HYDAC ACCUMULATOR TECHNOLOGY
FLUID ENGINEERING EFFICIENCY VIA ENERGY MANAGEMENT.

HYDAC Accumulator Technology has over 50 years' experience in research & development, design and production of Hydac accumulators. Bladder, piston, diaphragm and metal bellows accumulators from HYDAC together form an unbeatable range and as components or units, support hydraulic systems in almost all sectors.

The main applications of our accumulators are:
- Energy storage,
- Emergency and safety functions,
- Damping of vibrations, fluctuations, pulsations (pulsation damper), shocks (shock absorber) and noise (silencer),
- Suction flow stabilisation,
- Media separation,
- Volume and leakage oil adjustment,
- Weight equalization,
- Energy recovery.

Using accumulators improves the performance of the whole system and in detail this has the following benefits:
- Improvement in the functions
- Increase in service life
- Reduction in operating and maintenance costs
- Reduction in pulsations and noise

On the one hand, this means greater safety and comfort for operator and machine.
On the other hand, HYDAC accumulators enable efficient working in all applications.

Basic criteria, such as:
- Design pressure,
- Design temperature,
- Fluid displacement volume,
- Discharge / Charging velocity,
- Fluid,
- Acceptance specifications and also
- Installation options
are important parameters required for sizing the correct accumulator.
In addition the knowledge developed by our accumulator specialists will help to select the right type of accumulator. The comprehensive range of HYDAC accessories simplifies installation and maintenance according to the specification.

2. QUALITY

Quality, safety and reliability are paramount for all HYDAC accumulator components. They comply with the current regulations (or standards) for pressure vessels in the individual countries of installation.
In taking delivery of a HYDAC hydraulic accumulator therefore, the customer is assured of a high-quality accumulator product which can be used in every country in the world, depending on the certification.
For more details, please turn to Section 4.

All the processes involved, from development, engineering and production to approval and delivery are defined by HYDAC's certified management system and the relevant international accreditation for the manufacture of pressure vessels.

In conjunction with the customer service department at HYDAC's headquarters, service is possible worldwide. HYDAC's worldwide distributor network means that trained staff are close at hand to help our customers.

This ensures that HYDAC customers have the support of an experienced workforce both before and after sale.
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3. SAFETY INFORMATION

Hydraulic accumulators are pressure vessels as defined in the Pressure Equipment Directive 97/23/EC. They are closed vessels which are designed and built to store pressurised fluids. Hydraulic accumulators are charged with nitrogen which is separated from the fluid section by a piston, bladder or diaphragm. Hydraulic accumulators are specifically designed to store and then discharge pressurized fluids.

The regulations for commissioning and operating hydraulic accumulators which are in force at the place of installation must be observed. The plant operator is solely responsible for ensuring compliance with these regulations.

Relevant instructions are provided in the Operating Manuals for our products.

As regards production and placing on the market, HYDAC has carried out a comprehensive risk assessment.

Similarly the manufacturer of products utilizing hydraulic accumulators must proceed accordingly (see Pressure Equipment Directive 97/23/EC) and the following principles must be adhered to and in this order of priority:

- Removal or reduction of risks, insofar as this is reasonably possible,
- Application of appropriate protective measures against risks which cannot be eliminated;
- If required, training of the users on the residual risks and instructions on appropriate special measures for reducing the risks during installation and/or operation.

For safe handling and operation, the operator must draw up a risk assessment for the installation site, particularly in combination with other components and risks.

The resulting measures must be implemented accordingly.

In the case of fundamental risks affecting hydraulic accumulators, e.g.

- Excessive pressure and
- Increase in temperature (in the event of fire)

we already have the relevant products available.

On no account must any welding, soldering or mechanical work be carried out on the accumulator shell. After the hydraulic line has been connected it must be completely vented. Work on systems with hydraulic accumulators (repairs, connecting pressure gauges etc) must only be carried out once the pressure and the fluid have been released.

3.1. RISK OF EXCESSIVE PRESSURE

Products:

Safety and shut-off block for the fluid side in various sizes and versions.

See catalogue section:

- Safety and Shut-off Block SAF/DSV No. 3.551
- Gas safety valve and gas safety block for the gas side
- Bursting discs for gas and fluid sides

See catalogue section:

- Safety Equipment for Hydraulic Accumulators No. 3.552

3.2. RISK OF RISE IN TEMPERATURE

Products:

Safety and Shut-off Block with solenoid-operated valve (open when de-energised) in conjunction with temperature monitoring.

