

Important Information on the Use of Hydrocarbons with Bock[®] compressors

On this topic

This document contains important and valuable information on the use of hydrocarbon refrigerants with Bock compressors.

The compressor installation manual, including all safety instructions and warnings, is authoritative and binding.

Use of hydrocarbon refrigerants with Bock compressors

The approval of hydrocarbon refrigerants for Bock compressors must be checked in advance in the online selection program VAP.

Recommended application areas of hydrocarbon refrigerants

R290 for low- and medium-temperature refrigeration, air conditioning applications, and heat pumps.

R1270 for low- and medium-temperature refrigeration.

R600a for heat pumps.

Refrigerant quality

- Use refrigerant quality according to DIN 8960:1998
- Strictly avoid high moisture content. Use moisture indicators with defined drying level indication (≤ 50 ppm) and sufficiently sized filter driers.
- These requirements also apply to applications with other hydrocarbons and blends.

Chemical and physical properties of hydrocarbon refrigerants and oils

R290 and R1270 hydrocarbon refrigerants are non-critical in contact with metals and elastomers.

However, with R600a (isobutane), limitations may occur with certain elastomers; therefore, individual material compatibility testing is required.

PAG oils may chemically react with aluminum components in filter driers, leading to additive degradation or deposits. Therefore, use suitable aluminum-free filter driers.

Solubility of hydrocarbon refrigerants in oil

The very high solubility of hydrocarbon refrigerants in all common oils leads, especially at low oil temperatures and high suction pressure, to a reduction in oil viscosity in the compressor.

Possible consequences:

- Strong degassing in the oil sump and lubrication gaps during pressure reduction
- Foam formation with resulting increased oil carryover
- Performance reduction and increased wear of drive components

Recommended measures

- Use an oil according to Danfoss Bock recommendations with high base viscosity, high viscosity index, and improved tribological properties, in accordance with the application limit diagram.
- Keep refrigerant charge as low as possible.
- During standstill, ensure the oil is sufficiently heated. See minimum oil temperature for compressor start (assembly instructions -> application limits).
- Install the compressor in a temperature-controlled environment and insulate if necessary. For external evaluation of minimum oil temperature, a Pt1000 oil temperature sensor is optionally available for compressor types HG44–HG88.
- In case of high suction-side standstill pressures and long shutdown periods, provide an automatic pump-down system.
- Set the pump-down cut-out pressure only slightly below the lowest evaporation pressure to avoid pressure fluctuations and foaming.
- Ensure sufficient suction gas superheat; discharge gas temperature must be at least 20 K above condensing temperature; if necessary, use an internal heat exchanger between suction and liquid line.
- Protect the compressor against liquid operation at all times. Use expansion devices with stable control behaviour. For electronic expansion valves, reduce opening degree after defrost and use a liquid separator if required.

For systems with long predictable standstill periods (e.g., seasonal operation or precharged systems in storage/transport), it is recommended to close the compressor shut-off valves after a pump-down. Check valves in the discharge line are strongly recommended.

Cleaning effect of hydrocarbon refrigerants

Hydrocarbon refrigerants have a strong cleaning effect and dissolve deposits, bending oil and mounting oils in the piping system. Possible consequences:

- Heavy contamination deposits in the compressor and control devices.
- Strong foam formation and increased wear on moving parts.

Measures:

- Ensure maximum cleanliness during installation and service.
- Carefully clean piping and components.
- Perform brazing exclusively under shielding gas (dried nitrogen).
- Comply with cleanliness requirements according to DIN 8964 or comparable standards.
- Use suction-side cleaning filters in extensively branched systems.

Water content of hydrocarbon refrigerants

High-purity hydrocarbon refrigerants do not contain acid-forming components. Nevertheless, high moisture content must be strictly avoided. Possible consequences:

- Crystal formation in expansion devices.
- Increased risk of cavitation in moving components.
- The formation of gas hydrates in the liquid at high pressure and low temperature, which can block narrow points in the system.

Measures:

- Use refrigerants with low non-condensable content and no additives.
- Use high refrigerant quality ("2.5" or comparable) with at least 99.5% purity
- Prevent ingress of moisture and foreign gases.
- Use generously sized filter driers in accordance with the manufacturer's specifications.
- Use moisture indicators with a defined display of the degree of dryness (<50 ppm).
- Perform leak testing with dry nitrogen.
- Evacuate to a stable vacuum of 1.5 mbar (standing vacuum). Switch on oil sump heater during evacuation.

Additional note on suction gas superheat

Low suction gas superheat and/or low pressure ratios increase the risk of refrigerant enrichment in the oil.

To increase suction gas superheat at compressor inlet, the use of an internal heat exchanger between liquid and suction line is recommended.

Oils

Due to the high solubility of hydrocarbons in conventional oils, Bock HC compressors are filled with specially adapted lubricants with high viscosity index and excellent tribological properties.

Two different types of oil are available for reciprocating compressors.

PAG oil is used as the standard oil and is particularly suitable for compact refrigeration circuits and extended operating limits, especially for standard refrigeration and heat pump applications.

PAO oil is less hygroscopic but requires a suction gas superheat of at least 20 K at the compressor inlet to limit the dissolution of refrigerant in the oil and is particularly suitable for low-temperature and standard refrigeration applications. For this purpose, the use of an internal heat exchanger between the suction gas and liquid lines is provided.

