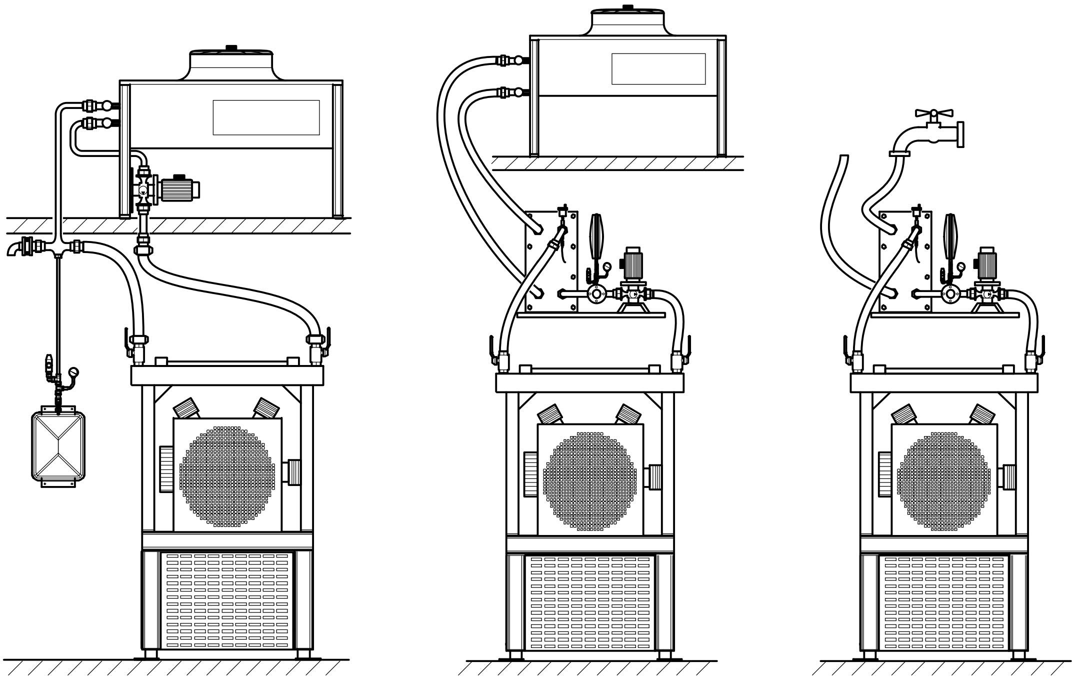
Installation Manual

Air and water cooled compressor installations



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INTRODUCTION

This handbook contains information and instructions for the installation of

BAUER Compressor installations

Follow all instructions exactly as described and in the order specified, where applicable, to prevent damage and premature wear. We can accept no liability for any operational faults and damage resulting from a failure to heed the information in this operating manual.

Issue January 2012

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1. PRELIMINARY NOTE

This handbook contains important information concerning the installation of BAUER compressors. Read this handbook carefully and please follow the instructions precisely. Non-observance of the installation instructions can lead to damage and injuries. Damage caused by unsuitable and improper installation by the customer or third parties or the use of unsuitable operating materials are excluded from the guarantee.

The erection and installation are, to a large extent, decisive for the reliability and economic efficiency of a compressor installation. During erection you should pay particular attention to ensure adequate heat dissipation by appropriate ventilation.

This manual contains instructions and provides notes for the installation of BAUER high and medium-pressure compressor plants. This exclusively covers 2 to 5 stage piston compressor installations with pressure ratings from 25 to 500 bar.

The guidelines in this manual have been created based on DIN, UVV and VDMA standards. Many years of experience and tips from practical use have been incorporated.

The installation instructions included are specially adapted to the BAUER typical piston compressors. The explanations and many of the quoted data are of a general nature and are, in principle, applicable to all BAUER high and medium-pressure plants. In special applications, the relevant data is listed in tabular form in the appendix or can be taken from the enclosed quotation drawing. Please note that any installation drawing which also may be enclosed is only a suggestion.

The most suitable installation is ultimately dependent on the operational conditions in each case.

Should you require further advice, the BAUER team of specialists will be pleased to help.

Even though all significant aspects of the erection are taken into account here, this does not, and must not, replace the operating instruction manual.
The right to make technical modifications is reserved.

If you have any questions regarding your compressor installation, please contact:

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Drygalski Allee 37 Tel.: +49 89 7 80 49 - 0
D-81477 Munich Fax: +49 89 7 80 49 - 167

We would be pleased to help you.

2. SAFETY

2.1. HOW SAFETY INFORMATION IS LABELLED

Important instructions that have a bearing on the level of danger to which persons are exposed, as well as technical safety and operational safety, are given particular emphasis as shown below. The symbols precede the relevant measures and have the following meanings:

CAUTION

Indicates working and operational procedures which must be adhered to precisely in order to prevent persons being put in a dangerous situation.

Strict compliance with this information is necessary in order to prevent the machine or its equipment from being damaged or destroyed.

This refers to technical requirements to which the operator must pay particular attention.

2.2. FUNDAMENTAL SAFETY INFORMATION

- Use personal protection equipment if required or demanded by the regulations.
- Observe all the safety and danger warnings on the machine/plant.
- Do not make any unauthorised changes, additions or modifications to the machine/station which could compromise safety. This also applies to installation, the setting of safety equipment and valves, as well as welding on the pipelines and containers.
- Work on the electrical equipment in the machine/station may only be carried out by an electrical technician or other trained persons working under the guidance and supervision of an electrical technician and must be performed in accordance with electrotechnical regulations.
- Work on pneumatic devices must only be carried out by persons having special skills and experience with pneumatics.
- Lay and fit the compressed air lines properly. Do not swap the connections over. The fittings, length and quality of the hoses must comply with requirements.
- Work on gas-related equipment must only be carried out by personnel who have undergone training in this field.
- Execute welding, flame-cutting and grinding work on the machine/plant only when the work has been specifically approved. e.g. there may be a danger of fire or explosion.

- Clean the machine/plant and surroundings of dust and flammable materials and ensure adequate ventilation (danger of explosion) before welding, flame-cutting and grinding.
- When working in confined spaces, follow national regulations where applicable.
- Use only experienced persons for slinging the loads and the instruction of the crane driver. The instructor must be in view of the operator or be in voice contact.
- When working above head height you must use access equipment and working platforms provided for the purpose or other safety-compliant equipment. Do not use machine parts as access aids. When carrying out maintenance work at higher levels you must wear fall arresting equipment.
- When loading/unloading, use only lifting tackle and load carrying equipment having adequate carrying capacity.
- Nominate an expert supervisor for the lifting procedure.
- Lift the machines properly using only lifting equipment.
- Use only a transport vehicle having adequate carrying capacity.
- Fit transport securing devices to the machine/plant for transporting if necessary. Fix the relevant sign. Remove the transport securing devices properly before commissioning/re-starting.
- Carefully re-fit and secure the parts removed for transport purposes before re-starting.

2.3. SAFETY REGULATIONS

The following regulations and provisions must be observed for commissioning and operation of compression plant as filling plant:

a- Pressure Equipment Directive (PED) of 29/05/1997

b- German Ordinance on Industrial Safety and Health (BetrSichV) of 27/09/2002

c- German Equipment Safety Act (GSG) of 11/05/2001

d- 14th Ordinance on the German Equipment Safety Act (14th GSGV - Ordinance on Pressure Vessels) of 03/10/2002

e- German Technical Regulations on Pressurised Gases (TRG 400, 401, 402, 730)

If a high pressure compressor is used for filling pressurised gas containers (cylinders) or for supplying pneumatic systems, the following apply to commissioning and operation within the Federal Republic of Germany:

f- The statutory accident prevention regulations (UVV) set out by accident prevention and insurance associations, including, in particular:

- **Accident prevention regulation BGV A1 of 1st January 2004**

The above ordinances can be obtained from publishing houses specialising in regulations, such as:

Carl Heymanns Verlag
Luxemburger Str. 449
50939 Cologne, Germany

Beuth-Vertrieb GmbH
Burggrafenstr. 4 - 7
10787 Berlin

The manufacturer observes all regulations which are of relevance to its activities, and designs its stations accordingly. If required, at our Munich factory we can offer a component testing service prior to commissioning, in accordance with section 14 of the German Ordinance on Industrial Safety and Health. If you wish to take advantage of this, please get in touch with our Technical Customer Service department. They will also provide our **"Important instructions for the approval process and the testing of filling plant before commissioning".**

This pamphlet is also available for download from our Internet site (www.bauer-kompressoren.de).

In accordance with the German Ordinance on Industrial Safety and Health (BetrSichV), compressor stations used as filling stations must be subjected to an acceptance test at the installation site by an expert prior to commissioning. If the compressor is going to be used for filling pressurised gas containers (cylinders) which are intended for others, the station must be licensed by the relevant authority before acceptance testing can take place. This authority will generally be the trade supervisory office. Licensing procedures must be followed in accordance with the German TRG 730, Richtlinie für das Verfahren der Erlaubnis zum Errichten und Betreiben von Füllanlagen (Technical Rule on Licensing Procedures for Constructing and Operating Filling Stations). The test certificates and documents supplied with the compressor are important and must be included in the application documents as part of the licensing procedures. The station documents that relate to recurrent tests also have an important role to play and must, therefore, be stored carefully.

Tests governed by accident prevention regulations are carried out by the manufacturer or a specialist. No liability can be assumed for damage that is directly or indirectly caused by a failure to heed these regulations. **We strongly urge you to pay heed to these regulations.**

3. PREREQUISITES FOR ERECTION

3.1. COMPRESSOR ROOM/BUILDING

Although not absolutely essential, the installation of compressors in specially designed machinery rooms is recommended. The optimum situation is to have a separate compressor room.

If no separate room is available, the following points should still be taken into account:

– The compressor room should be clean, dust-free, dry, and as cool as possible.

- Avoid direct sunlight. If possible, choose the north side of the building.
- Additional equipment or piping systems which produce heat should not be installed in the same room, or should be adequately insulated.
- The temperature of the room must not fall below +5 °C because of the danger of frost and corrosion damage caused by severe condensation formation. If necessary, separate room heating may be required.
- Ensure adequate ventilation. Caution: room temperature = cooling temperature!
  Min. = +5 °C, max. = +45 °C.
- Please ask for our special quotation for other erection temperatures. Temperatures of -35 °C to +50 °C may be possible by using technical modifications.
- Good access and lighting must be provided for maintenance purposes.
- Seasonal temperature fluctuations should be compensated as far as possible.

Particularly with larger compressor installations, the presence of a workshop crane or the availability of a fork-lift truck for maintenance and repair work is of great advantage.

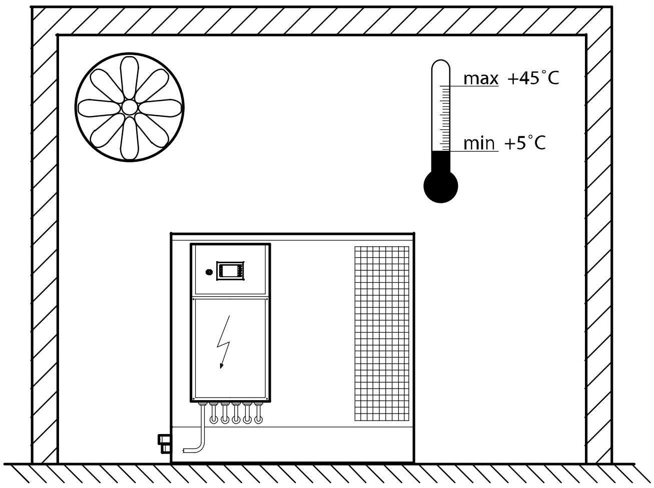


Fig. 1 Temperature limits

3.2. REQUIRED FLOOR AREA

The required floor area for your compressor installation can be taken from the BAUER compressor installation drawing.

For maintenance purposes, you should keep a distance of approx. 0.8 - 1 m around the plant, whilst also observing the applicable VDE regulations for switchgear cabinet access.

With VERTICUS installations, the distance between the back wall of the plant and the wall of the room should be at least 50 cm for maintenance access. On all VERTICUS, this distance can be reduced on an individual basis. However, these plants must then be relocated to a different position to allow working on the drive.

You must ensure that there is adequate door opening clearance to allow the machine through.

3.3. FOUNDATIONS

Every BAUER compressor installation is optimally balanced and well insulated from vibrations by rubber-metal vibration mounts. Special foundations are therefore not absolutely necessary.

However, the ground must be solid and the plant must be installed horizontally.

Larger compressor installations, whose feet are equipped with fixing holes, need to be fixed down onto the foundations with suitable bolts. The following must also be taken into account:

After the compressor has been installed, you must not forget to remove the transport securing devices (Fig. 2 and Fig. 3). Any time that you need to transport the plant, you must replace the transport securing devices to provide stabilisation!

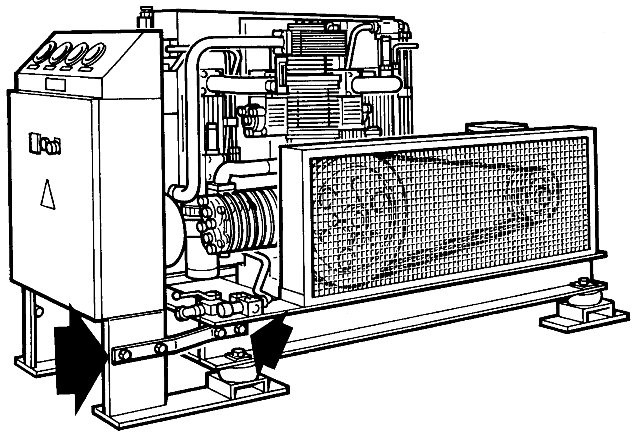


Fig. 2 Transport securing devices 1

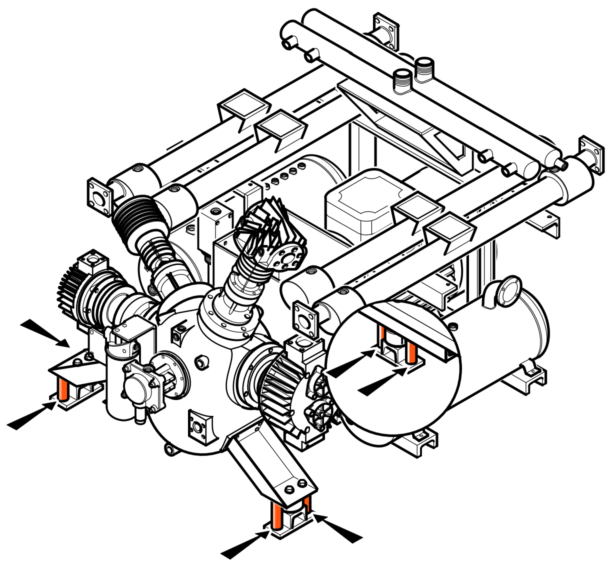


Fig. 3 Transport securing devices 2

3.4. GROUND LOAD-BEARING CAPACITY

The ground load-bearing capacity must correspond to the weight of the plant shown on the quotation drawing.