See catalogue section:

- Safety and shut-off block SAF/DSV No. 3.551 or on request

Temperature fuses

See catalogue section:

- Safety Equipment for Hydraulic Accumulators No. 3.552
4. REGULATIONS

4.1. PED

On 29 November 1999 the Directive 97/23/EC (Pressure Equipment Directive) came into force and since 29 May 2002 has been exclusively binding in Europe. This directive applies to the design, manufacture, conformity assessment and placing on the market of pressure equipment and assemblies with a maximum permitted pressure of over 0.5 bar. It guarantees the free movement of goods within the European Community. EU member states must not prohibit, restrict or obstruct the placing on the market and the commissioning of pressure equipment on account of pressure-related hazards, if the equipment complies with the requirements of the pressure equipment directive and has the CE mark, and is subject to a conformity assessment.

Hydraulic accumulators with a capacity of \( V \leq 1 \) litre, a maximum permitted pressure \( P_S \leq 1000 \) bar or a pressure capacity \( P_S \cdot V \leq 50 \) bar \( \cdot \) 1 for gases of fluid group 2 (non-hazardous fluids) are subject to Article 3, Paragraph 3 of the European Pressure Equipment Directive and do not receive the CE mark.

Inspection of the equipment and installation, operational safety and repeat testing are controlled as before by national laws.

The equipment relating to safety is described in AD2000, ISO 4126 and EN 14359.

The repeat testing intervals are stipulated in the new German health & safety regulations.

4.2. OTHER REGULATIONS

Pressure accumulators which are installed overseas (outside the EU), are supplied with the relevant test certificates required in the country of installation.

HYDAC pressure vessels can be supplied with virtually any test certificate.

Depending on the authority, the different material requirements must be observed.

Details of some selected approvals are as follows:

4.2.1 CERTIFICATE CODE = S (ASME)

HYDAC Technology GmbH has had authorization since 1985 to use the Certification Mark "ASME" on pressure vessels which have been manufactured in conformity with the ASME specifications and to market these using the "NB" symbol, in the jurisdiction (area of application) of "The National Board of Boiler and Pressure Vessel Inspectors".

4.2.2 CERTIFICATE CODE = P

(KHK certificate)

For the Japanese market, HYDAC Technology GmbH has had approval as a "Self Inspecting Manufacturer" since the year 2000. Consequently, HYDAC is authorized to manufacture and test pressure vessels for the Japanese market and to import them into Japan.

4.2.3 CERTIFICATE CODE = A9

(MANUFACTURER LICENSING CHINA)

Since 1998 HYDAC Technology GmbH has had approval from the Chinese authority “SELO” as a manufacturer of pressure vessels and valves. HYDAC is therefore authorized to import welded bladder, piston and diaphragm accumulators, and safety valves, into the Chinese market.

4.2.4 CERTIFICATE CODE = A11

(KGS Code)

Since concluding the registration procedure in 2012 HYDAC Technology GmbH is authorized to supply pressure vessels and safety equipment according to the Korean Gas Safety (KGS) Code for Korea.

4.3. CERTIFICATE TABLE

The following table lists the codes recommended for use in the model code for different countries of installation.

The country of installation must be stated at the time of ordering (see code in Model Code for the particular product: Certificate Code).

For those countries not listed, please consult HYDAC. Alternative certificates and variations are also possible. Please consult HYDAC.

<table>
<thead>
<tr>
<th>European member states</th>
<th>Certificate code (AKZ)</th>
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<tbody>
<tr>
<td>AT Austria</td>
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<td>BE Belgium</td>
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<td>BG Bulgaria</td>
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<td>CY Cyprus</td>
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<td>CZ Czech Republic</td>
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<td>DE Germany</td>
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<td>DK Denmark</td>
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<td>EE Estonia</td>
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Rest of the world

<table>
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<th>Certificate code (AKZ)</th>
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<td>AU Australia</td>
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<td>BY Belarus</td>
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<td>CE Canada</td>
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<td>CH Switzerland</td>
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<tr>
<td>CN China</td>
</tr>
<tr>
<td>HK Hong Kong</td>
</tr>
<tr>
<td>IS Iceland</td>
</tr>
<tr>
<td>JP Japan</td>
</tr>
<tr>
<td>KR Korea (Republic)</td>
</tr>
<tr>
<td>NO Norway</td>
</tr>
<tr>
<td>NZ New Zealand</td>
</tr>
<tr>
<td>RU Russia</td>
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<td>TR Turkey</td>
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<td>UA Ukraine</td>
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<td>US USA</td>
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<td>ZA South Africa</td>
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1) Registration required in the individual territories or provinces others on request

4.4. TRANSPORT REGULATIONS FOR PRESSURE VESSELS

The transport of gas-filled accumulators must be carried out with the utmost care and in compliance with all relevant transport safety regulations (e.g. in the public domain, dangerous goods regulations, etc.).
5. PRODUCT OVERVIEW
The following overview shows the standard product range of HYDAC hydraulic accumulators. For other models and sizes please ask.

