

# OPERATING INSTRUCTIONS

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# DIAPHRAGM ACCUMULATORS

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The illustrations and texts in these supplementary notes correspond to the state of the art at the time of preparation. We reserve the right to make changes!

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Further languages are available on request.

In the unfortunate event of translation differences, the German version shall prevail.

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## 1. Safety

### 1.1 General

This document applies exclusively to Freudenberg diaphragm accumulators. Careful reading of the following safety instructions and process descriptions before commissioning, maintenance or repair is absolutely essential. Documents supplied must be kept carefully; they are required for recurring inspections.

The legal regulations applicable at the place of installation are mandatory for commissioning and continuous intended use of the diaphragm accumulators. The operator is solely responsible for compliance with these regulations.

### 1.2 Technical Data

Diaphragm accumulators are pressure vessels according to the European directive 2014/68/EU and used to charge and supply hydraulic energy in applications such as pressure fluid storage, pulsation dampening and shock absorption. Its diaphragm acts as a separator between the pressure fluid of a hydraulic system and the pressure-energy-storing nitrogen gas volume of the diaphragm accumulator. Diaphragm accumulators are designed in accordance with generally accepted technical regulations and standards.

Diaphragm accumulator  $\leq 1$  liter: according to directive 2014/68/EU it is not allowed to put CE sign on Accumulators with a nominal volume up to one liter and max. permissible working pressure up to 1000 bar.

Diaphragm accumulator  $>1$  liter: according to directive 2014/68/EU accumulators with a nominal volume more than one liter must be marked with an CE-identification.

|                                |                                                                               |
|--------------------------------|-------------------------------------------------------------------------------|
| Type [D ...]                   | D ...(V) - ... (PS)                                                           |
| Volume [V]                     | 0,07 ... 3,5 [l]                                                              |
| Perm. working pressure [bar]   | 40 ... 350                                                                    |
| Perm. working temperature [°C] | -10...+80 °C<br>Other temperatures please request or see stamp on accumulator |
| Year of manufacture            | See stamp on accumulator                                                      |
| Working fluid                  | Mineral oil (other liquids please request)                                    |
| Security valve                 | Is not included in the delivery capacity                                      |

| Type      | Nominal volume<br>V [l] | Max. allowed working pressure<br>PS [bar] | Max. allowed pressure<br>range <sup>(1)</sup><br>[bar] |
|-----------|-------------------------|-------------------------------------------|--------------------------------------------------------|
| D0,07-170 | 0,07                    | 170                                       | 110                                                    |
| D0,07-250 | 0,07                    | 250                                       | 160                                                    |
| D0,16-250 | 0,16                    | 250                                       | 160                                                    |
| D0,32-210 | 0,32                    | 210                                       | 130                                                    |
| D0,32-250 | 0,32                    | 250                                       | 180                                                    |
| D0,32-330 | 0,32                    | 330                                       | 200                                                    |
| D0,5-160  | 0,50                    | 160                                       | 90                                                     |
| D0,5-210  | 0,50                    | 210                                       | 130                                                    |
| D0,5-250  | 0,50                    | 250                                       | 130                                                    |
| D0,5-330  | 0,50                    | 330                                       | 200                                                    |
| D0,6-330  | 0,60                    | 330                                       | 200                                                    |
| D0,75-110 | 0,75                    | 110                                       | 50                                                     |
| D0,75-160 | 0,75                    | 160                                       | 90                                                     |
| D0,75-210 | 0,75                    | 210                                       | 140                                                    |
| D0,75-250 | 0,75                    | 250                                       | 180                                                    |
| D0,75-350 | 0,75                    | 350                                       | 200                                                    |
| D1,0-210  | 1,00                    | 210                                       | 140                                                    |
| D1,0-250  | 1,00                    | 250                                       | 170                                                    |
| D1,0-350  | 1,00                    | 350                                       | 200                                                    |
| D1,4-140  | 1,40                    | 140                                       | 90                                                     |
| D1,4-210  | 1,40                    | 210                                       | 90                                                     |
| D1,4-250  | 1,40                    | 250                                       | 120                                                    |
| D1,4-350  | 1,40                    | 350                                       | 135                                                    |
| D2,0-100  | 2,00                    | 100                                       | 50                                                     |
| D2,0-210  | 2,00                    | 210                                       | 130                                                    |
| D2,0-250  | 2,00                    | 250                                       | 150                                                    |
| D2,0-350  | 2,00                    | 350                                       | 200                                                    |
| D2,8-250  | 2,80                    | 250                                       | 140                                                    |
| D2,8-350  | 2,80                    | 350                                       | 180                                                    |
| D3,5-250  | 3,50                    | 250                                       | 110                                                    |
| D3,5-350  | 3,50                    | 350                                       | 180                                                    |

(1) Note:

The values given for the permissible pressure fluctuation range are the maximum differential pressures  $\Delta P_{2,1} = (P_2 - P_1)$  related to a failure probability of 0.01% and at least  $2 \times 10^6$  load cycles.