For plants that are to be installed in containers, you must make sure that the floor has adequate vibration resistance.

Lightweight containers with profiled steel reinforcements are less resistant to vibrations than containers with steel profile bracings (e.g. channel section steel). These must be reinforced at a later date if necessary.

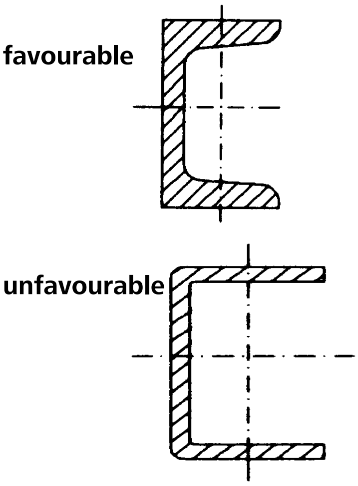


Fig. 4 Container reinforcement

3.5. EXTREME CONDITIONS

For extreme environmental conditions, e.g. heat, cold or storms, the compressor plant can be adapted in the factory to match the conditions. Any necessary technical modifications to the compressor must be clearly stipulated at the enquiry or quotation stage.

3.6. OTHER INFLUENCING FACTORS

- Air containing dust or sand

In particularly dusty or sandy environments, the compressor should be preceded by an additional suction-side filter. This prevents the penetration of damaging and abrasive particles.

- Air containing solvents

Contamination of the fresh air being drawn in with solvent vapours must be avoided. If this is not possible, the quality of the air entering the compressor must be modified using special air preparation measures. This should be clarified at the quotation stage.

- Corrosive cleaning agents

In rooms where corrosive cleaning agents are used, the metal parts that come into contact with the cleaning agent can suffer corrosion. In order to prevent this, it is beneficial to place the compressor plant either on hard rubber plates or in a stainless steel tank.

- Tropical installation conditions

When installing in tropical environments, ensure that the quoted temperatures are not exceeded. In addition, you should clarify whether the plant needs to be termite-resistant. These clarifications should also be made at the enquiry and quotation stage.

B. HEAT DISSIPATION

1. *HEAT DISSIPATION – CHOOSING THE RIGHT VENTILATION SYSTEM*

As already mentioned, special care must be taken with adequate heat dissipation during installation. Heat is created from the compressive work done in the compressor. The more the compressor works, the greater the amount of heat. Around 70 % of the energy supplied is transformed into heat by the compression work carried out in the compressor. The additional heat generated in the motor must also be dissipated. This means that almost 100 % of the energy supplied is transformed into heat, which then has to be dissipated.

1.1. AIR-COOLED COMPRESSOR INSTALLATIONS

On air-cooled installations, heat dissipation is exclusively by convection. The following rule-of-thumb provides an adequately accurate method of calculating the required minimum cooling air flow rate:

Required cooling flow rate [m^3/h] = 360 x drive power rating [kW]

Example:

The existing motor power rating is 30 kW, the required cooling airflow rate is thus:

360 x 30 = 10,800 m^3/h.

The exact values for the individual flow rates can be taken from the tables in the appendix.

1.2. WATER-COOLED COMPRESSOR INSTALLATIONS

On water-cooled installations, the heat is dissipated mainly by the water-cooling, the remaining heat is dissipated by ventilation (convection). This residual heat represents approx. 15 % of the heat generated or drive power rating.

The following rule-of-thumb provides an adequately accurate method of calculating the required minimum cooling air flow rate:

Required cooling flow rate [m^3/h] = 54 x drive power rating [kW]

Example:

The existing motor power rating is 75 kW, the required cooling airflow rate is thus:

54 × 75 = 4,050 m^3/h

1.3. SELECTING THE CORRECT TYPE OF VENTILATION

Ventilation is carried out by natural or forced ventilation, depending on the power rating and the installation.

A decisive factor, in addition to the calculation of the cooling airflow rate, is the selection of the most favourable type of ventilation.

The following criteria must be taken into account in the selection:

- Drive power rating
- Size of the installation room
- Ambient temperatures in the installation room
- Maximum size of the inlet and outlet openings
- Length of the duct if any ventilation ducting is involved
- Additional heat sources in the installation room
- Pressure drop in the ventilation duct

The following illustration is intended to clarify the interrelations when selecting the correct type of ventilation:

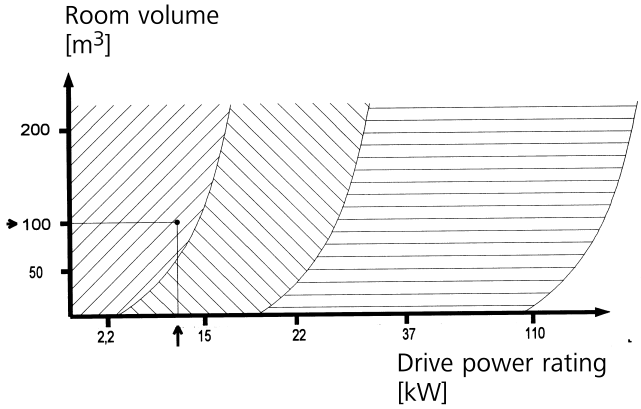
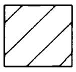
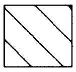
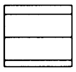


Fig. 5 Relationship between ventilation type, room size and drive power rating

 = natural ventilation

 = forced ventilation by free blowing out

 = forced ventilation by ducted venting

Example:

Room volume: 100 m^3
Power rating: 11 kW

From the illustration: natural ventilation is adequate.

C. AIR COOLING

1. NATURAL VENTILATION – FREE CONVECTION

Natural ventilation is the simplest form of ventilation. It is produced practically automatically by heating or cooling. The resulting temperature differences produce differences in density which lead to balancing flows, either upwards or downwards. This creates free circulation. The required cooling airflow is thus produced automatically and is created without the need for additional measures, e.g. by using additional fans.

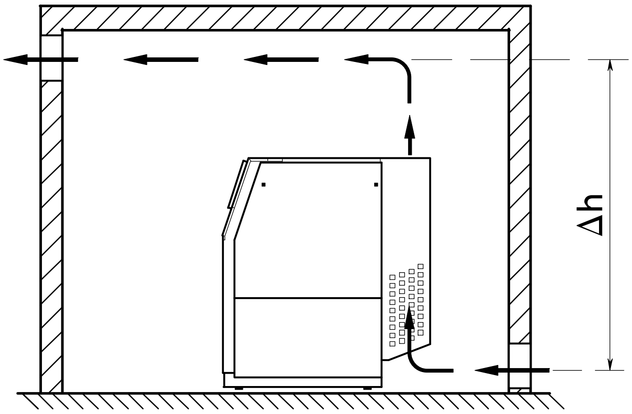


Fig. 6 Natural ventilation

The following points must be taken into account to provide a beneficial effect on this free circulation (convection):

– Natural ventilation should only be used up to a maximum power rating of the drive motor of 15 kW.
– The compressor must be installed in such a way that the planned flow between the inlet and outlet flows through the compressor.
– The cooling air inlet opening should be close to the ground, in other words, low down.
– The hot air discharge should be as high as possible.
– The compressor should be installed near to the inlet air opening.
– The cooling air should be drawn in directly from the air inlet opening, and when the temperature falls below +5 °C, a diverter flap must be provided for direct drawing in.
– The drawing in of hot exhaust air is to be avoided.

1.1. SIZE OF THE REQUIRED INLET AND OUTLET OPENINGS

Outlet opening

The size of the exhaust air outlet is dependent on

– the compressor drive power rating
– the height difference between the inlet and outlet openings Δh
– the size of the room V

Inlet opening

– The inlet opening for fresh air should be approximately 20 % greater than the exhaust air opening because of possible contamination of fitted blinds, mesh gratings etc.
– The individual guideline values are summarised in the following table:

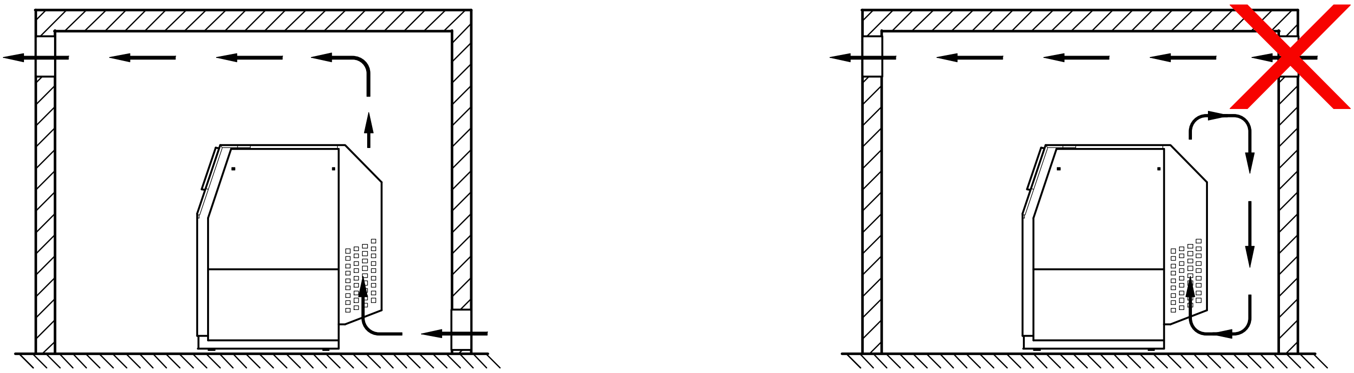
Air inlet and outlet openings						
Motor power rating (kW)	Room volume/height difference					
	V = 50 m^3 Δh = 2 m		V = 100 m^3 Δh = 3 m		V = 200 m^3 Δh = 4 m	
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
2.2	0.12 m^2	0.10 m^2	--	--	--	--
3	0.24 m^2	0.20 m^2	0.12 m^2	0.10 m^2	--	--
4	0.30 m^2	0.25 m^2	0.12 m^2	0.10 m^2	--	--
5.5	0.42 m^2	0.35 m^2	0.24 m^2	0.20 m^2	0.12 m^2	0.10 m^2
7.5	0.90 m^2	0.75 m^2	0.60 m^2	0.50 m^2	0.24 m^2	0.20 m^2
11	1.38 m^2	1.15 m^2	0.90 m^2	0.75 m^2	0.54 m^2	0.45 m^2
15	1.92 m^2	1.60 m^2	1.45 m^2	1.20 m^2	0.90 m^2	0.75 m^2

If these values are undershot, e.g. for structural reasons, forced ventilation will be required.

Example: The motor power rating is 7.5 kW, the room volume is approx. V≈ 40 m^3, the height difference between the inlet and outlet openings is Δh = 2 m.

From the table:
Exhaust air opening approx. 0.75 m^2
Air inlet opening approx. 0.75 m^2 x 1.2 = 0.9 m^2

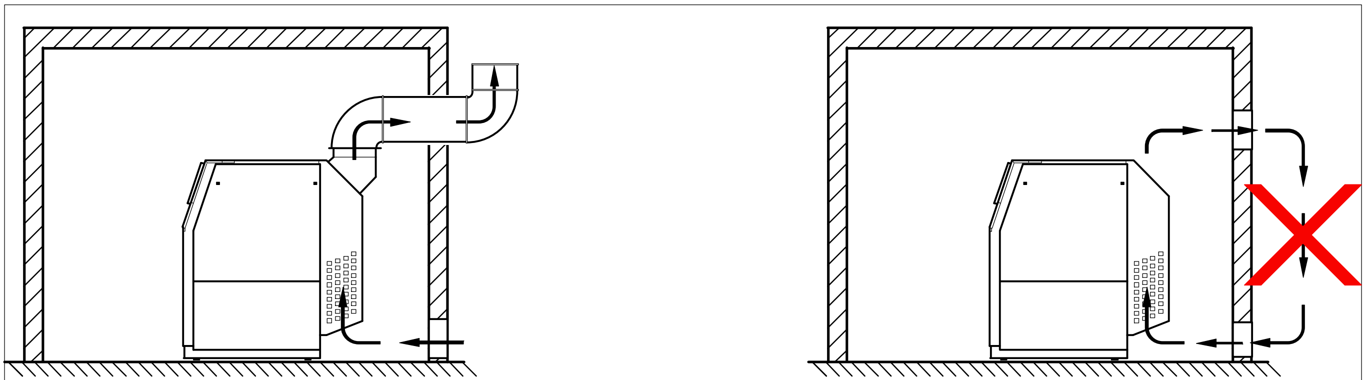
1.2. INSTALLATION EXAMPLES FOR NATURAL VENTILATION



Correct: Air inlet low down, cooling air flows through the plant

Incorrect: Air inlet too high, cooling air does not reach the plant

Fig. 7 Erection with natural ventilation, Example 1



Correct: Air outlet directed upwards, cooling circuit not possible

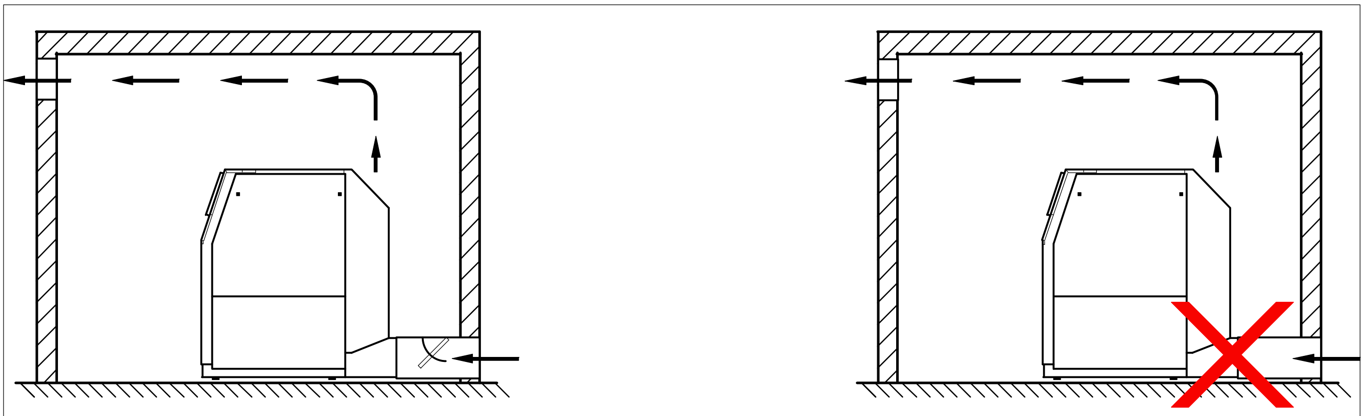
Incorrect: The hot air is not dissipated, circulates and is drawn in again

Fig. 8 Erection with natural ventilation, Example 2

Correct: Cooling air is directed directly into the plant

Incorrect: Cooling air does not reach the inlet opening, inlet duct is too short

Fig. 9 Erection with natural ventilation, Example 3



Correct: Inlet air opening guided, with circulation flap, below +5 °C, the opening must be closed off to the outside, circulation flap!