5.1. BLADDER ACCUMULATORS

5.1.1 Low Pressure
Permitted operating pressure: up to 40 bar
Nominal volume: 2.5 ... 450 l

Benefits of HYDAC bladder accumulators:
- high discharge velocities,
- no pressure differential between fluid side and gas side,
- compact, low-maintenance,
- high charge and discharge frequencies.

5.1.2 Standard
Permitted operating pressure: up to 550 bar
Nominal volume: 0.5 ... 200 l

5.1.3 High pressure
Permitted operating pressure: up to 1000 bar
Nominal volume: 1 ... 54 l

5.2. PISTON ACCUMULATORS

5.2.1 Standard
Permitted operating pressure: 210 ... 350 bar
Nominal volume: up to 3300 l

Benefits of HYDAC piston accumulators:
- minimal pressure differential between fluid side and gas side,
- large effective volume,
- variable installation position,
- monitoring of the piston position possible using a variety of systems,
- particularly suitable for back-up configurations,
- extreme flow rates,
- no sudden discharge of gas when seals are worn.

5.2.2 Series SK280
Permitted operating pressure: 280 bar
Nominal volume: 0.16 ... 6 l

5.2.3 High pressure
Permitted operating pressure: up to 1000 bar
Nominal volume: up to 50 l

5.3. DIAPHRAGM ACCUMULATORS

5.3.1 Diaphragm accumulators
Weld and screw type
Permitted operating pressure: up to 750 bar
Nominal volume: up to 4 l

Benefits of HYDAC diaphragm accumulators:
- function-optimized and weight-optimized design,
- unlimited choice of installation positions,
- no pressure differential between fluid side and gas side,
- low-maintenance and long service life.
5.4. METAL BELLOWS ACCUMULATORS

5.4.1 Metal bellows accumulator
Please contact us

Benefits of the HYDAC metal bellows accumulator:
- durable
- wear-free
- media resistant over a wide range of temperatures
See also flyer
- "Heavy Diesel Engines - Metal Bellows Accumulators"
  No. 10.129.1

5.5. HYDRAULIC DAMPERS

5.5.1 Dampers
Permitted operating pressure: 10 ... 1000 bar
Nominal volume: 0.075 ... 450 l

Advantages of the HYDAC hydraulic damper:
- reduces pressure pulsations,
- improves the suction performance of displacement pumps,
- prevents pipe breaks and damage to valves,
- protects measuring equipment and its function in a system,
- reduces noise level in hydraulic systems,
- reduces maintenance and servicing costs and
- extends service life of the system.

5.5.2 SILENCER
Permitted operating pressure: 330 bar

5.6. SPECIAL ACCUMULATORS

5.6.1 Weight reduced hydraulic accumulators
Over 80% reduction in weight compared to equivalent carbon steel accumulators.
The choice ranges from weight-optimized accumulators, e.g. by using aluminium, through to light-weight and ultra light-weight accumulators.

5.6.2 Spring accumulators
are equipped with a spring.
The energy is produced by the spring force, instead of gas.
Further information on request.

See also flyer
- "Weight-reduced accumulators"
  No. 3.305

5.7. ACCUMULATOR STATIONS

HYDAC supplies fully assembled piston accumulator stations which are ready for operation, complete with all the necessary valve controls, ball valves and safety equipment
- as an individual accumulator unit or
- in a back-up version with nitrogen bottles to increase the effective volume.
5.8. ACCUMULATOR ACCESSORIES

5.8.1 Hydraulic accumulators with back-up nitrogen bottles
HYDAC also offers nitrogen bottles which can be used to back up bladder and piston accumulators. Nitrogen bottles used as back-ups increase the gas volume in the accumulator.

Using HYDAC nitrogen bottles provides the following benefits:
- cost-effective increase in the accumulator volume and as a result
- smaller accumulators for the same gas volume.

5.8.2 Universal charging and testing unit FPU-1
Charging hose, pressure gauge and pressure reducer for HYDAC and other brands of accumulator, up to 350 bar.
(Higher pressures on request)

Benefits of the HYDAC Safety and Shut-off Block:
- minimum of space and maintenance required,
- minimum of pipework (1 SAF replaces up to 10 individual pipe connections, as a rule),
- considerable reduction in installation time,
- can be adapted to different types and also different brands of accumulator, and
- additional valves (pilot-operated check valves, flow control valves, etc).

5.8.3 Safety and shut-off block SAF/DSV
Nominal size: 10 ... 50
Permitted operating pressure: 400 bar
 Fluid side protection, pressure relief valve, venting to tank and separation of the accumulator from the fluid side system.

5.8.4 Safety equipment
- Gas safety valve GSV6
- Temperature fuse
- Bursting disc
- Gas safety block as safety equipment for HYDAC accumulator products.
Approval according to Pressure Equipment Directive PED and CE mark.