Further information in the corresponding application-specific technical drawings must be given priority.

### 1.3 Safety instructions

Diaphragm accumulators are pressure devices with inner gas load. They operate in pressure retaining applications and machines.



**WARNING:** *The permissible operating conditions (max. working pressure, min./max. working temperature) specified in the technical documentation and on the name, plate must be observed.*

Never install the diaphragm accumulator in a machine or system under hydraulic system pressure. Prior to repair and maintenance work on the diaphragm accumulator, the gas pre-charge pressure must be completely relieved. The accumulator shall cool down sufficiently before starting work.



**CAUTION:** *Risk of Burns! Diaphragm accumulators may generate high surface temperatures during operation.*



**WARNING:** *Work on improperly pressure-relieved Diaphragm accumulator or its machine/system may result in death, serious injuries or property damage!*



**CAUTION:** *Commissioning as well as repair and maintenance shall only be carried out by trained and qualified people.*

Do not make any unauthorized modifications to the diaphragm accumulator. This will result in an immediate expiry of the operating permit! This includes the use of non-approved or third-party spare parts.



**DANGER:** *There is a risk of bursting during mechanical processing!*



**DANGER:** *There is a risk of explosion during welding and soldering work!*

Diaphragm accumulators may only be charged with nitrogen of Class 4.0 (N<sub>2</sub>-vol.%>99.9). Oxygen and air are not permitted as filling gas, as they can cause a fire or an explosion.



**DANGER:** *When filling with oxygen or compressed air, there is a risk of explosion!*

The diaphragm accumulator may only be operated with fluids of fluid group 2. Flammable, oxidizing, explosive, toxic or corrosive fluids of fluid group 1 must not be used.



**WARNING:** *Danger to health when handling hydraulic fluids! Pressure fluids can cause skin damage, eye injuries or poisoning when inhaled.*

## 1.4 Safety devices

The equipment, installation and operation of diaphragm accumulators are specified in legal national regulations. In the Federal Republic of Germany, these are regulated by the Ordinance on Industrial Safety (BetrSichV), the Technical Rules for Pressure Vessels and EN 14359. They require the following safety devices:

- Pressure relief valve (type-examined)
- Pressure relief device
- Pressure monitoring
- Pressure gauge connection
- Shut-off device

Additionally may be installed:

- Solenoid-operated relief device
- Temperature monitoring

The safety devices mentioned above are not included in the scope of delivery. However, suitable devices are available from Freudenberg.

## 2. Transport and storage

Accumulator transport must be carried out with special care and in compliance with all applicable transport and safety regulations.

Diaphragm accumulators should be stored dry and cool (ideal temperature 5°C to 20°C) and protected from direct sunlight. It must be ensured that no contamination can penetrate the vessel, i.e. the gas valve is to be covered with its plug and the oil valve with its protective cap.

If the accumulator is to be stored for a long time, it is recommended to reduce the gas pre-charge in order to prevent warping of the membrane.



**WARNING:** Accumulators which have been damaged during transport must not be put into operation!



*Inspection intervals in accordance with legal regulations applicable at the installation site are often related to the date of manufacture and are therefore not extended by the storage period before commissioning.*



*The warranty period also remains unaffected by storage prior to commissioning. It starts at the date of delivery.*

### 3. Installation

#### 3.1. Preparation for on-site installation

After removing the transport packaging, the following checks must be carried out in advance to the on-site installation:

- Inspection of the nameplate information and alignment with the operating conditions of the machine or application system for which the diaphragm accumulator is intended.
- Comparison of the name plate data with the details of the declaration of conformity.
- Visual inspection to exclude transport damage of the vessel, gas and oil port connections as well as any indication of corrosion or other surface damage.
- Await sufficient temperature compensation of the accumulator with the ambient conditions at the installation site.



**DANGER:** Before assembly, ensure that the hydraulic system is pressure free. Incorrect assembly may result in serious accidents.

#### 3.1 General arrangement and system integration

The installation location can be where desired. An installation space of 200 mm should be maintained above the gas port for a testing and filling device.

#### 3.3. Installation and fastening

The accumulator must be fixed such that it is securely held in place in the event of vibrations caused by operation or any break in the connection line and such that the accumulator will not be affected by any tensions.



## 4. Commissioning

### 4.1. Gas pre-charge pressure

Accumulators are generally supplied ready for operation. The pre-charge pressure ( $P_0$ ) is specified on the accumulators housing. Before Commissioning, the pre-charge pressure must be checked by the operator and the accumulator is to be filled, if necessary.