Incorrect: Inlet air opening guided, but without circulation flap, this solution is not suitable for temperatures below +5 °C!

Fig. 10 Erection with natural ventilation, Example 4

2. FORCED VENTILATION – FORCED CONVECTION

With drive power ratings in excess of 15 kW, natural ventilation is no longer adequate. Under certain conditions, this can also apply to lower drive power ratings, e.g.:

– if the compressor has to be installed in a very small room,

– if the cooling openings are not large enough,

– if other equipment with higher rates of heat development operate in the same room, or

– if two or more compressors operate in the same room.

In order to prevent thermal overload, it may also be useful and/or necessary to use forced ventilation with plants having lower drive power ratings under unfavourable installation conditions.

Depending on the type of compressor, forced convection = forced ventilation may be executed in different ways.

Types of forced ventilation:

– free blowing out with room fan

– ducted ventilation with/without additional fan

– ducted ventilation with circulation flap and additional fan

– ducted ventilation with waste heat recycling

2.1. FORCED VENTILATION USING FREE BLOWING OUT WITH ROOM FAN

This ventilation variant is the simplest method of forced ventilation. It operates, in principle, in the same way as natural ventilation, but the hot air is blown out using a ventilation fan. Inlet and outlet ducts are not required.

The following must be taken into account:

– Because this variant does not include fitting any ventilation ducting it must be ensured, during installation, that the blow out fan is placed close to the compressor air outlet and as high up as possible. The air inlet must be installed in such a way that the compressor can draw the air in **unhindered**. Required minimum distance 0.5 metres.

– The fan must be adequately dimensioned. In the ideal case, the fan is controlled by the room temperature or via a thermostat.

– The air inlet opening must be adapted to the fan power rating.

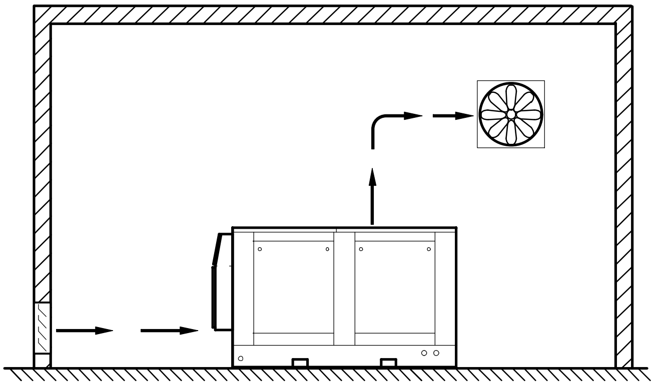


Fig. 11 Forced ventilation by free blowing out

Required cooling airflow of the blow out fan

The required flow of cold air can be determined using the aforementioned rule-of-thumb. See the table in the appendix for exact determination.

In order to be able to ensure adequate cooling at higher temperatures, the fan power should be approx. **15 %** greater than the required cooling air flow.

When selecting the exhaust fan, you must also observe the resistance height or dynamic pressure Δp.

The resistance height Dp depends on the shape and size of the inlet and exhaust openings with the associated ducts (if fitted). On simple openings, without any awkward bypass (ducting) we can assume **Δp = 10 mmWs** (1 mbar).

Required inlet opening

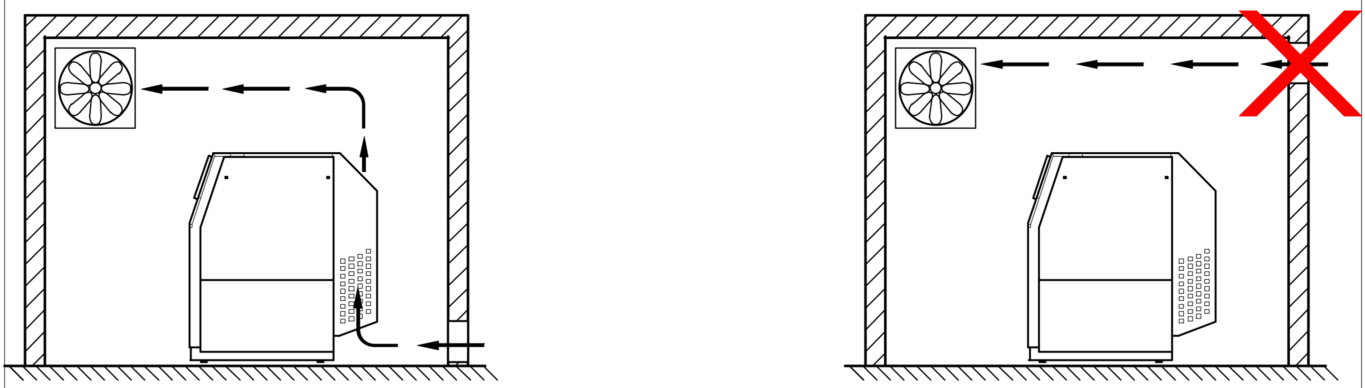
The minimum size of the air inlet opening depends on the power of the fan and the maximum flow speed.

The recommended flow speed is approx. **3 m/sec**. If the size of the opening is restricted because of structural reasons, the flow speed cannot exceed a max. of **5 m/sec**.

The following equation cab be used to calculate the size of the air inlet opening:

$$\text{Inlet opening [m}^2\text{]} = \frac{\text{Fan power rating [m}^3\text{/h]}}{\text{Flow speed [m/s] x 3,600 [s/h]}}$$

2.2. INSTALLATION EXAMPLES OF FORCED VENTILATION USING FREE BLOWING OUT



Correct: the air flows along an intended flow line through the compressor

Incorrect: the cooling air "draws" through

Fig. 12 Erection with forced ventilation, Example 1

Correct: the cooling air is directed downwards through a ventilation duct

Incorrect: Length of the ventilation duct inadequate

Fig. 13 Erection with forced ventilation, Example 2

2.3. FORCED VENTILATION BY DUCTED VENTING

A ventilation duct is connected directly to the exhaust air duct of the compressor. Above a specific duct length, an additional fan must be installed in the duct.

This type of ventilation is recommended for large drive power ratings and when installing several compressors in one operating room. Heat dissipation is optimum in this case.

The cross section and length of the ducting cannot be random, but rather needs to be adapted to suit the conditions. Also, special cooling air outlets must be used to ensure that they continue to work even if the wind is coming from the blow out direction.

Notes about duct ventilation

- The **insulation** of the cooling air ducts with insulating material increases the efficiency of the ventilation.
- If individual exhaust ducts are not possible for structural reasons, we must fit an **exhaust manifold duct** in the station. In order to incorporate the compressors properly we require a non-return baffle to prevent hot air from flowing back into the erection room.
- In order to prevent stresses and vibrations from being transferred, the ventilation duct must be mounted on the compressor housing with a soft connection or **canvas flange** (available as an option).
- The standard DIN 4102 stipulates specific **fire protection measures** for ventilation installations. Ventilation installations that are not erected in accordance with the standard, and which are not checked on a regular basis, represent a considerable potential risk. In all locations where storeys are bridged and where fire protection sectors are penetrated, this air line must be secured in a fire-protection manner by fitting self-closing fire protection flaps.
- You should note that the longer the ventilation duct and the more frequent the fittings, such as elbows, flaps or silencers, the greater the **duct cross-section** will need to be.
- The **dynamic pressure** increases if the ventilation duct is unfavourable or too long. If the dynamic pressure in the duct exceeds the free pressure of the compressor, the ventilation will fail. In this case you will need to fit an additional exhaust fan.
- We recommend controlling the inlet and exhaust flaps and additional fan via a **thermostat** in the operating room.
- In general, BAUER Compressors recommend having the design of the air ducts and the execution of the structural work done by a corresponding **specialist company**.

Calculating the duct cross section

The recommended flow speed in the duct is around 3 - 5 m/sec.
The max. permissible rate is 7 - 8 m/sec.

The required cooling air volume can be determined using the known equation or can be taken from the tables in the appendix.

The duct cross section can be determined using the flow speed and the required volume of cooling air.

The following equation can be used to calculate the cross section of the cooling air duct:

$$\text{Duct cross section } [m^2] = \frac{\text{Cooling air flow } [m^3/h]}{\text{Flow speed } [m/s] \times 3{,}600 \ [s/h]}$$

Example: compressor with 11 kW drive power rating:

Cooling airflow = 360 x 11 = 3,960 m^3/h
Duct cross section = 3,960 : (5 x 3,600) = 0.22 m^2

Fitting an additional fan

The free pressure of the BAUER high and medium-pressure compressors is approx. 0.2 mbar = 2 mm water column. That is to say, the fan incorporated in the compressor operates up to a counter-pressure of max. 2 mm water column, measured at a distance of 1 m.[a)] from the cooling air outlet of the compressor plant in the exhaust duct, is capable of providing an adequate cooling air flow. If the counter-pressure exceeds this value an additional fan should be fitted in the exhaust duct.

The approximate value for assessment of the counter-pressure is obtained as follows:

1m duct ≅ × approx. 0.1 mbar = 1 mm water column
90° elbow ≅ approx. 0.4 mbar = 4 mm water column

This means that the maximum permissible value is reached with a duct length of 10 m with 2 90° elbows. If the duct needs to be longer or if more elbows are required, then an additional fan must be installed.

2.3.1. Forced ventilation with ducted ventilation with circulation flap

This type of ventilation is, in general, the same as simple ducted ventilation. However, a circulation flap is also installed. This is absolutely essential if the outside temperature falls below +5 °C. The circulation flap can be used to mix the cold fresh air drawn in from outside with the hot exhaust air, thus providing an optimum cooling air temperature. To prevent the room from cooling too much when the plant is at a standstill, it may be necessary to install heating in the room to ensure that the temperature in the room does not fall below 5 °C.

a) Measurement of free compression at 1 m separation from the cooling duct outlet.

The circulation flap is controlled either manually or thermostatically.

This variant represents the best inlet and outlet ventilation, thus we recommend this type of ventilation for all BAUER COMPRESSORS with one or more of the following characteristics:

- Drive power rating greater than 37 kW
- Long periods of operation
- Outside temperature sometimes below +5 °C
- Multiple installations

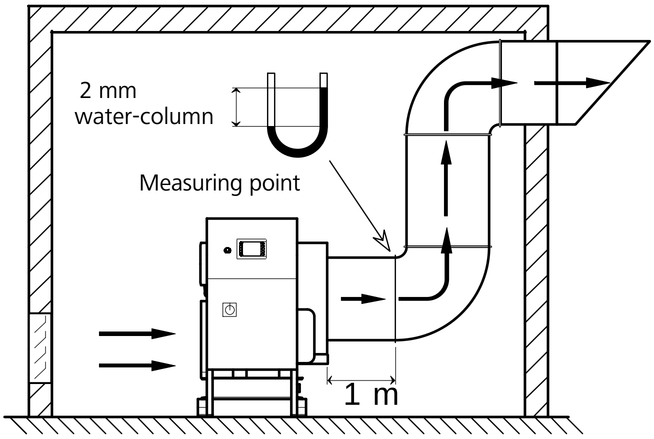


Fig. 14 Forced ventilation by ducted venting

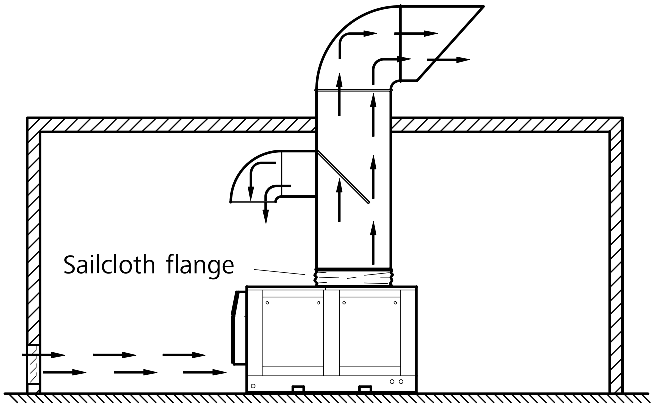


Fig. 15 Duct ventilation with circulation flap

2.3.2. Forced ventilation with ducted exhaust for hot air

This version is also a development of the previous one, i.e. the same calculation principles apply. Use of the hot air from the compressor for room heating (e.g. store room) is possible, in principle, but is seldom used because of the noise levels and the relatively short running periods.