Benefits of the HYDAC Gas Safety Block:
- A gas safety block simplifies the operation of the hydraulic accumulator on the gas-side and also offers the possibility of installing the above safety equipment using the various ports.

5.8.5 Supports for hydraulic accumulators
Accumulator sets, clamps and consoles for efficient mounting of hydraulic accumulators.

5.8.6 ACCUSET SB
Permitted operating pressure: 330 bar
Nominal volume: 1 ... 50 l
6. INDUSTRIES AND APPLICATIONS

HYDAC Technology GmbH is represented in almost all industries of the world which use hydraulic accumulators. The main sectors are industrial hydraulics, mobile technology and process technology. Further applications in oil & gas/offshore as well as more energy efficient systems utilizing accumulators are gaining in importance.

Listed below is a selection of examples with accumulators/dampers which are typical for these industries:

6.1. INDUSTRIAL HYDRAULICS

Automotive industry
- General industrial hydraulics, e.g. energy storage

Mining machinery
- Hydraulic accumulators, e.g. in suspended monorails
- Pulsation damping
- Comfort and safety for mobile working machines

Iron and steel industry
- Accumulator to maintain the pressure in rolling mills
- Blast furnace hydraulics

Plastics machinery
- Accumulator stations for energy storage during the injection moulding process
- Pulsation damping on the hydraulic drive

Paper industry
- Energy storage for emergency functions in friction bearing hydraulics
- Energy storage in high/low pressure power units

Test rigs and test systems
- Energy storage on crash test systems
- Pulsation damping on servo hydraulic axes

Thermal power plants
- Emergency supply for turbine control system
- Pulsation damping on pumps
- Lubrication, control and seal oil supply

Forming machines
- Accumulators used to store energy to support the pump

Machine tools
- Support for the hydraulics for tool drive or tool change
- Energy storage in the compact hydraulics of machining centres

Wind turbines
- Accumulators in the pitch control system
- Support of the pitch drive
- Accumulators on braking units
6.2. MOBILE TECHNOLOGY

Automotive technology
- Automatic and manual transmission
- Automatic clutch systems
- Engine management systems
- Accumulators for turbocharger emergency lubrication

Construction Machinery
- Accumulators in braking systems
- Chassis damping
- Bucket damping
- Boom damping on mobile cranes

Agricultural and forestry machines
- Front loader damping
- Accumulators in tractor suspension systems
- Stone strike protection for ploughs
- Boom suspension on field sprayers

Municipal machines
- Energy storage
- Boom damping
- Pulsation dampers
- Chassis damping

Lifting and material handling
- Noise damping
- Energy recovery
- Braking systems

Shipping
- Water treatment plants (pump support)
- Pulsation damping on diesel engines
- Heave compensation (cranes)
- Emergency function for lifeboats

6.3. PROCESS TECHNOLOGY

Chemical industry
- Energy storage and pulsation damping on dosing pumps
- Suction flow stabilisation on the suction side of pumps

Loading stations / Refineries
- Shock absorption for valve closing
- Pulsation damping on pipelines

Offshore / Oil & Gas
- Accumulators to support valve closing systems
- Energy storage for deep sea rams
- Blow Out Preventers (BOP)
- Emergency function for safety systems
- Accumulators on wellhead control systems

Pipeline construction
- Energy storage for emergency actuation of valve stations
- Compressor stations

7. WEBSITE

Please visit us at the following address:

In addition to Industries, Service and Fluid Engineering, under Products » Hydraulic Accumulators, you will find the standard product range and the comprehensive range of accessories from HYDAC TECHNOLOGY GmbH.

Under Downloads you will find this product catalogue in different languages in PDF format as well as other information on HYDAC accumulator products.

You can find the required product via the product search tab and download the relevant CAD model.

The web version of ASPlight facilitates quick and simple input, calculation and evaluation of the required accumulator parameters. For further information on ASPlight see Section 9.4.

8. SPECIFICATION FORMS

Our aim is to provide optimal customer service both before and after purchasing the accumulator.

The following specification forms are designed to help pre-select the required accumulator/damper or accessories.

You can also download these as a pdf document from the intranet and the HYDAC website (www.hydac.com/ Hydraulic accumulators) under the Downloads tab. You can then complete them at your convenience on your PC and send them to your HYDAC contact, e.g. by e-mail.

The areas highlighted in green constitute the minimum information required for a response or calculation.
GENERAL ACCUMULATOR SPECIFICATION FORM (Page 1/2)
(Subject to technical modifications)

Company: 
Project name: 

Name, First name: 
Application: 

E-mail: 
Requirement: 

Telephone no.: 
as □ spare part □ original equipment

Note: Calculation of the appropriate accumulator is possible using the HYDAC Accumulator Simulation Program ASP. Download from www.hydac.com.

