the differences?

A: The professional ranges means pistons with direct or belt technology, that are aiming towards applications where you only require intermittent use. The industrial ranges means pistons that focus more on industrial applications that requires periods with continues operation.

Q: When should I sell a piston and when should I sell a screw compressor? Is there any general role?

A: There is no real general role here. This is something that you need to look over in every specific case. But there is a few statements that you as a dealer can follow to choose the right offer to customer.

For example:

- Will the compressor run 100% or just ones in a while. Unless you order an Industrial piston, a piston should not be used more than 70% use factor, while a screw compressor can be used at 100%.
- If pressure higher than 13 bar is needed the piston is a popular product.
- Minimum maintenance
- Reliable and well tested technology

Q: What is your general sales-strategy for pistons within the organization?

A: It is to be best in class for every segment, from the smallest direct driven pistons up to the Industrial full cast iron units. It doesn't matter if the customer are going to use the piston 5 hours per week or 5 hours per day we can always give an offer that is best in class.

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FAQ SHEET SCREW COMPRESSORS

Q: What is the availability (lead time)?

A: Its depending on your customer center, some customer centers has chosen to have the most frequent compressors in stock some not. We recommend to keep a few compressors in your own stock for quick delivery to customer site.

Q: How big difference in running cost is it between a belt driven screw compressor and a direct driven?

A: There is a difference in running cost between the 2 technologies. The belt driven unit is less expensive investment but consumes in average 3% extra energy. Also a little bit more time has to be put to maintenance, by adjusting for example the belt. The most suitable technology depends on the customer needs.

Q: Does the screw compressors with integrated dryer require separate voltage supply?

A: Depending on the models. For the active range from 30 to 110 kW the transformer can be ordered as an option => when this option is fitted, there is no need for a separate power supply. On future ranges it will most likely be an std option.

Q: Can the leadair control system run with 2 or more Variable Speed Units?

A: Yes you can control 2 or more variable speed compressors with a leadair control system.

Q: Can an screw compressor without a controller(just electro-pneumatic control) be connected to a leadair control system (as slave unit)?

A: Yes it's possible to connect to a compressor without any sophisticated control system. The leadair will just signal to the compressors when it needs to start or stop.

Q: What is the recommended period for screw element overhaul?

A: We strongly recommend every 24 000 running hour. To exceed this limit you are facing a major risk of machine break down, which will cause in an increased service cost or investing in a new compressor.

Q: I just bought a direct driven screw compressor with integrated energy recovery, how do I decide what flow I should have over the energy recovery water circuit?

A: Its depending on the site conditions, and what temperature the customer wishes to have. Below you see a chart that you can use as a reference, the chart below is for a 30 kW and 37 kW compressor. This data can be found on the MBP > Marketing > Range > Oil injected screws > your model.

Softened water for 30 kW

T. inlet	T. outlet	Flow (l/min)	ΔP Bar
0	60,0	7,2	0,005
5	58,0	8,0	0,006
10	56,0	9,4	0,007
15	54,0	11,0	0,010
20	**52,0**	**13,5**	**0,015**
25	50,0	17,4	0,025
30	46,5	26,0	0,055
35	44,0	48,0	0,170
40	45,0	90,0	0,566

Softened water for 37 kW

T. inlet	T. outlet	Flow (l/min)	ΔP Bar
0	59,0	9,0	0,007
5	57,0	10,0	0,009
10	55,0	12,0	0,012
15	53,0	14,0	0,017
20	**50,0**	**17,7**	**0,026**
25	47,0	24,0	0,045
30	44,5	39,0	0,117
35	41,0	87,0	0,540

Q: What certifications do you deliver with the compressor from production site?

A: The included documentation at delivery is the local certificates: Europe for example the CE documentation, for North America the UL/cUL, ASME. If you are missing your certificate at delivery you can download it on the MBP > Aftermarket > Service Connect. Then write the serial number of the unit in the open field and press search.

Q: Do you have NEMA4 as option?

A: NEMA4 is a protection class for a cubicle like you have IP55 for a motor. From 2012 this will not be an option on our screw compressors.

Q: Do you have oil-free choice in the screw compressor ranges?

A: For some brands in the Multibrand organization (Multibrand is a shared name for the brands acquired by Atlas Copco group) there is water injected screw compressors available. Contact your local customer center for more information.