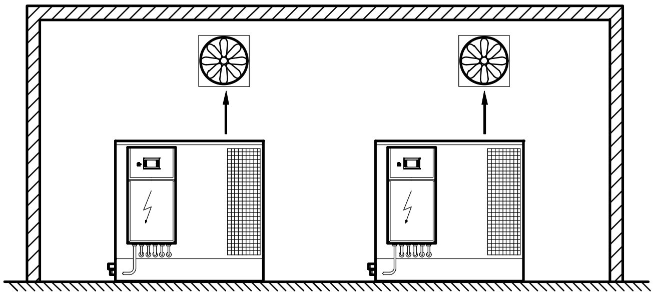


Fig. 16 Exhaust heat utilisation

2.3.3. Installation examples with forced ventilation

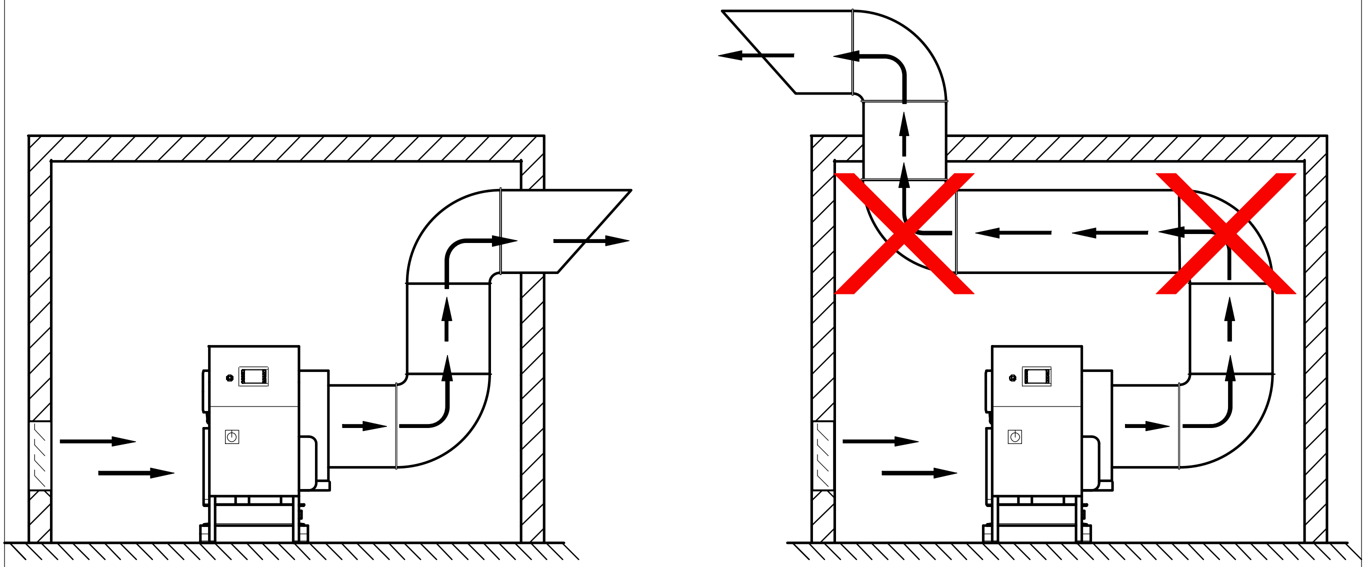


Fig. 17 Erection with forced ventilation, Example 1

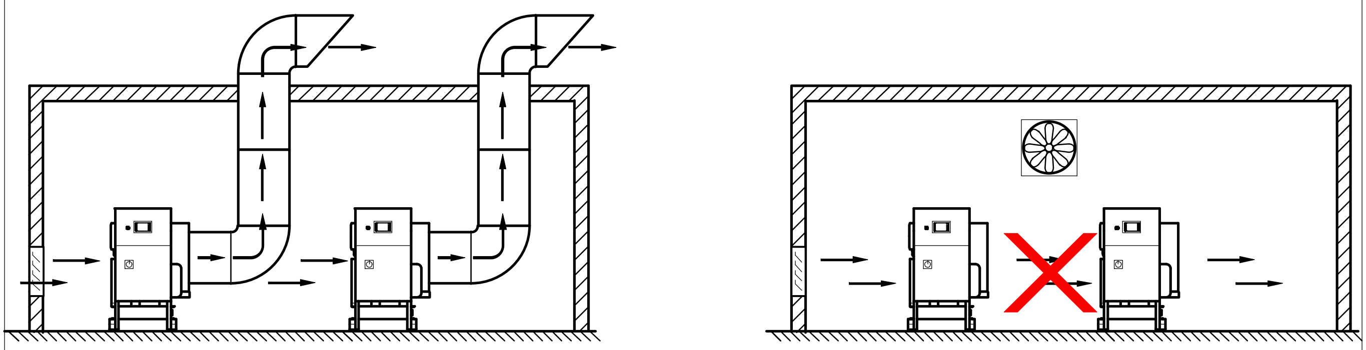


Fig. 18 Erection with forced ventilation, Example 2

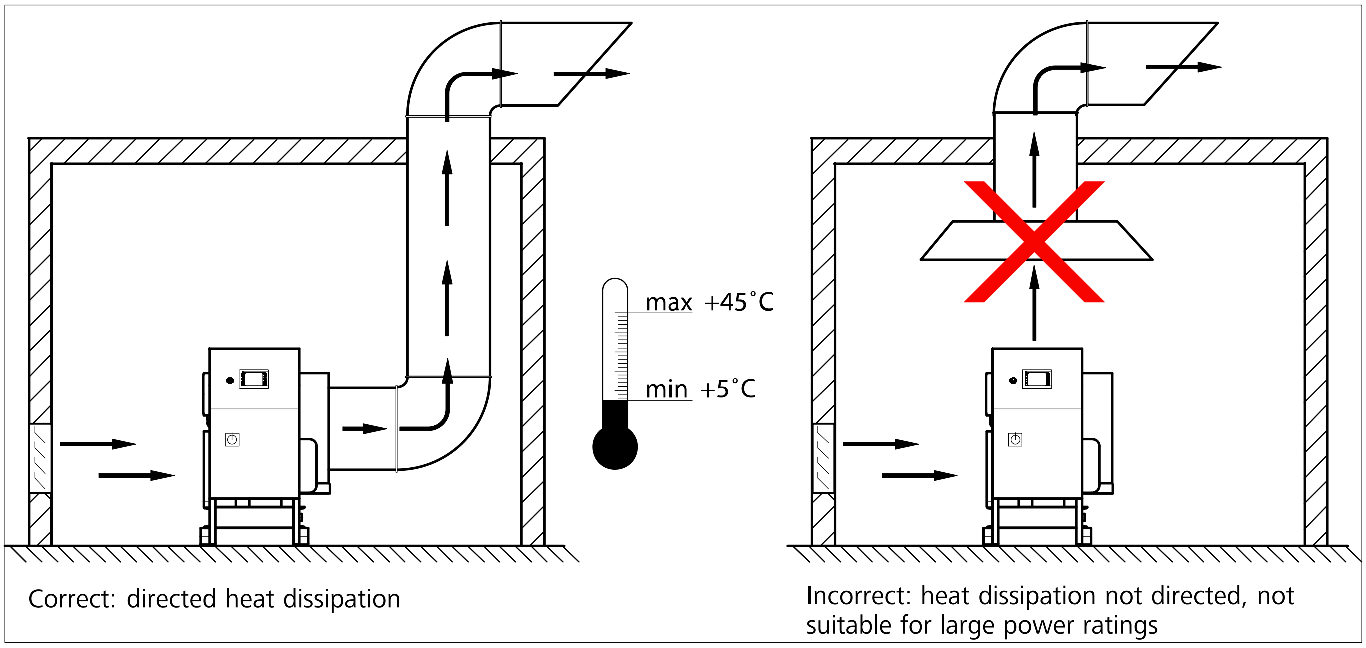


Fig. 19 Erection with forced ventilation, Example 3

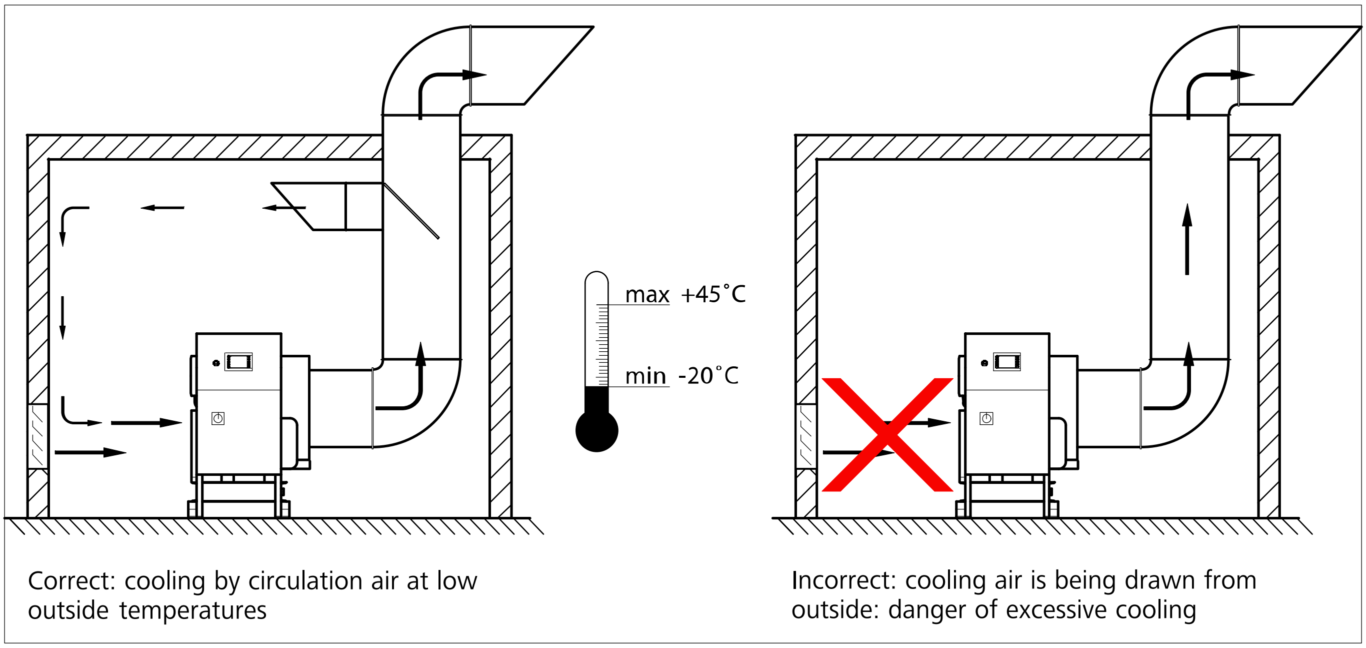


Fig. 20 Erection with forced ventilation, Example 4

2.4. PLANNING TIPS FOR THE LAYOUT OF AIR DUCTING (SUMMARY)

The duct cross section can be determined using the flow speed and the required volume of cooling air.

The recommended flow speed in the duct is around 3 - 5 m/sec.
The max. permissible rate is 7 - 8 m/sec.

The following rule-of-thumb provides an adequately accurate method of calculating the required minimum cooling air flow rate:

Required cooling flow rate [m^3/h] = 360 x drive power rating [kW]

The exact values for the individual flow rates can be taken from the tables in the appendix.

The following equation can be used to calculate the cross section of the cooling air duct:

$$\text{Duct cross section [m}^2\text{]} = \frac{\text{Cooling air flow [m}^3\text{/h]}}{\text{Flow speed [m/s] x 3,600 [s/h]}}$$

The recommended cooling air flow speed is 3 to 5 m/s, max. 10 m/s.

Example: I 22.0-22, drive power rating 22 kW:

Cooling air flow = 360 x 22 = 7,920 m^3/h
Duct cross-section =

$$\frac{7{,}920 \text{ m}^3\text{/h}}{3 \times 3{,}600 \text{ [s/h]}} = 0.73 \text{ m}^2$$

Maximum counter-pressure in duct

The max. permissible free compression of the BAUER high and medium-pressure compressors is 0.2 mbar = 2 mm water column. This means that the fan integrated in the compressor, measured at 1 m distance from the cooling air outlet of the compressor plant in the exhaust duct, is capable, up to a counter-pressure of max. 2 mm water column, of producing an adequate flow of cooling air. If the counter-pressure exceeds this value an additional fan should be fitted in the exhaust duct.

The approximate value for assessment of the counter-pressure is obtained as follows:

1 m duct ≅ approx. 0.1 mbar = 1 mm water column

Connecting the ventilation duct

BAUER compressor installations, without sound-insulation hoods, are supplied with a ventilation duct connection flange as standard above the drive power rating of 22 kW. This connection flange is also available as an option on smaller installations, or on SUPER SILENT installations with sound-insulation hoods.

In order to avoid vibration transmission, the connection between the connection flange and the ventilation ducting must be executed with a flexible sailcloth flange.

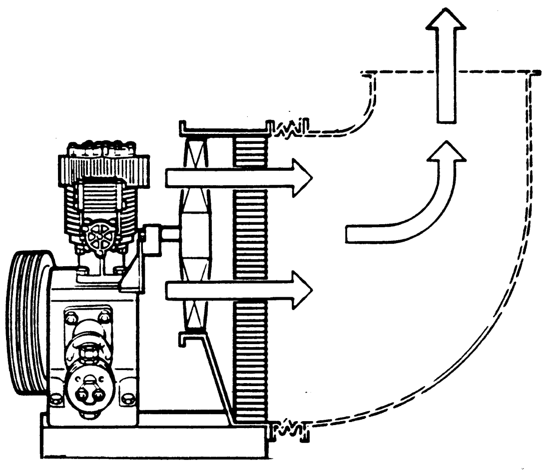


Fig. 21 Connection frame

Protection devices

The penetration of foreign bodies must be avoided as much as possible.
For this reason, the fitting of a bird protection mesh and insect protection mesh in the inlet and outlet openings is to be recommended. These mesh gratings must be regularly checked for dirt and cleaned if necessary.
In addition, you need to install weather protection, i.e. louvres with a rain impact protection hood, which can be closed if required.

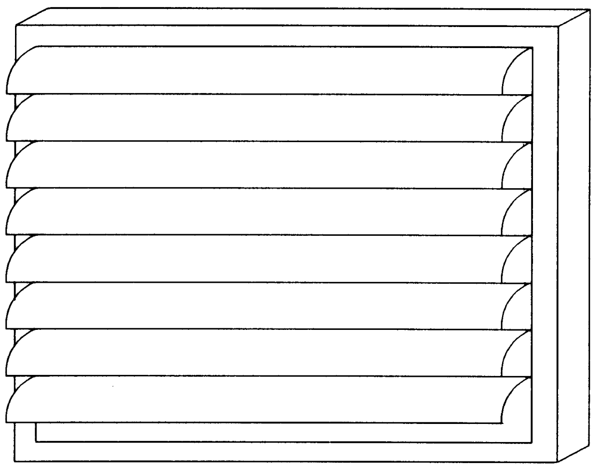


Fig. 22 Rain impact protection hood

2.5. CORRECT VENTILATION WITH MULTIPLE INSTALLATIONS

With multiple installations you must place more importance on correct ventilation.
In this case, the plants are often run continuously or two or more plants are operated simultaneously, so that, normally, high values of heat dissipation are required.
Each individual machine therefore needs to be well cooled. It is not sufficient to simply provide air-conditioning in the room.

Natural ventilation is generally not adequate for multiple installations.

A separate inlet and outlet opening must be provided for each individual machine. The above installation rules are applicable.