Type of accumulator □ Bladder accumulator □ Piston accumulator □ Diaphragm accumulator □

Fluids/medium
Fluid: 
Viscosity at 20 °C: cSt
Density: kg/m³ 
Viscosity at operating temperature: cSt

Functioning of the pump □ Continuous operation □ Intermittent operation

Accumulator data
Max. operating pressure: bar
Min. operating pressure: bar
Pre-charge pressure at 20 °C (nitrogen): bar
(See catalogue section: No. 3.000, Sizing)
Ambient temperature: °C
Operating temperature: °C
Complete cycle time: s

Fluid demand time schedule for ONE pump and ONE consumer:
Accumulator discharge rate: l/min
Accumulator discharge time: s
Flow rate of the pump: l/min
Pump runs continuously: □
Pump starts after discharge: □

Additional details on the accumulator
Industry: 
Country of installation: 
Design/Certification: 
Specification: 

Materials*
Accumulator shell: 
Fluid connection: 
Elastomer: 

Additional information
Installation dimensions: mm
(height x Ø ext.)
Fluid connection: Type: 
for thread □ internal □ external
Standard: 
Gas connection:
Coating/finish: □ internal □ external

Spare parts/Accessories: see www.hydac.com under Products/Accumulators

* dependent on operating temperature and/or fluid resistance

Remarks:

Date: ______________ Signature: ____________________
Fluid demand diagram for several pumps and/or consumers

Designation / Example:
Q = Consumer flow rate [l/s]
EV = Switch-on time of consumer [s]
AV = Switch-off time of consumer [s]
EP = Switch-on time of pump [s]
AP = Switch-off time of pump [s]

Please indicate cycle data below

Number of consumers: 
QV1 = E V1 = AV1 = 
QV2 = EV2 = AV2 = 
QV3 = EV3 = AV3 = 
QV4 = EV4 = AV4 = 

Number of pumps: 
P1 = EP1 = AP1 = 
P2 = EP2 = AP2 = 
P3 = EP3 = AP3 = 
P4 = EP4 = AP4 = 

Q [l/s] 
Time [s]
SHOCK ABSORBER SPECIFICATION FORM (Page 1/2)

Company: 
Name, First name: 
E-mail: 
Telephone no.: 
Project name: 
Application: 
Requirement: 

Note: The appropriate accumulator can be calculated using the HYDAC Accumulator Simulation Program ASP. Download from www.hydac.com.

Type of accumulator: □ Bladder accumulator □ Piston accumulator □ Diaphragm accumulator □

Causes of the pressure shock:
□ When pump starts □ When pump switches off
□ When check valve flap (valve) closes

Fluids/media
Fluid 1): 
Density: kg/m³

Accumulator data
Max. operating pressure: bar
Min. operating pressure: bar
Pre-charge pressure at 20 °C (nitrogen): bar
(See catalogue section: No. 3.000, Sizing)
Ambient temperature: °C
Operating temperature: °C

Fluid connection: Type:
for thread □ internal □ external

Pipeline data for A SINGLE pipe
Length: m
Diameter (internal): mm
Wall thickness: mm
Material of line:
Max. permitted pressure in the line: bar
Total closing time of the valve: s
Speed of sound in the system: m/s

Alternatively:
Pipeline data for ADDITIONAL sections of pipe (see Page 2)

Pump data
Zero head: m
Pressure of the pump at the operating point: bar
Flow rate of the pump at the operating point: l/min

Materials* 
Accumulator shell:
Fluid connection:
Elastomer:

Additional information on the accumulator/system:
Available installation space: m (L x W x H)
Industry:
Country of installation:
Design/Certification:
Specification:

Remarks:

Date: __________________________ Signature: __________________________

1) please send datasheet
* dependent on operating temperature and/or fluid resistance

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Industriegebiet
66280 Sulzbach/Saar, Germany
Tel.: +49 (0) 68 97 / 509 - 01
Fax: +49 (0) 68 97 / 509 - 464
Internet: www.hydac.com

Pipeline data for additional sections of pipe

Designation / Example

H = Zero head of the pump [m]
Di = Internal diameter of the pipe [mm]
T = Closing time of the valve [sec]
(Effectively approx. 30% of the total closing time)
L = Length of the pipeline [m]

Typical values for speed of sound
Water = 1200 m/s
Fuel = 1100 m/s

Please complete below with the pipeline data

Number of different pipes: ________

<table>
<thead>
<tr>
<th>L1</th>
<th>Di1</th>
<th>L2</th>
<th>Di2</th>
<th>L3</th>
<th>Di3</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>100</td>
<td>50</td>
<td>200</td>
<td>20</td>
<td>500</td>
</tr>
</tbody>
</table>