Q: What Ampere fuse(A) is needed?

A: "Rules Of Thumb"

At 575 volts, a 3-phase motor draws 1 amp per horsepower.

At 460 volts, a 3-phase motor draws 1.27 amps per horsepower.

At 400 volts, a 3-phase motor draws 1.5 amps per horsepower.

At 230 volts, a 3-phase motor draws 2.5 amps per horsepower.

At 230 volts, a single-phase motor draws 5 amps per horsepower.

At 115 volts, a single phase motor draws 10 amps per horsepower.

These number above has no safety margin. For example a 10hp compressor=15A, the standard fuse size is 16(A). To be safe for peaks we recommend the 20(A) fuse. Please check with a certified electrician.

Q: What is normally the pay back for an inverter compressor?

A: The normal pay back is between 1-2 years during normal conditions and 4000 running's hours per year. Not seldom we see pay backs within a year.

Q: Operating principle of an inverter compressor?

A: It has almost the same components as a conventional compressor but there is, of course, a few main differences. A frequency driven compressor has an integrated inverter and often a more advanced control system. The inverter adjusts the motor speed to the actual air demand. This is controlled by a sensor that measures the system pressure this is signaled to the controller of the compressor. The controller registers the pressure and sends a signal to the inverter which regulates how much air the compressor needs to produce in order to keep the set pressure.

Q: Why is an inverter compressor saving energy?

A: Because an inverter/frequency driven compressor is not producing more air than needed. A conventional compressor works within a pressure band. When reaching the higher pressure the machine goes into unload mode (the motor is running but no air is produced). When reaching the lower pressure value the compressor starts to build up pressure again until it reaches its unload pressure again. An inverter/frequency driven compressor has less unload time and works towards a set pressure value, this makes the inverter compressors in general 30% more energy efficient than a conventional load/unload compressor.

Q: Why is an internal water separator drain necessary?

A: First, an internal Water Separator Drain (inside of the compressor) is NOT necessary.
But it can have some benefits in two cases:

1) Screw without an integrated dryer: Using a water separator drain, we remove some water from the compressed air, before its delivered to the final area of use with less water content.
2) Screw with an integrated dryer: Using it before the dryer, some of the water gets removed before the dryer, this gives the opportunity to choose a smaller sized air dryer.

Q: Is there any recommendations regarding ventilation of compressor room?

A: All compressor rooms require ventilation. Minimum room ventilation can be calculated from the formula:

Qv = 1.06 N / T for Pack unit

Qv = (1.06 N + 1.3) / T for Full-Feature unit

Qv = required cooling air flow (m^3/s)

N = shaft input of compressor (kW)

T = temperature increase in compressor room. (usually 7 °C)

If the compressor is conducted, the required ventilation is the same as the fan capacity of the compressor. This is mentioned in the instruction manual.

FAQ SHEET QUALITY AIR SOLUTIONS

Q: What is the maximum ambient and inlet temperature for the dryers?

A: Max ambient temperature is 45°C, and Max working temperature is 55 °C . See table A and B on page 39 for advice, how to size your dryer according to site conditions?

Q: What is the connection size of the discharge pipe?

A: I guess you mean the condensate drain? For all industrial dryers this outlet is 10mm. The largest sized dryer with this outlet has 700 m^3/h in max capacity.

Q: Sometimes I receive mails from my customer center about dryers and I see that designation on dryers are called A3, A11 and so on. What does this designation mean?

A: It's an internal designation code which is used in the product company. From customer point of view there is no need to learn this codes, but as a dealer you can from time to time run into this terms, so it's good to have some knowledge what it means. This "internal designation" is also visible on the data plate attached on the back of the dryer.

Q: What is "PRESSURE DEW POINT"?

A: Pressure Dew Point - For a given pressure, the temperature at which water VAPOR will begin to condense INTO liquid water.

Q: Where are the refrigerant dryers produced?

A: Most of the dryers are produced in the north part of Italy(Brendola). Northern Italy has a long tradition within the compressed air business and the region offers very competent and high skilled work force.

Q: Where should I place the dryer? Before or after the receiver and where should I place the filters?