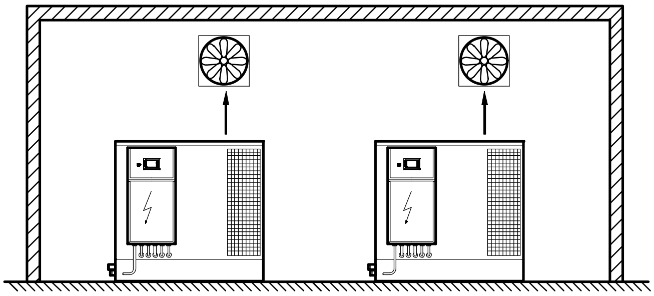


Fig. 23 Installation example for multiple installations

D. WATER COOLING

Water-cooling of a compressor carries out approx. 85 % of the total heat dissipation, the residual heat is dissipated by air-cooling.

On water-cooling, the heat is dissipated by the circulation of cooling water in a cooling circuit. In order to ensure perfect circulation of the cooling water, the composition of the cooling fluid is decisive. As a result, the cooling water circuit must be structured in such a way that the quality of the cooling fluid is guaranteed at all times.

1. COOLING FLUID

1.1. COOLING WATER

The quality or composition of the cooling water represents an important factor with regard to cooling efficiency and service life of the installation. In order to minimise inorganic deposits (scale and salt encrustation) and the formation of coatings by microbic growth, the cooling water must meet the following minimum requirements or be at least drinking water quality. Have a water analysis carried out, if necessary.

Component	Volume
Ph value (at 25 °C)	7.0-8.0
Total hardness	<15 °dH
Chloride (Cl_-)	<130 mg/l
Sulphates ($SO4_{2-}$)	<150 mg/l

1.2. FROST AND CORROSION PROTECTION

You must always add frost and corrosion protection agent to the cooling water. We recommend the use of **Antifrogen® N** from **Clariant** (Order No. N27089; 22 kg) or equivalent.

The minimum proportion of anti-freeze in the cooling water is 20 % Vol. This represents frost safety down to -9 °C.

To provide stronger frost protection, increase the proportion of anti-freeze in accordance with the diagram "Frost protection“ (see Section G. Appendix).

1.3. COOLANT VOLUME

The cooling fluid volume required depends on the configuration of the installation. The volume required is estimated by adding the following values:

- **V(b)**: Compressor block fill volume [l]. See the compressor installation operating instructions.
- **V(s)**: the cooling water volume [l] in the connecting hoses = volume per metre [l/m] x length of connecting hoses [m]

Hose diameter (mm)	Volume per metre (l/m)
38	1.2
50	2.0
65	3.4
80	5.1

- **V(r)**: the cooling water contained in the cooler [l].

Compressor series	Cooling water volume [l] contained in:	
	Water/air cooler	Water/water cooler
K23	21	8
K24	41	8
K26	51	8

Example: G 23.0-30

Cooler type = water/water cooler,
distance between installation and cooler = 5 m,
hose diameter = 50 mm.

Required coolant volume [l] = V(b) + V(s) + V(r)

Required coolant volume [l] = 14.5 l + (2x (2 l/m x 5 m)) + 8 l

Required coolant volume = 42.5 l

2. COOLING WATER CIRCUIT

Depending on the equipment, the BAUER water-cooled compressor installations can be connected to an open or closed cooling water circuit. The scope of the cooling water circuit depends on the order.

BAUER COMPRESSORS offer two different closed cooling water circuits for cooling the compressors:

– Water/air cooling set: closed cooling water circuit with water/air cooler or,
– plate heat exchanger set: closed cooling water circuit with water/water cooler (plate heat exchanger).

The selection of cooling water circuit depends on the local conditions.

If there is no cooling water circuit available in the building, we recommend installing a closed cooling water circuit with a water/air cooler. See A, Fig. 24.

When connecting the installation to an existing cooling water circuit you must always ensure the water quality requirement. See Chap. 1.1. If the existing cooling water circuit cannot meet these quality requirements, you will need to install a closed intermediate cooling circuit with a plate heat exchanger. See B and C, Fig. 24.

We do not recommend running the machine with open circuits, or with untreated water. see Fig. 24.

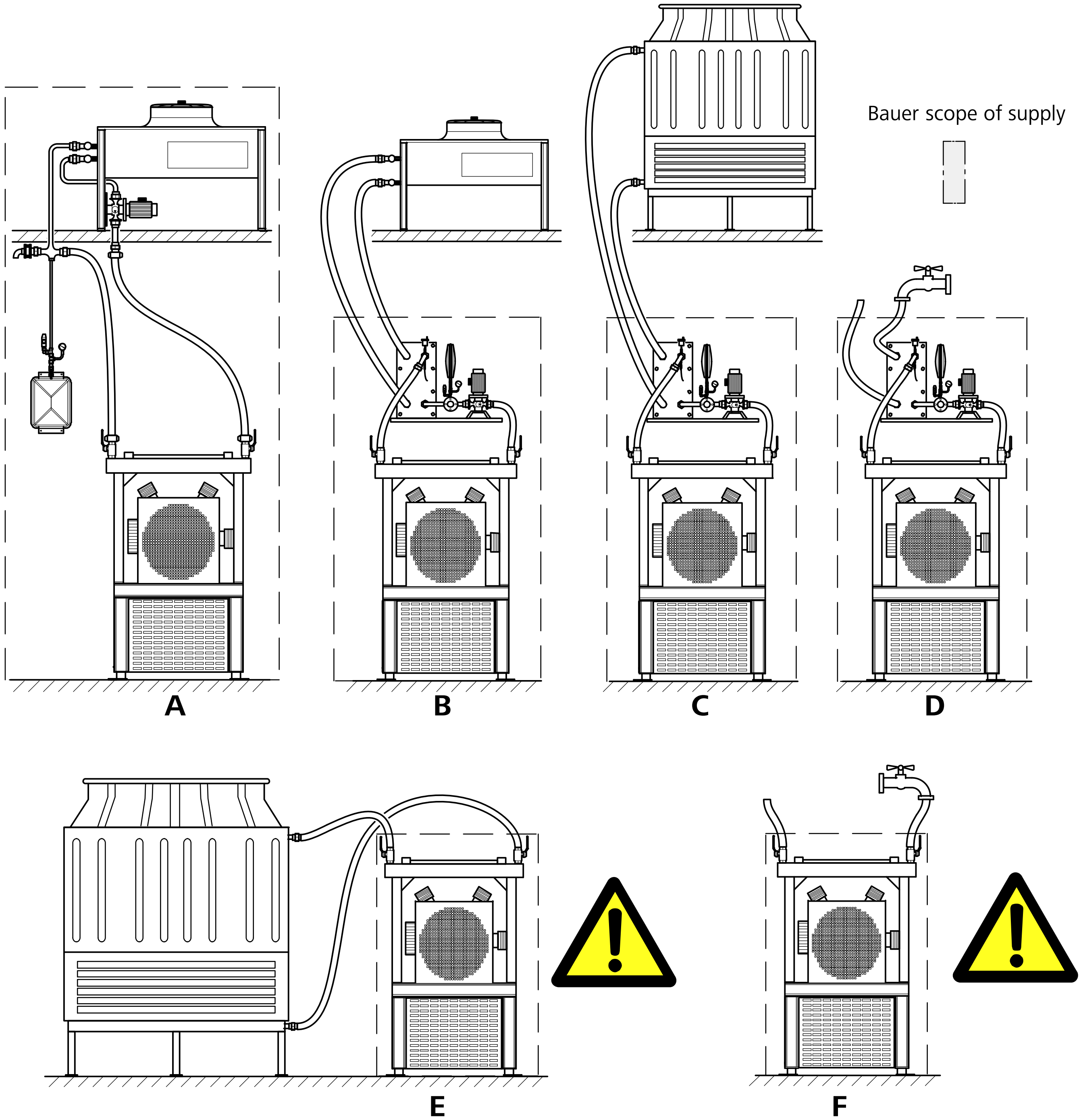


Fig. 24 Connection examples

A Water/air cooling set: closed cooling water circuit
B Plate heat exchanger set for connection to a closed cooling water circuit
C Plate heat exchanger set for connection to a cooling tower
D Plate heat exchanger set for connection to an opened cooling water circuit
E Compressor directly connected to a cooling tower. Pay attention to water quality!
F Compressor directly connected to an open cooling water circuit. Pay attention to water quality!

3. *INSTALLATION*

3.1. GENERAL NOTES

- Ensure adequate ventilation. Water-cooling the compressor dissipates approx. 85% of the generated heat; the remaining heat must be dissipated by convection, i.e. by air-cooling. For this reason, always observe the installation instructions in sections B. and C. when erecting the compressor. Reminder: room temperature = cooling temperature!
  Min. = +5 °C, max. = +45 °C.
- The room temperature should always be monitored. If necessary, the installation should be updated.
- Use only hoses to connect the cooler with the compressor to prevent transmitting vibrations.
- Use only anti-freeze resistant hoses.
- Our cooling water circuits are designed as standard so that:
  - The height difference between cooler connection and compressor connection must be max. 5 m.
  - The length of the connection hoses must be max. 10 m.

Other distances on request.

- Do not kink the hoses and when fitting make sure that loops are not created. The gradient must run continuously and without interruptions.
- Connect the water pump and cooler in accordance with the circuit diagram provided and check for function. On three-phase AC motors, check the direction of rotation of the motors! If the direction of rotation is wrong, switch off the power supply and swap two of the incoming mains lines.
- Provide a suitable collection vessel under the rupture disc to prevent any cooling fluid from contaminating the environment.

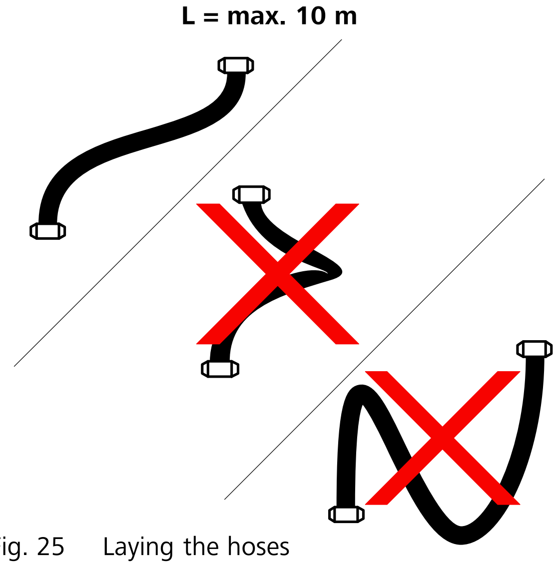


Fig. 25 Laying the hoses

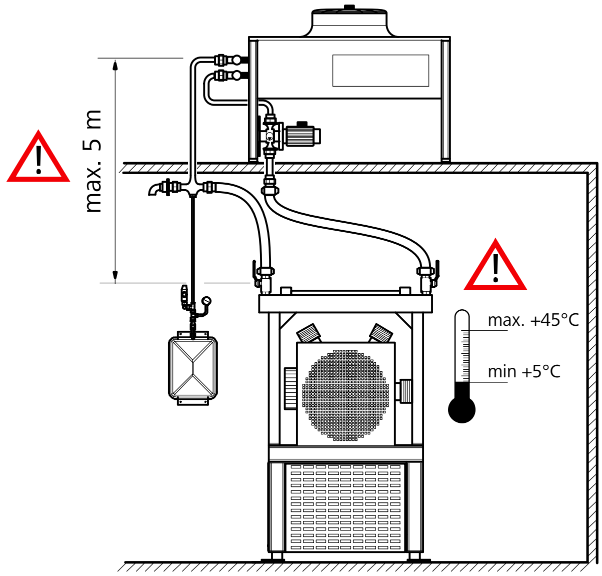


Fig. 26 Installation example 1

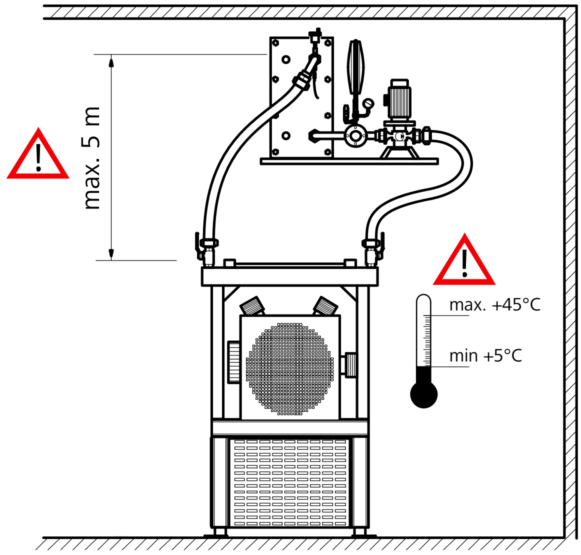


Fig. 27 Installation example 2

3.2. COOLING WATER CIRCUIT WITH WATER/AIR COOLER

3.2.1. Structure

The cooling water circuit with water/air cooler (Fig. 28) consists of the following components:

- Water/air cooler for cooling the heated cooling water
- Water pump for conveying the cooling water
- Venting valve for removing air from the circuit
- Temperature sensor for temperature monitoring by the compressor control system
- Rupture disc for protection from excess pressure
- Safety valve to prevent from slight over-pressure
- Pressure gauge to monitor the pressure
- Expansion vessel to regulate the thermal expansion of the cooling water

3.2.2. Installation

You must always observe the following when installing the cooling water circuit:

- The components need to be connected in the sequence shown in Fig. 28.
- Erect the cooler outside. Ideally above the compressor room. The substrate must be suitable for the plant. Fix the cooler down to the floor.
- Leave 1 m free space around the cooler. Also leave the exhaust from the cooler free.
- Erect the expansion vessel with safety valve, pressure gauge and isolation cock in the compressor room.