Number of different pipes: ________

<table>
<thead>
<tr>
<th>L1</th>
<th>Di1</th>
<th>L2</th>
<th>Di2</th>
<th>L3</th>
<th>Di3</th>
<th>L4</th>
<th>Di4</th>
<th>L5</th>
<th>Di5</th>
<th>L6</th>
<th>Di6</th>
<th>L7</th>
<th>Di7</th>
<th>L8</th>
<th>Di8</th>
</tr>
</thead>
<tbody>
<tr>
<td>______</td>
<td></td>
<td>______</td>
<td></td>
<td>______</td>
<td></td>
<td>______</td>
<td></td>
<td>______</td>
<td></td>
<td>______</td>
<td></td>
<td>______</td>
<td></td>
<td>______</td>
<td></td>
</tr>
</tbody>
</table>
PULSATION DAMPER SPECIFICATION FORM
(Subject to technical modifications)

Company: __________________________ Project name: __________________________
Name, First name: __________________________ Application: __________________________
E-mail: __________________________ Requirement: __________________________ pieces/year
Telephone no.: __________________________ as □ spare part □ original equipment

Note:
The appropriate pulsation damper can be calculated using the HYDAC Accumulator Simulation Program ASP.

Type of accumulator
□ Bladder accumulator □ Piston accumulator □ Diaphragm accumulator □ ______

Fluids/medium
Fluid: __________________________ Density: __________________________ kg/m³
Viscosity at 20 °C: __________________________ cSt
Viscosity at operating temperature: __________________________ cSt

Pump and system data
Oper. press./pump pressure: __________________________ bar
Flow rate: __________________________ l/min
Speed: __________________________ 1/min
Number of displacements: __________________________ □ single □ double acting
Pump factor: __________________________ optional (if available)
Stroke volume: __________________________ 1 dm³

Vₜ = \frac{d^2 \pi}{4} \times H \times 10^6

\text{for piston pumps:}
\begin{align*}
\text{d} &= \text{Ø piston:} \quad \text{mm} \\
\text{H} &= \text{stroke length:} \quad \text{mm}
\end{align*}

\text{for diaphragm pumps: see manufacturer’s specifications}

Additional details on the accumulator
Industry: __________________________
Country of installation: __________________________
Design/Certification: __________________________
Specification: __________________________
Design pressure: __________________________ bar
Design temperature: __________________________ °C

Materials*
Accumulator shell
Fluid: __________________________
Viscosity at operating temperature: __________________________ cSt
Density: __________________________ kg/m³

Pump factor: __________________________
Flow rate: __________________________ l/min
Speed: __________________________ 1/min
Number of displacements: __________________________ □ single □ double acting

Additional information
Installation dimensions: __________________________ mm
(Height x \text{Ø})

Fluid connection: __________________________
Type: __________________________
for thread □ internal □ external

Gas connection: __________________________
□ internal □ external

Coating/finish: __________________________
□ internal □ external

Spare parts/Accessories: see www.hydac.com under Products/Accumulators

Remarks:
______________________________

Date: __________________________ Signature: __________________________

\* dependent on operating temperature and/or fluid resistance

\[1\) see catalogue section: No. 3.000, Sizing

\[2\) normally pre-charged with nitrogen (N₂)
SILENCER SPECIFICATION FORM

(Subject to technical modifications)

Company: ___________________________  Project name: ___________________________
Name, First name: ____________________  Application: ___________________________
E-mail: ______________________________  Requirement: ___________________________
Telephone no.: ________________________  pieces/year

Company: ___________________________  Project name: ___________________________
Name, First name: ____________________  Application: ___________________________
E-mail: ______________________________  Requirement: ___________________________
Telephone no.: ________________________  as ☐ spare part ☐ original equipment

Sizing example:

Pump: A10VSO71  Design pressure: 210 bar  Silencer inlet: SAE 1 1/4" 3000 psi
Pump rpm: 1500 1/min  No. of pump pistons: 9  Silencer outlet: SAE 1 1/4" 3000 psi
Fluid: Aral Vitam GF  Fluid density: 890 kg/m³  Design temperature: 50 °C

Element no. | Length [m] | Ø int. [m] | Ø ext. [m] | Subsequent connection type | Hose type
--- | --- | --- | --- | --- | ---
E1 | 0.5 | 0.020 | 0.030 | Straight connection | –
E2 | 0.4 | – | 0.200 | Straight connection | –
E3 | 1.5 | 0.025 | 0.040 | T-junction | 4SP (DIN EN 856)
E4 | 0.6 | 0.015 | 0.025 | Pressure relief valve | –
E5 | 0.2 | 0.015 | 0.025 | Right-angle | –
E6 | 0.6 | 0.015 | 0.025 | Shut-off valve | –

Please enter design data here:

Pump: ___________________________  Design pressure: __________ bar  Silencer inlet: ___________________________
Pump rpm: ______ 1/min  No. of pump pistons: ______ Silencer outlet: ___________________________
Fluid: ___________________________  Fluid density: __________ kg/m³  Design temperature: ______ °C