### 4.2. Fill Gas

Accumulators must be filled only with nitrogen class 4.0, i.e.  $N_2$  99.99 vol. %. The pre-charge pressure should be chosen between 0,9...0,95 of the lower operating pressure ( $P_1$ ) at operating temperature and below 130 bar. Furthermore, the ratio of gas pre-charge pressure and upper operating pressure ( $P_0:P_2$ ) should not be higher than 1:6...1:8.



*The pre-charge pressure changes with the gas temperature. The pre-charge pressure  $P_0$  indicated on the nameplate, on drawings or in other documents applies to nitrogen with a gas temperature of 20°C. After filling or draining nitrogen, the actual pressure can only be correctly adjusted to its specified value after a sufficient temperature compensation period.*

### 4.3. Max. operating temperature

Freudenberg accumulators are suitable for operating temperatures of between -10°C and 80°C. Please enquire for other temperatures. When used with more suitable diaphragm and vessel materials there are variant temperature ranges e.g. -40°C to +80°C possible.

### 4.4. Testing prior to operation

Both testing prior to operation and recurring tests are to be carried out in accordance with national regulations. All lines and connections are to be particularly checked for functionality and replaced in the case of a fault.

### 4.5. Filling of refillable accumulators

A filling and testing device must be used for filling the accumulator. Observe the filling device operating instructions. Freudenberg supplies suitable filling and testing devices.



The pre-charge pressure changes with the gas temperature. After filling or releasing nitrogen, it is necessary to wait until the temperature has levelled before checking the gas pressure.



**CAUTION:** Maintenance and repair of the accumulator may only be carried out by a trained specialist.

## 5. Maintenance

Freudenberg diaphragm accumulators are almost maintenance-free after commissioning. To avoid malfunctions and to ensure a long service life, the following service checks must be carried out at regular intervals:

- Pre-charge pressure check and refilling if necessary
- Visual inspection for outer corrosion
- Check line connection and fittings for possible leaks
- Check safety device for condition and proper function

### 5.1. Inspection intervals

Freudenberg recommends the following inspection intervals:

|                                                        |                                |
|--------------------------------------------------------|--------------------------------|
| Initial inspection after (re-)commissioning            | After one week of operation    |
| Second inspection after initial one without objections | After 2 - 3 month of operation |
| Regular inspections if no abnormal leakages were found | Annually                       |

 *Regardless of the requirements of this document, recurring inspections must be carried out in accordance with nationally applicable regulations.*

### 5.2 Checking the pre-charge pressure

Checking the nitrogen pre-charge pressure and comparing the actual and set value allows conclusions to be drawn about the condition of the diaphragm as well as a monitoring of the gas losses due to permeation over the operating time. Freudenberg offer suitable filling devices.

The procedure is explained in the respective operating instructions.

After testing we recommend an inspection of the seal tightness of the charging valve (e.g. with leak detection spray) and if necessary, a replacement of the USIT-Ring.

### 5.3 Checking on the fluid side

Connect the pressure gauge to the accumulator via the line. Alternatively, the pressure gauge can be connected directly to the ventilation connection.

Procedure:

1. Pour the pressure fluid into the accumulator
2. Close the shut off device
3. Allow the pressure fluid to run off slowly (temperature levelling), by opening the release valve
4. Watch the pressure gauge during the emptying procedure. As soon as the fill pressure in the accumulator is reached, the indicator drops sharply to zero.

If deviations are being measured, the following should also be checked:

- Can these be traced back to varying ambient or gas temperatures?
- Are pipelines and fittings sealed

Further checking of the accumulator is only necessary once these fault causes are eliminated.

## 6. Service life

The service life limit of diaphragm accumulators, in particular the limit of the accumulator vessel, depends on the number of load cycles and the related operating pressure range.

The max. allowable pressure range for the diaphragm accumulator assembly can be taken from chapter 1.2.

Diaphragm accumulators, i.e. their pressure containing parts are fatigue-resistant if maintenance instructions are observed and if they are operated within the permissible limit values.

## 7. Disposal

Hydro accumulators as sealed hollow bodies are not allowed to be included unopened in scrap for smelting, as per German regulation BGV D23. It is therefore necessary to depressurize hydro accumulators on the gas side by carefully unscrewing gas filling screws or gas filling valves and opening the accumulator. Filling devices are also well suited to this task.



On special designs with a permanently sealed gas filling opening (non-repairable accumulators) carefully drilling of the gas chamber in a suitable retaining jig can be used. As the gas flowing out can draw metal splinters or particles with it, safety glasses must be worn.



**CAUTION:** Carefully drill the accumulator open, as the escaping gas might cause damage to hearing. Therefore, be advised to wear hearing protection.



**CAUTION:** Furthermore, please note the accumulator contains nitrogen which suppresses oxygen. Please make sure workplaces are ventilated sufficiently.