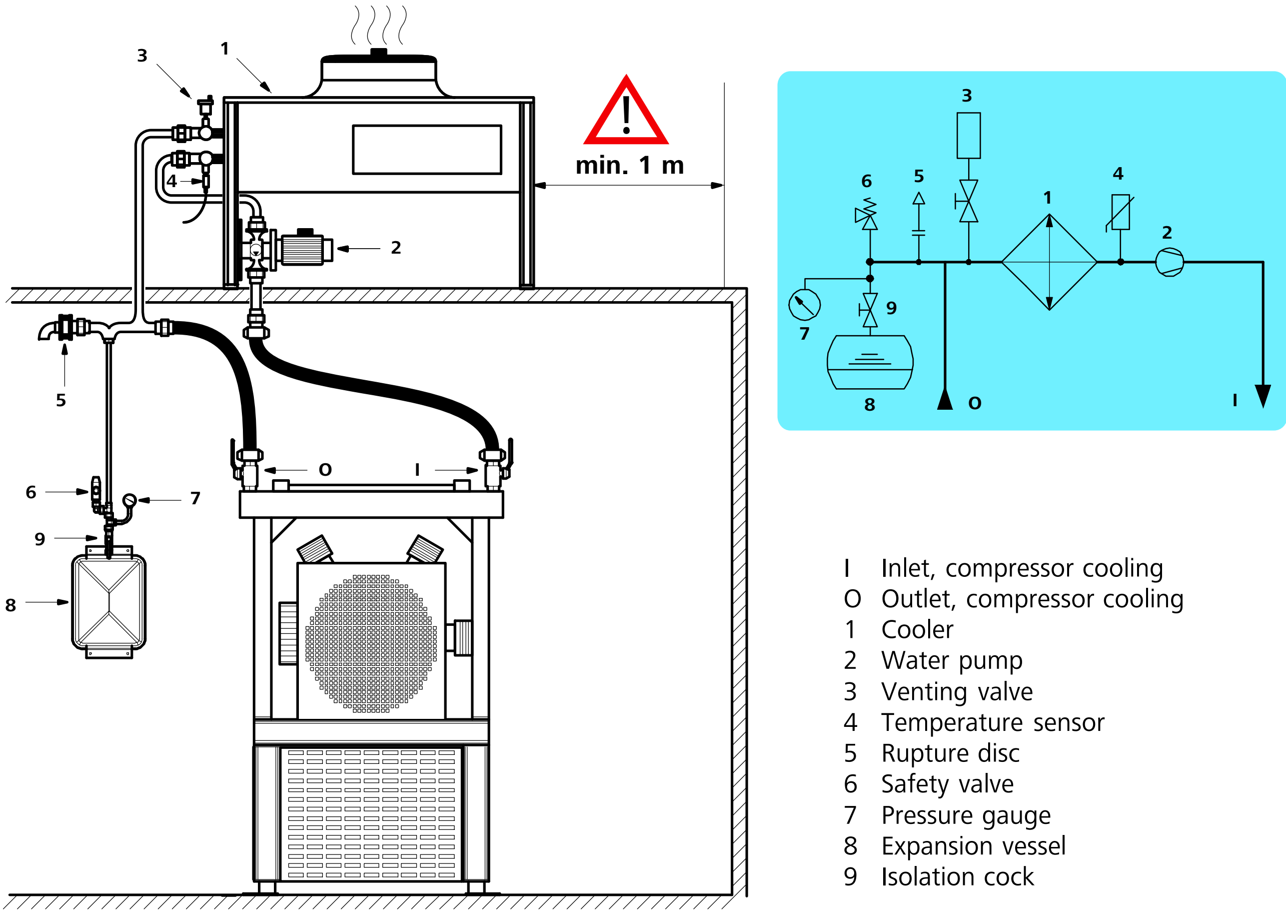


Fig. 28 Installation example of an installation with closed cooling water circuit

3.3. PLATE HEAT EXCHANGER SET

The plate heat exchanger set facilitates the connection of a compressor installation to an existing cooling water circuit. In doing so, the cooling water circuit minimum requirements must always be met.

3.3.1. Requirements for the cooling water circuit

The customer's cooling water circuit must be equipped with temperature and flow monitoring systems to protect the compressor installation. Connect the sensors to the compressor control system so that the compressor installation switches off automatically when a fault occurs. In addition, the cooling water circuit must fulfil the following minimum requirements:

Cooling water circuit: Minimum requirements			
Plate heat exchanger set for:	K23	K24	K26
Cooling medium customer side	Water		
Operating pressure building side	max. 10 bar		
Cooling water inlet temperature	<40 °C		
Cooling water outlet temperature	<30 °C		
Delta T (outlet – inlet)	approx. 10 °C		
Max. pressure loss (bar)	0.40	0.40	0.42
Min. cooling water flow (m³/h)*	12.66	12.66	18.09
Cooling water connection	R1 1/2" (DN 40)		

3.3.2. Structure

The plate heat exchanger set consists of:

- Plate heat exchanger for cooling the heated cooling water
- Water pump for conveying the cooling water
- Venting valve for removing air from the circuit
- Temperature sensor for temperature monitoring by the compressor control system
- Rupture disc for protection from excess pressure
- Safety valve to prevent from slight over-pressure
- Pressure gauge to monitor the pressure
- Expansion vessel for balancing small volume variations

3.3.3. Installation

You must always observe the following when installing the heat exchanger set (Fig. 29):

- Erect the plate heat exchanger set in the compressor room.
- The automatic quick venting unit must always be at the highest point of the cooling circuit. If the plate heat exchanger set is installed no higher than the compressor plant, the quick acting venting unit must be mounted as shown in Fig. 29 (illustration right, Item 3).

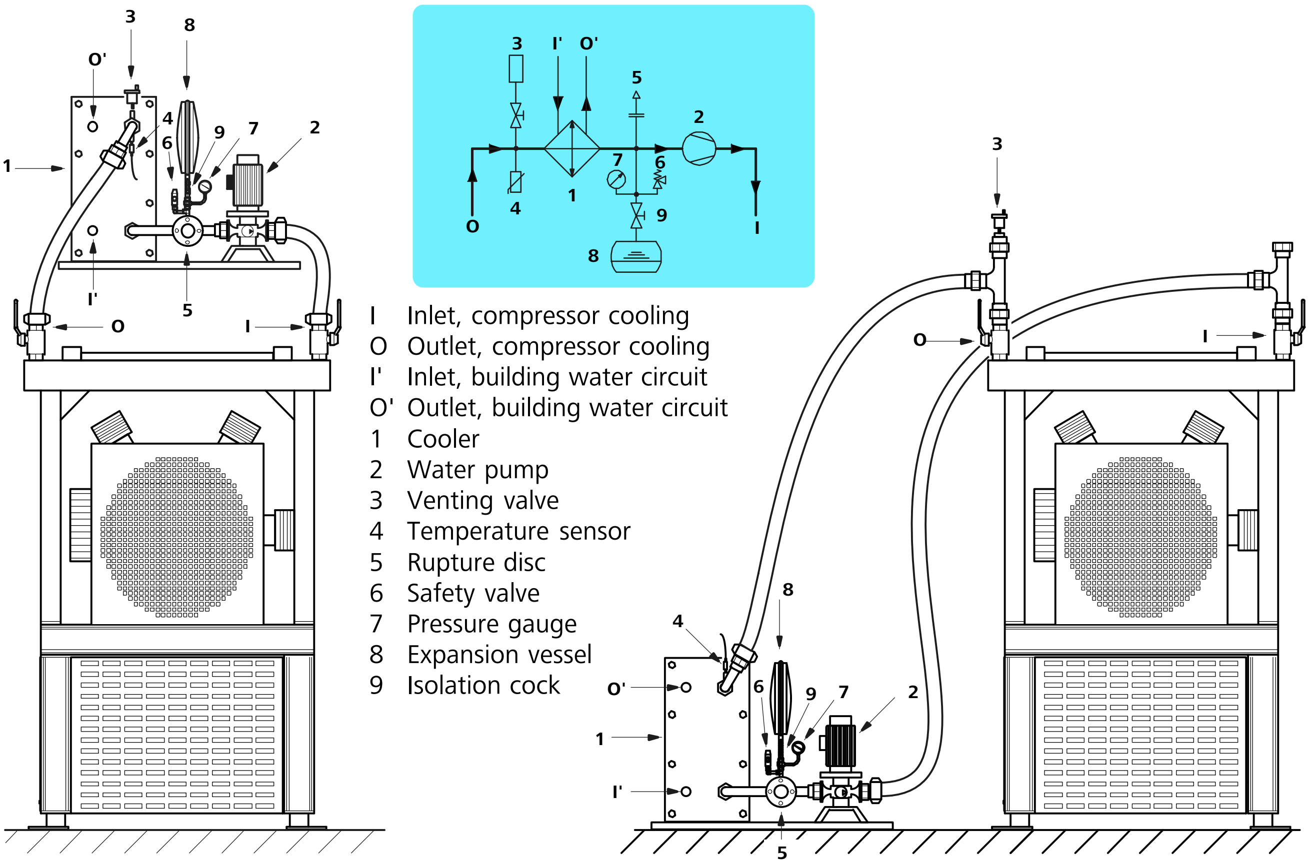


Fig. 29 Installation example of an installation with plate heat exchanger set

4. FILLING THE WATER CIRCUIT

The following fundamental activities for (re)filling the cooling circuits must be carried out:

- Prepare the coolant mixture
- Filling by an external fluid pump
- Check/switch on the circulation pump and vent the system.

4.1. PREPARE THE COOLANT MIXTURE

Before filling, the coolant mixture consisting of **3 parts of normal tap water** and at least **1 part Antifrogen-N** is produced in a separate container so that adequate corrosion protection is ensured. That corresponds to a concentration of 25 % and frost protection down to -12 °C. For stronger frost protection see Chap. 1.2.

For the cooling fluid volume see Chap. 1. Prepare slightly more coolant mixture than the calculated fill volume in order to be able to top up after venting.

4.2. FILLING THE WATER CIRCUIT

For the initial filling of the water circuit we recommend the water pump (Order No. N27749) and the associated initial filling set (Order No. 84320).

Filling is by means of a fluid pump, that produces a pressure of more than 3.0 bar. Proceed as follows to fill the installation (all items refer to Fig. 30):

– Fit a hose (1) to the blow-off fitting on the safety valve and which ends in a collection vessel (2).

– Ensure that ball cocks (5 and 6) on the compressor are open.

– Fit suction and pressure hose (8 and 9) to the pump.

– Immerse the suction hose (8) on the fluid pump in the mixing vessel (7) and connect the pressure hose (9) to the drain ball cock (10, if fitted) on the compressor. If there is no ball cock, fit the ball cock (R1/2" connection) from the initial filling set to one of the heat exchangers on the compressor.

– Fill the fluid pump (11) with coolant through the screw plug on the pump housing.

– Open the filling cock (10), switch the fluid pump (11) on and continuously increase the system pressure. Observe the pressure increase on the pressure gauge (4) (it can take up to 4 minutes after switching the pump on before water is delivered).

– Switch the pump off as soon as the safety valve (3) opens.

– Close the filling cock (10) and unscrew the filling hose (9).

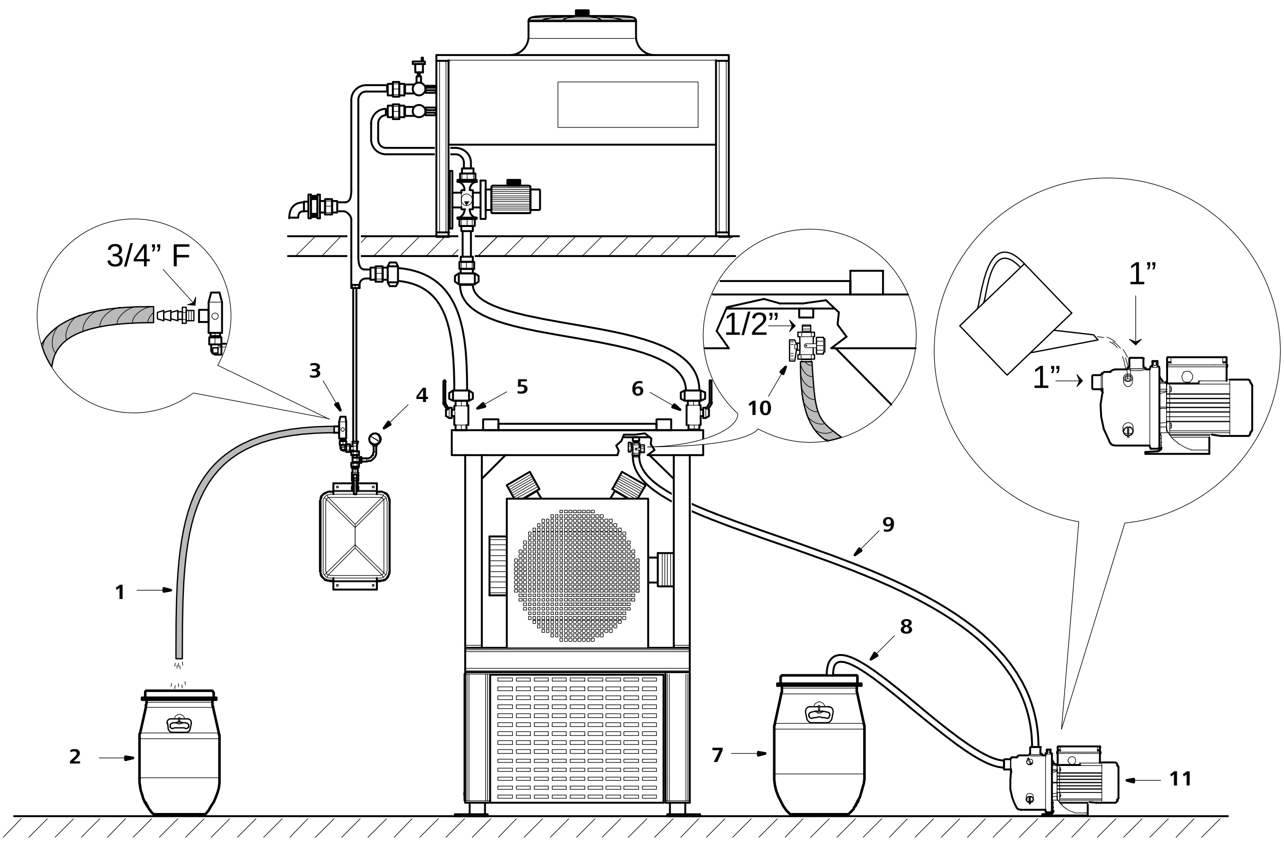


Fig. 30 Filling the cooling water circuit

4.3. VENTING THE WATER CIRCUIT

The cooling system must be bled as well as possible in order to prevent overheating of the compressor during operation.

On the cooler or at the highest point of the cooling circuit there is an automatic quick venting unit.

– Switch on the system and you must immediately check the direction of rotation of the pump (if necessary using a rotating field measuring unit) (direction of rotation arrow on the casing).

If the direction of rotation is wrong, the system must be switched off immediately at the main switch on the switchgear cabinet! Switch off the power supply and swap two of the incoming mains lines.