Element no. | Length [m] | Ø int. [m] | Ø ext. [m] | Subsequent connection type | Hose type
--- | --- | --- | --- | --- | ---
E1  |  |  |  |  | 
E2  |  |  |  |  | 
E3  |  |  |  |  | 
E4  |  |  |  |  | 
E5  |  |  |  |  | 
E6  |  |  |  |  | 
E7  |  |  |  |  | 
E8  |  |  |  |  | 
E9  |  |  |  |  | 
E10 |  |  |  |  | 
E11 |  |  |  |  | 
E12 |  |  |  |  | 

Remarks: ___________________________

Date: ___________________________  Signature: ___________________________
# METAL BELLOWS ACCUMULATOR SPECIFICATION FORM FOR HEAVY DIESEL ENGINES

(Subject to technical modifications)

<table>
<thead>
<tr>
<th>Company:</th>
<th>Project name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name, First name:</td>
<td>Application:</td>
</tr>
<tr>
<td>E-mail:</td>
<td>Requirement: pieces/year</td>
</tr>
<tr>
<td>Telephone no.:</td>
<td>as □ spare part □ original equipment</td>
</tr>
</tbody>
</table>

**Note:**
The appropriate pulsation damper can be calculated using the HYDAC Accumulator Simulation Program ASP. Download from www.hydac.com.

## Engine data

<table>
<thead>
<tr>
<th>Manufacturer:</th>
<th>max. &quot;spill volume&quot; of the high pressure injection pumps: ccm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>max. flow of the supply line: l/min</td>
</tr>
<tr>
<td>Design:</td>
<td>max. flow of the tank line: l/min</td>
</tr>
<tr>
<td>Fuel:</td>
<td></td>
</tr>
</tbody>
</table>

## Operating conditions of the supply line:

<table>
<thead>
<tr>
<th>Proportion of operation</th>
<th>min. / max. speed</th>
<th>P&lt;sub&gt;max&lt;/sub&gt; at T&lt;sub&gt;min&lt;/sub&gt; p&lt;sub&gt;min&lt;/sub&gt; at T&lt;sub&gt;max&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine start</td>
<td>/ 1/min</td>
<td>bar °C</td>
</tr>
<tr>
<td>Main operation</td>
<td>% 1/min</td>
<td>bar °C °C bar °C °C</td>
</tr>
<tr>
<td>Auxiliary operation</td>
<td>% 1/min</td>
<td>bar °C °C bar °C °C</td>
</tr>
</tbody>
</table>

## Operating conditions of the tank line:

<table>
<thead>
<tr>
<th>Proportion of operation</th>
<th>min. / max. speed</th>
<th>P&lt;sub&gt;max&lt;/sub&gt; at T&lt;sub&gt;min&lt;/sub&gt; p&lt;sub&gt;min&lt;/sub&gt; at T&lt;sub&gt;max&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine start</td>
<td>/ 1/min</td>
<td>bar °C</td>
</tr>
<tr>
<td>Main operation</td>
<td>% 1/min</td>
<td>bar °C °C bar °C °C</td>
</tr>
<tr>
<td>Auxiliary operation</td>
<td>% 1/min</td>
<td>bar °C °C bar °C °C</td>
</tr>
</tbody>
</table>

## Additional information on the accumulator/system

<table>
<thead>
<tr>
<th>Available installation space: (L x W x H)</th>
<th>Industry:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation vertical: yes no</td>
<td>Country of installation:</td>
</tr>
<tr>
<td>(accumulator gas valve at top)</td>
<td>Design/Certification:</td>
</tr>
<tr>
<td>If no, specify position:</td>
<td>or</td>
</tr>
<tr>
<td>Material: Carbon steel Stainless steel</td>
<td>Ship's name (IMO):</td>
</tr>
<tr>
<td>Finish requirement: HYDAC Standard (RAL 7035)</td>
<td>Ship classification:</td>
</tr>
<tr>
<td>Gas and fluid connection: see flyer &quot;Heavy Diesel Engines - Metal Bellows Accumulators&quot; No. 10.129.1</td>
<td>Spare parts/Accessories: see <a href="http://www.hydac.com">www.hydac.com</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Remarks:</th>
<th></th>
</tr>
</thead>
</table>

| Date: | Signature: |
### 9. SIZING

#### 9.1. DEFINITION OF VARIABLES FOR SIZING A HYDRAULIC ACCUMULATOR

<table>
<thead>
<tr>
<th>Function principle</th>
<th>Limits for the gas pre-charge pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bladder accumulator</strong></td>
<td></td>
</tr>
<tr>
<td>$p_0 \leq 0.9 \cdot p_1$ with a permitted pressure ratio of $p_2 : p_0 \leq 4 : 1$</td>
<td></td>
</tr>
<tr>
<td>For HYDAC low pressure accumulators, the following must also be taken into account: Type SB40: $P_{0,\text{max}} = 20$ bar Type SB35H: $P_{0,\text{max}} = 10$ bar</td>
<td></td>
</tr>
</tbody>
</table>