A: The optimal solution to have a calm and stable flow over the dryer is to place the receiver before the dryer. Also the filter should be place before the dryer but after the receiver. To get clean air into the dryer extend the life time of the dryer and will increase your air quality. Ask the customer what the area of use is, for example instrument air its classified under ISO certification. Talk to your sales responsible if you are unsure how the ISO classing is build up, or read the filter leaflet for advice.

Q: When and why is a dryer necessary?

A: In almost all application and areas of use there is a need of a dryer. In a very few applications you can skip the dryer, for example if the air is in direct contact with water. Water have a direct damaging impact on all kinds of machinery equipment, to protect your production we strongly recommend you to always offer a dryer to end customer and explain the risks without having dry and clean air.

Q: Difference between refrigeration and adsorption dryer ?

A: The refrigerant dryers uses an refrigerant gas in order to cool the compressed air and then remove the water condensate from the air, with this technique we can reach MAX. 3°C. PDP. An adsorption dryer, use an "adsorption material called desiccant" in order to remove (adsorb) the humidity on the compressed air. With this method we can reach a PDP < 3°C. (-40°C. or -70°C.). Depending on which dryer and option the customer chooses to use. An adsorption dryer is required to be used when the ambient temperature goes under ZERO °C, to avoid ice building in pipes and applications.

Q: Advantages of an integrated dryer?

A: The footprint gets drastically smaller, also the installation cost gets more cost efficient due to less need to pipes and couplings. One disadvantage can be the service access which decrease due to the integration with the compressor.

Q: Is there any control or monitoring system available for the refrigerant dryers?

A: The dryers has ONLY a PDP indicator, just to indicate if the PDP is inside of the range (green zone). NO input and output signals is available.

Q: Can you get dew point control as an option to the dryers?

A: For the refrigerant dryers there is no option. For Adsorption dryers you have this as an option from the middle range and starting at reference max capacity 115 m^3/h. For the bigger range starting from 648 m^3/h its standard.

Q: What arguments can I as a dealer use to promote my dryers to customers?

A: The product company produce more than 12 000 dryers per year. Well priced and high quality together with low maintenance costs are some of the main arguments. The compact design and the wide product range is other strong arguments. The simplicity and well planned placement of the service parts results in easy and quick maintenance.

Q: How should I size the dryer? Should it be equal to the compressors max capacity?

A: There is no exact role to follow. But some of the major points to consider are:
- Pressure Dew Point needed (PDP).
- Volume of compressed air (SCFM or l/min)
- Maximum compressed air dryer inlet temperature (°F or °C)
- Maximum ambient temperature (°F or °C)
- Maximum compressed air pressure (PSIG or BAR)
- Maximum allowable dryer pressure drop (PSIG or BAR)

The FAD published in leaflets are referring to the REFERENCE CONDITION:
- Working pressure 7 bar.
- Working temp. 35°C
- Ambient temp. 25°C.
- If the dryer will work at different reference condition, then we must to calculate the new FAD that it can treat using the below correction factors:

Correction factor for conditions differing from the project k= A x B x C

A	Room temperature (°C)				
	25	30	35	40	45
0,4 - 7,7 m^3/m	1,00	0,92	0,84	0,82	0,74
10 - 70 m^3/m	1,00	0,91	0,81	0,72	0,62

B	Operating temperature (°C)					
	30	35	40	45	50	55
0,4 - 7,7 m^3/m	1,24	1,00	0,82	0,69	0,58	0,45
10 - 70 m^3/m	1,00	1,00	0,82	0,69	0,58	0,49

C	Operation pressure (bar)											
	5	6	7	8	9	10	11	12	13	14	15	16
0,4 - 7,7 m^3/m	0,90	0,96	1,00	1,03	1,06	1,08	1,10	1,12	1,13	1,15	1,16	1,17
10 - 70 m^3/m	0,90	0,97	1,00	1,03	1,05	1,07	1,09	1,11	1,12			

Contact your local ALUP Kompressoren representative

ORIGINAL PART

Care

Care is what service is all about: professional service by knowledgeable people, using high-quality original parts.

Trust

Trust is earned by delivering on our promises of reliable, uninterrupted performance and long equipment lifetime.

Efficiency

Equipment efficiency is ensured by regular maintenance. Efficiency of the service organization is how Original Parts and Service make the difference.

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