– To bleed, release the cap on the quick venting unit (1, Fig. 31) slightly to allow the air to escape from the cooling circuit.
– Briefly open the venting valve (2) on the pump housing.
– The safety valve (3) should be opened briefly for this purpose by turning the red cap to vent the line to the expansion vessel.
– Allow the circulation pump to run for at least 30 minutes. Observe the water pressure and temperature in order to detect correct venting and thus avoid possible overheating of the compressor.
  Venting has been successful if the water pressure and water temperature are stable and within the permissible limits:
  Water pressure: . . . . 1.5 to 3 bar
  Water temperature: . . . . <40°
– Carry out a leak test when running.

4.3.1. Repeated venting

It may be necessary to top up with cooling fluid and then vent again.

After filling and bleeding the system, the circulation pump should be allowed to run for approx. 1 hour before commissioning the compressor in order to detect proper bleeding and to prevent possible overheating of the compressor during the subsequent commissioning.

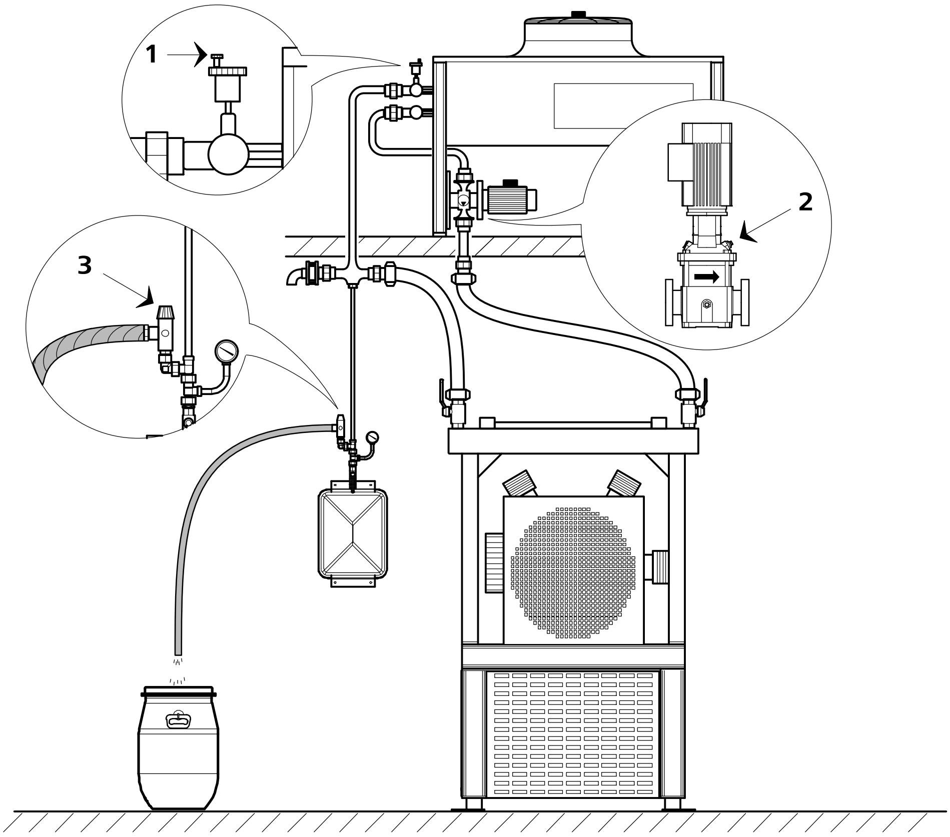


Fig. 31 Venting the water circuit

E. ELECTRICAL INSTALLATION

1. GENERAL POINTS

You must take account of the following when installing the electrical equipment:

Observe the local electrical supply company (EVU)'s regulations.

The connection should only be carried out by an expert technician.

Check for perfect protection laying.

Check that the motor voltage, switchgear voltage and frequency agree with the mains voltage and mains frequency.

The customer must provide the necessary cables, main fuses and a main switch. The fuses must be in agreement with the regulations of the responsible electrical supply company.

Set the thermal motor protection over-current relay to the motor nominal current for direct switching, and, with star-delta switching to a motor nominal current of x 0.58:
Example: Motor nominal current = 10 A, setting to 5.8 A.

If the motor is not already secured in the framework of the installation control system, the guideline values in the connection value table in Chap. 2. (using slow-response fuses).

2. CONNECTION VALUES FOR THE THREE-PHASE MOTORS

Operating voltage 230 V						Operating voltage 400 V/500 V					
Motor rated power in kW	Motor rated current in A	Fuse for start-up in A		Supply line in mm^2 for[a)]		Motor rated power in kW	Motor rated current in A	Fuse for start-up in A		Supply line in mm^2 for[a)]	
		direct	star/ delta	mains to con-tactor	S/D to motor			direct	star/ delta	mains to con-tactor	S/D to motor
1.1	4.6	6	6	1.5	1.5	1.1	2.6	4	4	1.5	1.5
1.5	6.3	16	10	1.5	1.5	1.5	3.6	6	4	1.5	1.5
2.2	8.7	20	16	1.5	1.5	2.2	5	10	6	1.5	1.5
3	11.5	20	16	2.5	1.5	3	6.6	16	10	2.5	1.5
4	14.8	25	20	2.5	1.5	4	8.5	20	16	2.5	1.5
5.5	19.6	35	25	4	2.5	5.5	11.3	25	20	2.5	1.5
7.5	26.4	50	35	6	4	7.5	15.2	25	20	2.5	1.5
11	38	63	50	6	4	11	21.7	35	25	4	2.5
15	51	80	63	10	4	15	29.9	50	35	6	4
18.5	63	100	80	16	6	18.5	36	63	50	6	4
22	71	100	80	16	6	22	41	63	50	10	4
30	96	125	125	25	10	30	55	80	63	10	6
37	117	200	160	35	16	37	68	100	80	16	6
45	141	250	160	50	16	45	81	125	100	25	10
55	173	300	200	70	25	55	99	160	125	25	16
75	233	355	300	95	35	75	134	200	160	35	25
90	279	425	355	120	50	90	161	224	200	50	25
110	342	500	400			110	196	250	224	70	35
132	401	630	500			132	231	300	250	95	50
169	486	630	630			160	279	355	300	120	70

Notes

1. This table contains non-binding guideline values and only has validity for the plant manufacturing division of BAUER COMPRESSORS.

2. The basis are the currently applicable regulations DIN VDE 0100 and the DIN VDE 0113 as well as the generally applicable rules of technology.

3. With plants without start-up process (direct switch-on), the line cross sections "mains to contactor" need to be used up to the motor.

a) Supply line, in addition to the delivered volume, must be selected by the electrician, depending on the length of the line, the type of routing (cable duct on the wall, open), temperature, bundling of the cable etc. If this is not observed, this can result in damage to the electrical equipment and danger to persons and property. This table is based on data from VDE 0100 and VDE 0298 in the current issue in each case.

F. CONDENSATE DRAIN

When air is compressed, the moisture contained in it is separated as condensate. The water-oil emulsion produced is collected in the individual separators after the individual compressor stages and regularly drained by the automatic condensate drain device.

This emulsion naturally contains mainly water (depending on the type of gas). The percentage of oil is very low when compressing air.

1. *VOLUME OF CONDENSATE*

1.1. OIL PROPORTION

The proportion of oil in the condensate emulsion depends on:

- the power rating of the compressor plant
- the wear of the piston and cylinder surfaces
- the condition of the piston rings
- the ambient temperature (almost exponential relationship)
- excess or negative pressure in the draw-in area

As an approximation, the proportion of oil refers to the compressor drive power rating.

Under normal conditions there will be a specific oil consumption of 0.2 ± 0.2 g/kWh.

Unfavourable operating conditions can increase this value.

1.2. WATER PROPORTION

The volume of moisture that condenses, and which is separated as water, is dependent on:

- Air temperature in the inlet connection
- Air moisture in the inlet connection
- Air temperature in the final separator
- Pressure of the compressed air in the separator
- Delivery rate of the compressor

If an exact calculation is carried out a dewpoint table for air is required.

As a rough estimate the moisture deposition can be taken from the following table: (assuming a temperature increase in the separator Δt = 10 °C)

Condensate deposition in l/h, referred to a compressor output of 1,000 l/min.			
Environmental temperature	**Relative humidity**	**Working pressure**	
°C-	**%**	**35 bar**	**220 bar**
	50	0.26	0.29
+10 °C	70	0.38	0.41
	90	0.49	0.52
	50	0.50	0.55
+20 °C	70	0.72	0.77
	90	0.94	0.99
	50	0.90	0.99
+30 °C	70	1.31	1.40
	90	1.71	1.80
	50	1.62	1.73
+40 °C	70	2.33	2.44
	90	3.02	3.13

1.3. EXAMPLE OF CALCULATION OF THE VOLUME OF CONDENSATE

Compressor plant:	A28.2-45
delivery rate	3,400 l/min
Operating pressure:	35 bar
Drive power rating:	45 kW
Ambient temperature:	+20 °C
Air humidity:	70 %

Water proportion

From the table: 0.72 l/h, referring to 1,000 l/min

Referring to the delivery rate of the compressor, the water deposition is 3.4 x 0.72 l/h = 2.45 l/h

Oil proportion

Approximately:
$0.2^{\pm 0.2}$ g/kWh x 45 kW = 9 - 18 g/h = 0.009 - 0.018 l/h

Conclusion: The oil content is less than 1 % and can be disregarded for the calculation of the condensate volume.

2. CONDENSATE DISPOSAL

The condensate must be disposed of as monitored special waste (waste listing No. 54405) in accordance with German Waste Disposal Law.

This offers the following possibilities:

- **<u>Completely disposal of the accumulated condensate</u>**
  This includes the accumulation of the condensate in the vessels described below and disposed of completely **>>> simple**
- **<u>Reduction of the volume of condensate by evaporation of the included water</u>**
  That is to say, the condensate is accumulated in the vessels provided and then stored intermediately in larger collection vessels until the water is evaporated **>>> cost-effective**
- **<u>Splitting the emulsion of the condensate by special processes</u>**
  In this case the condensate emulsion is split and cleaned by physical or chemical processes. The base material can be incorporated again in the process cycle **>>> environmentally-friendly**

Note concerning emulsion splitting:

The splitting of high-pressure condensate into oil and water is virtually impossible using simple mechanical splitting systems. The physical or chemical splitting process are, on the other hand, technically relatively complicated and associated with relatively high investment costs.

These investment costs can, however, be amortised in a short period of time with large volumes of condensate.

2.1. CONDENSATE COLLECTION VESSEL FOR BAUER COMPRESSOR PLANTS

For BAUER compressors there is a specially-developed condensate collection vessel. The vessel is specially adapted to the automatic condensate system.

This vessel represents the optimum and cleanest type of condensate collection for all plants.

The vessel is fitted with a mechanical fill-level indicator for advance visual warning of the need to drain the condensate. In addition, an electronic signal generator can send a warning signal to an operating field, or the compressor can be switched off automatically. Overfilling of the vessel is therefore prevented.

The vessel is particularly environmentally-friendly because, on the one hand, the air flowing out through an activated charcoal filter is completely free from oil particles and is therefore odour-free, and, on the other, the draining noise is reduced considerably.

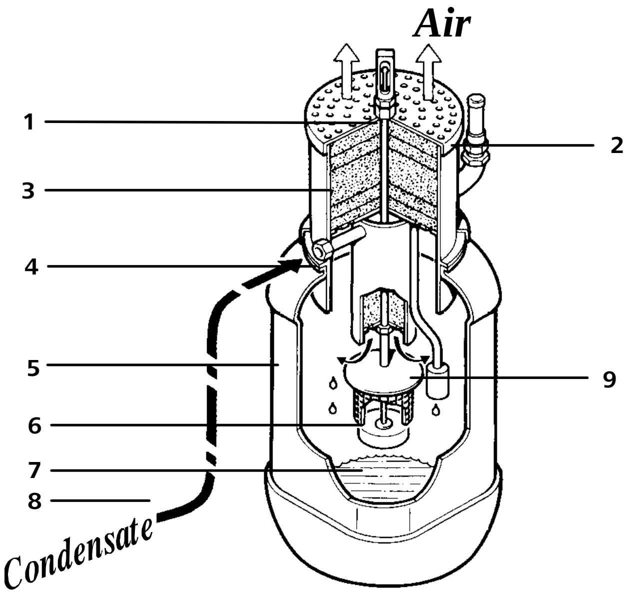


Fig. 32 Condensate collection vessel

1 Level indicator
2 Safety valve
3 Activated charcoal filling
4 Condensate inlet
5 Plastic vessel
6 Float
7 Condensate
8 Hose from compressor
9 Level switch

The volume of this vessel is 40 litres.

The two available condensate inlet connections have a termination as a female thread G 3/4" and G1" .

2.2. CONDENSATE LINES

The routing of condensate lines is a very important aspect of the compressor installation. If, in breach of the installation instructions, the condensate is not drained off properly, a condensate build-up may occur and cause considerable damage, e.g.

- Machine failure caused by condensate backflow
- In extreme cases: Machine destruction
- Corrosion
- Damage to subsequent consumers, or filters, adsorption driers etc.

Increased maintenance and repair costs or production standstill can be caused by damage from inadequate condensate draining.