The two oil types must not be mixed, as this can lead to excessive foaming, phase separation of the two oils and consequently to insufficient lubrication.

Due to the high solubility of hydrocarbons, special requirements apply to compressor design, operation, and control. Low or unstable suction gas superheat and insufficient oil heating during standstill lead to reduced oil viscosity.

Possible consequences:

- Reduced performance.
- Strong foam formation.
- Increased wear on engine components.
- Increased oil carryover.

Therefore, ensure that the compressor is properly protected against wet running and operate it with sufficiently high suction gas temperature. Discharge temperature must always be at least 20 K above condensing temperature.

Additional measures:

- Avoid low oil temperatures; an oil heater is mandatory and may need to be supplemented by a pump-down control and compressor insulation. Refer to the required minimum oil temperature for compressor start (assembly instructions -> application limits).
- Avoid high suction-side standstill pressures, as they increase the refrigerant content in the oil.
- Avoid rapid changes in suction pressure, as they can cause significant outgassing of refrigerant dissolved in the oil, as well as foaming and unstable suction gas superheat.
- Avoid rapid changes in condensing pressure, as they promote strong foaming in the oil separator.

In heat pump applications with a 4-way reversing valve, switching is only permitted when the compressor is at a standstill. Switching during compressor operation leads to strong pressure fluctuations that negatively affect the lubricating properties of the oil.

All operating conditions must be checked in advance to ensure safe and stable operation.

Water content in oil

The water content in compressor oil is particularly critical when operating with hydrocarbon refrigerants and must be kept as low as possible. Even small amounts of moisture in the oil, combined with the high solubility of hydrocarbons, can lead to foaming, a drop in viscosity, and unstable lubrication behavior.

An increased water content in the oil also promotes:

- Crystal and ice formation in throttling and expansion devices.
- Corrosion of metallic components.
- Cavitation in bearing points due to local pressure and temperature changes.
- Accelerated oil aging and deterioration of tribological properties.

The permissible water content in the oil must therefore be strictly limited.

As a guideline, DIN 51503-2:2015 (or comparable) applies. Values in the low double-digit ppm range should be targeted, even for PAG oils. Exceeding these values is not permissible.

To ensure a low water content, the following measures must be observed:

- First evacuate the system, then include the compressor in the evacuation process.
- Ensure consistent and continuous heating of the oil sump during drying and evacuation of the system and compressor before commissioning, as well as during service work.
- Use adequately sized filter driers according to the manufacturer's specifications.
- Avoid air ingress during operation, installation, service, and standstill.
- Perform regular oil analyses to monitor water content and oil condition.
- Evacuate using a vacuum pump on both the suction and high-pressure sides of the compressor.
- At the end of the evacuation process, the vacuum should be < 1.5 mbar with the pump switched off.
- Repeat this process if necessary and flush the compressor with dried nitrogen.

Note for service & commissioning:

High water content is a critical long-term damage factor and may lead to premature bearing and compressor failure.

Additional service notes on handling oils.

PAG oils in particular are highly hygroscopic and absorb moisture even after short exposure to ambient air. Once opened, an oil container immediately begins to absorb water.

Service notes and recommendations:

- Avoid contaminants (bending oils, leak detection agents, assembly greases/silicones, etc.).
- Open oil containers only immediately before use.
- Do not leave opened containers exposed.
- Never store oil in open containers or funnels.
- Do not reuse remaining quantities from opened containers.
- Use small container sizes close to the application.
- Use large containers only in controlled workshop environments and prevent moisture ingress.
- Keep oil containers tightly sealed.
- Protect containers from moisture, direct sunlight, and temperature fluctuations.
- Minimize the time between opening the container and filling.
- Use only clean, dry, and closed filling systems.
- Dry and flush filling hoses and pumps beforehand.

- Always perform sufficient evacuation after work on the oil circuit.
- Replace or resize filter driers if necessary, according to manufacturer specifications.
- Perform an oil analysis after major interventions.
- Do not mix different oil types such as PAG and PAO oils.
- Even small residual amounts of other oils in the system can lead to foaming and insufficient lubrication.

Measures to achieve a long compressor service life

- Use oil with high base viscosity in accordance with the Danfoss Bock standard.
- Select the lowest possible refrigerant charge and generously size the oil sump heater (see compressor installation manual).
- Install the compressor in a temperature-controlled environment and insulate if necessary.
- If there is a risk of high suction-side standstill pressures: provide a pump-down control (avoid vacuum conditions).
- Protection against “wet operation” during start-up and operation:
use expansion devices with stable control behavior; install a liquid separator if required.
- Avoid strong and rapid changes in suction and condensing pressure. Risk of severe outgassing (foaming) in the oil sump or oil separator (may lead to increased oil carryover).
- Thoroughly clean piping and components.
- Use dried nitrogen as shielding gas during brazing.
- Maintain cleanliness requirements according to DIN 8964 or comparable standards.
- Use filters in the suction line in case of complex or extensive systems.
- Ensure a dry system:
 - Install filter driers.
 - Integrate moisture indicators with indication > 50 ppm.
- For inverter operation: start frequency and ramp time.
During operation, increase and decrease frequency as slowly as possible to prevent strong outgassing (foaming) in the oil sump.

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