As such, the following points must always be taken into account when routing the condensate lines:

- The lines between the condensate connection point and the collection vessel must be kept as short as possible, 3-5 m must not be exceeded
- Select the cross section of the condensate line as large as possible

Recommended line diameter:

Drive power rating	Line diameter	
up to 15 kW	DN 12	G 1/2 ″
as from 15 kW	DN 25	G 1 ″

- Rule of thumb: the longer the condensate line, the larger the line diameter should be
- Avoid pipe elbows or unnecessary bends
- Do not combine the condensate lines from several plants together
- Always avoid flow resistances e.g. silencers or non-return valves

2.3. EXAMPLES FOR ROUTING CONDENSATE LINES

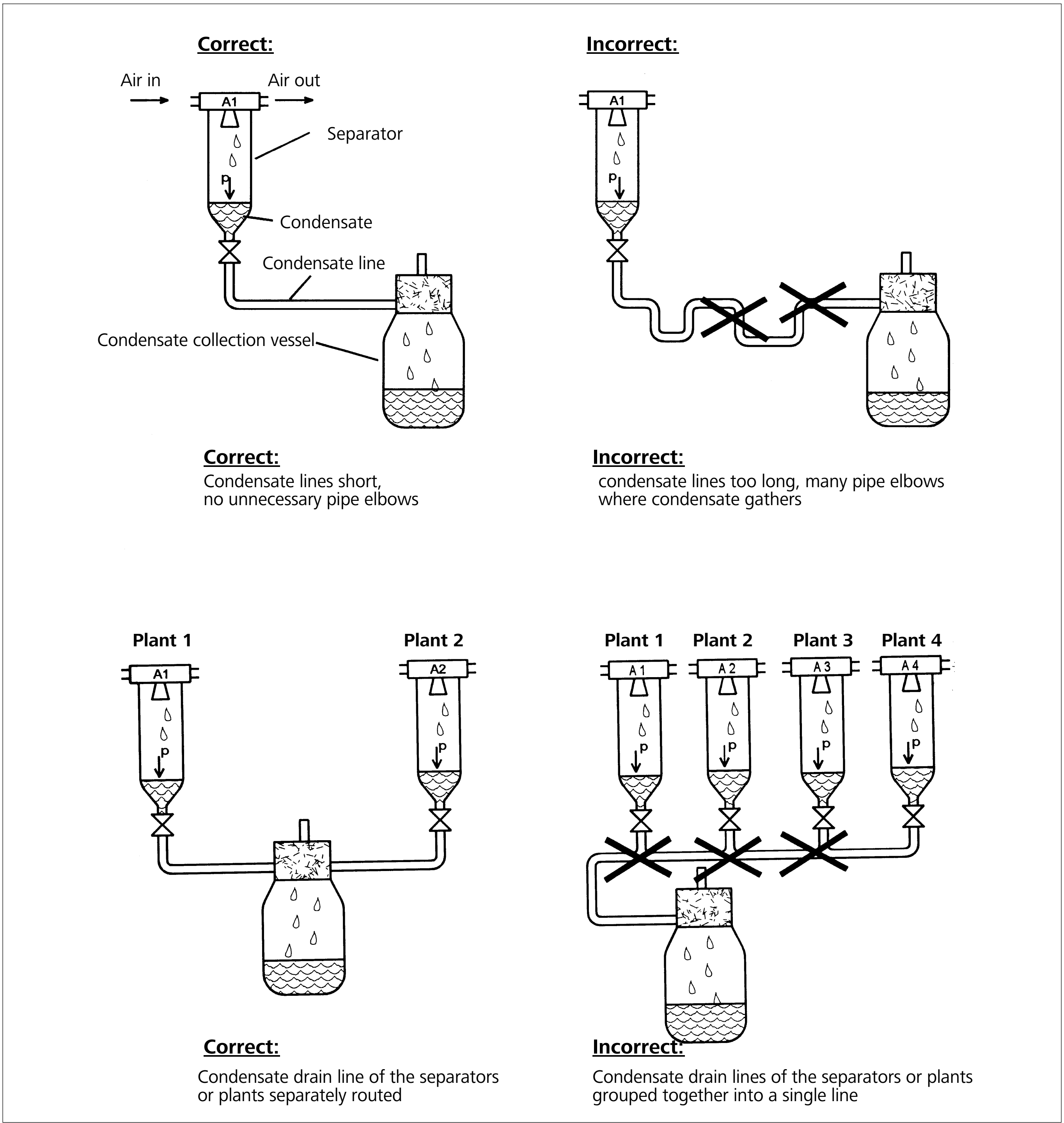
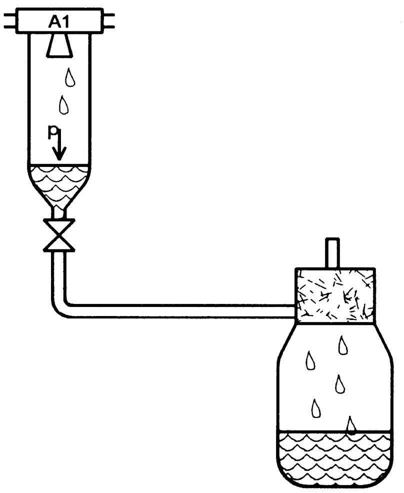


Fig. 33 Routing of condensate lines, Example 1

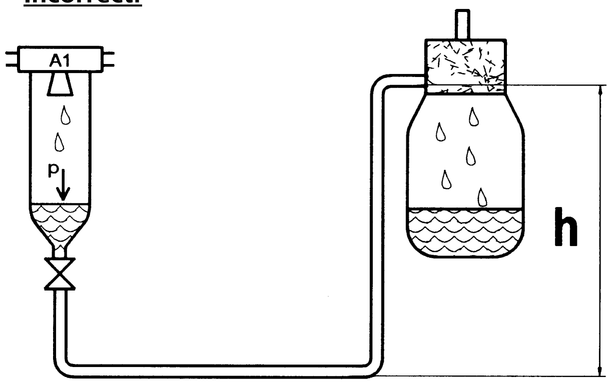
Correct:



Correct:

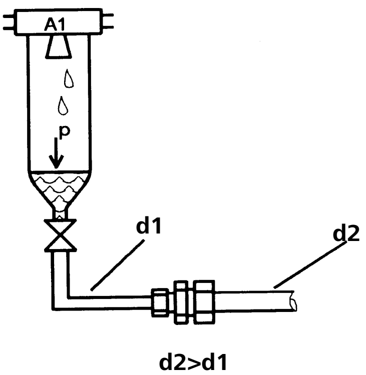
Condensate lines short,
without much height difference
max. height difference: < 1 m

Incorrect:



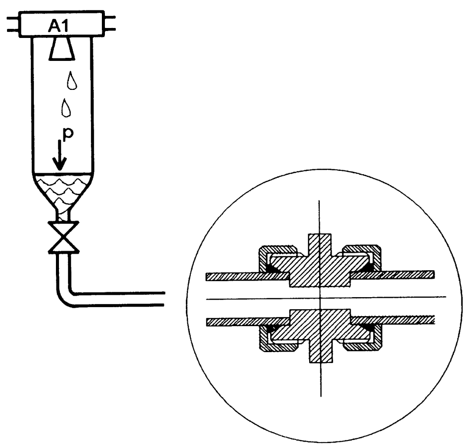
Incorrect:

Condensate lines too long,
max. height difference: < 1 m



Correct:

Increase in pipe cross-section



Incorrect:

Reduction in cross section, e.g. by pipe fitting
from S series
Reduction in ongoing pipe
diameter

Fig. 34 Routing of condensate lines, Example 2

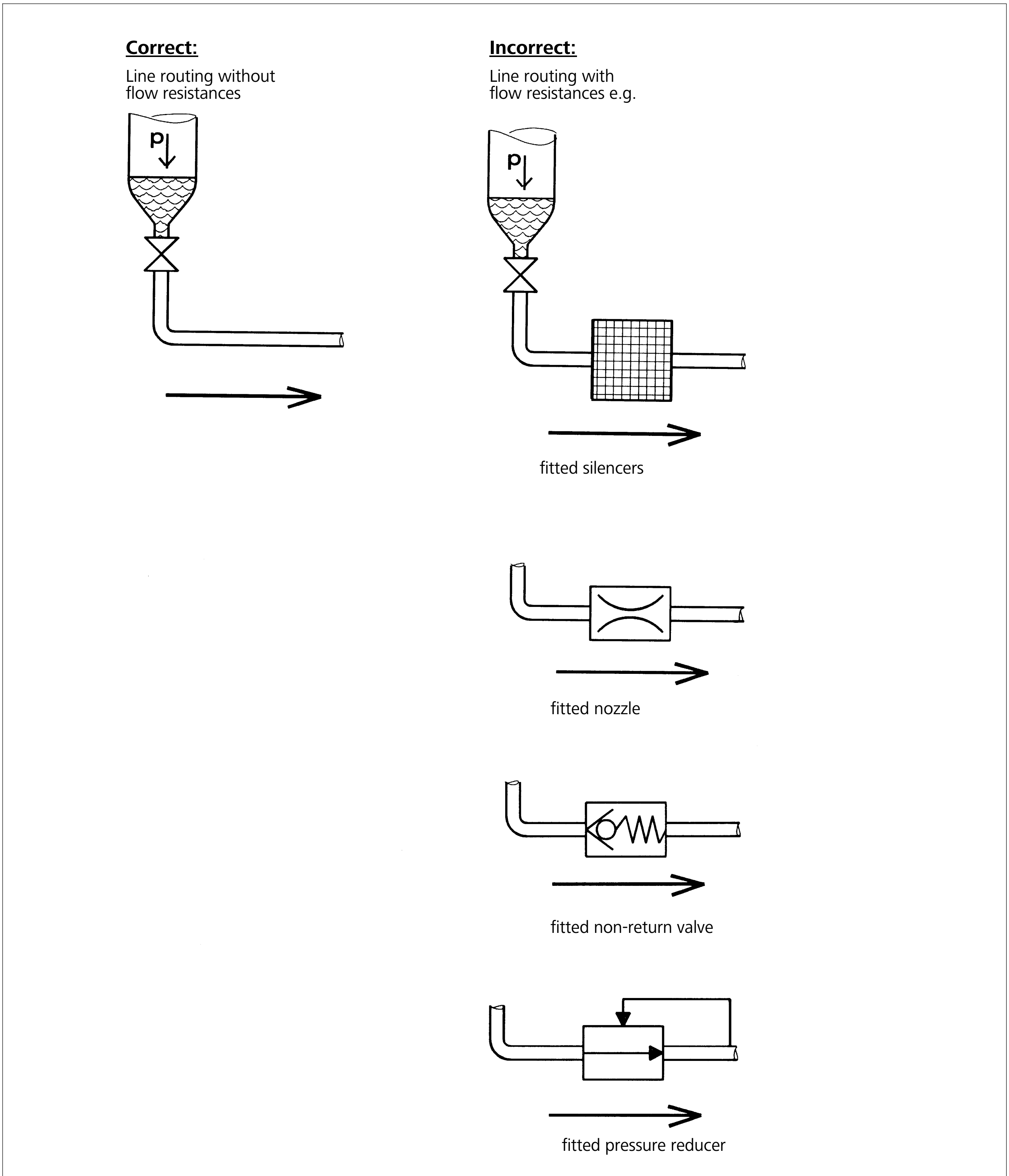


Fig. 35 Routing of condensate lines, Example 3

G. APPENDIX

1. COOLING AIRFLOW WITH NATURAL VENTILATION (depending on room size, motor power rating and wall consistency)

Room size	Motor drive power rating	Required cooling air flow rate V m³/h Walls of compressor made of		
m³	**kW**	**Gravel concrete DIN 4108**	**Brick DIN 4108**	**Pumice concrete DIN 4108**
	3	50	150	250
25	4	200	370	400
	5.5	700	870	1000
	7.5	1100	1300	1500
	11	1800	2000	2200
	15	2700	3000	3100
Height	18.5	3300	3600	3700
2.5 m	22	4000	4200	4300
	3		25	200
50	4		180	350
	5.5	400	650	900
	7.5	800	1100	1350
	11	1400	1800	2100
	15	2400	2700	3000
Height	18.5	3000	3300	3600
2.5 m	22	3700	4000	4250
	3			100
100	4			250
	5.5		300	750
	7.5	200	800	1200
	11	900	1500	1900
	15	1800	2400	2800
Height	18.5	2400	3000	3400
3 m	22	3200	3700	4100
	3			
100	4			170
	5.5		50	600
	7.5		500	1000
	11	400	1250	1800
	15	1800	2100	2600
Height	18.5	1900	2700	3200
3.5 m	22	2600	3400	3900
	3			
200	4			50
	5.5			400
	7.5		200	900
	11		1000	1600
	15	900	1800	2500
Height	18.5	1500	2500	3100
4 m	22	2200	3200	3800

2. REQUIRED EXHAUST AIR OPENING WITH NATURAL VENTILATION (depending on room size and cooling air flow)

Cooling airflow V m^3/h	Room height h m	Exhaust air opening f_{from} m^2
500	2 3 4 5	0.3 0.25 0.2 0.15
1000	2 3 4 5	0.6 0.5 0.4 0.3
1500	2 3 4 5	0.9 0.7 0.6 0.5
2000	2 3 4 5	1.2 0.9 0.8 0.7
2500	2 3 4 5	1.4 1.2 1.2 0.9
3000	2 3 4 5	1.7 1.4 1.2 1.1
3500	2 3 4 5	2 1.7 1.4 1.3
4000	2 3 4 5	2.3 1.9 1.7 1.5

3. *REQUIRED INLET AIR OPENING WITH NATURAL VENTILATION (depending on cooling air flow and flow rate)*

Cooling airflow	**Inlet opening f_{to} (m^2)**	
V **m^3/h**	**for** **c_{to} = 3 m/s**	**for** **c_{to} = 5 m/s**
5000	0.5	0.3
10000	0.9	0.6
15000	1.4	0.9
20000	1.9	1.1
25000	2.3	1.4
30000	2.8	1.7
35000	3.2	2.0
40000	3.7	2.2
45000	4.2	2.5
50000	4.6	2.8

4. COOLING AIR FLOW WITH FORCED VENTILATION
(depending on room size, motor power rating and wall consistency)

Room size	Motor drive power rating	Required cooling air flow rate V m³/h Walls of compressor made of		
m³	kW	Gravel concrete DIN 4108	Brick DIN 4108	Pumice concrete DIN 4108
	18	5000	5300	5600
50	22	6100	6400	6700
	30	8600	9000	9200
	37	10800	11200	11400
	45	13400	13700	14000
	55	16500	16900	17100
Height	75	22800	23200	23400
2.5 m	90	27600	28000	28200
	110	33900	34300	34500
	18	4400	5000	5400
100	22	5500	6100	6500
	30	8000	8600	9000
	37	10300	10800	11200
	45	12800	13400	13800
	55	15900	16500	16900
Height	75	22300	22850	23200
3 m	90	27000	27600	28000
	110	33300	34000	34300
	18	3600	4500	5100
200	22	4600	5600	6200
	30	7200	8100	8800
	37	9400	10300	11000
	45	12000	12900	13500
	55	15100	16000	16700
Height	75	21400	22300	23000
4 m	90	26200	27100	27700
	110	32500	33500	34100
	18	1300	3100	4300
500	22	2400	4200	5500
	30	4900	6700	8000
	37	7100	8900	10200
	45	9600	11500	12800
	55	12800	14600	15900
Height	75	19900	20900	22200
5 m	90	23900	25600	27000
	110	30200	32000	33300

5. FROST AND CORROSION PROTECTION

Frost safety (Source: Clariant Produkte (Deutschland) GmbH, D-65840 Sulzbach, Germany)