| **Piston accumulators** | |
| $p_{0,\text{min}} \geq 2$ bar (piston type 2) $p_{0,\text{min}} \geq 10$ bar (piston type 1) $p_{0,\text{min}} \leq p_1 - 5$ bar |
| In extreme cases, during slow charging (isothermal) and rapid discharge (adiabatic) of the effective volume, and after accurate calculation, the gas pre-charge pressure $p_0 \geq p_1$ can be selected. Accumulator supplied uncharged or with 2 bar storage pressure. |

| **Diaphragm accumulator** | a) Permitted pressure ratio: $p_2 : p_0$ |
| Weld type: The pressure ratio of weld-type diaphragm accumulators is between 4 : 1 and 8 : 1, depending on the design, see catalogue Section Diaphragm Accumulators, No. 3.100, Point 3.1 |
| Screw type: All sizes: 10 : 1 Other pressure ratios on request |
| b) $p_0 \leq 0.9 \cdot p_1$ |

| **Metal bellows accumulators** | a) Metal bellows accumulator with convoluted bellows: The max. permitted or optimal pre-charge pressure of a metal bellows accumulator with convoluted bellows must be determined for each application by providing the particular operating conditions and in consultation with HYDAC (see "Metal Bellows Accumulator Specification Sheet for Heavy Diesel Engines"). |
| b) Metal bellows accumulator with diaphragm bellows: $p_0 \leq 0.9 \cdot p_1$, $p_2 : p_0 \geq 20 : 1$ at $t_{\text{min}}$ The required pressure ratio must be indicated when ordering. |

1. The accumulator is pre-charged with nitrogen. The separating element (piston, bladder, diaphragm, corrugated bellows) shuts off the fluid connection.
2. The minimum operating pressure should be higher than the gas pre-charge pressure. This should prevent the separating element from striking the fluid connection every time fluid is discharged.
3. Once the max. operating pressure is reached, the effective volume $\Delta V$ is available in the accumulator:

\[
\begin{align*}
p_0 & = \text{pre-charge pressure} \\
p_1 & = \text{minimum operating pressure} \\
p_2 & = \text{maximum operating pressure} \\
V_e & = \text{effective gas volume} \\
V_1 & = \text{gas volume at } p_1 \\
V_2 & = \text{gas volume at } p_2 \\
t_0 & = \text{pre-charge temperature} \\
t_{\text{min}} & = \text{min. operating temperature} \\
t_{\text{max}} & = \text{max. operating temperature}
\end{align*}
\]
9.2. SELECTION OF GAS PRE-CHARGE PRESSURE

The selection of the pre-charge pressure defines the accumulator capacity. In order to obtain optimum utilization of the accumulator volume the following pre-charge pressures are recommended:

9.2.1 Recommended values for energy storage:

\[ p_{0, \text{max}} = 0.9 \cdot p_1 \]

for shock absorption:

\[ p_{0, \text{max}} = 0.6 \text{ to } 0.9 \cdot p_m \]
\[ (p_m = \text{average operating pressure for free flow}) \]

for pulsation damping:

\[ p_{0, \text{max}} = 0.6 \cdot p_m \]
\[ (p_m = \text{average operating pressure}) \]
\[ \text{or} \]
\[ p_{0, \text{max}} = 0.8 \cdot p_1 \]

During operation the separating element (piston, bladder, diaphragm, corrugated bellows) must not touch the fluid-side connection. Since the volume of the gas increases as the temperature increases, the pre-charge pressure must be determined at the maximum operating temperature using the recommended values.

9.2.2 Limits for gas pre-charge pressure

(see point 9.1.)

9.2.3 Temperature effect

So that the recommended pre-charge pressures can be maintained, even at relatively high operating temperatures, the \( p_{0, \text{charge}} \) for charging and testing cold accumulators must be selected as follows:

\[ p_{0, \text{charge}} = p_{0, \text{max}} \cdot \frac{t_{\text{charge}} + 273}{t_{\text{max}} + 273} \]

\( t_0 = \text{pre-charge temperature in } ^\circ \text{C} \)

To take the temperature effect into account when sizing accumulators, \( p_0 \) at \( t_0 \) must be selected as follows:

\[ p_{0, \text{min}} = p_{0, \text{max}} \cdot \frac{t_0 + 273}{t_{\text{max}} + 273} \]

9.3. ACCUMULATOR SIZING ON YOUR PC – ASP 5

When calculating the accumulator gas volume, the most important parameters are: pressure, volume and temperature. In the past these were used in complicated and unwieldy equations to calculate the required accumulator size. In 1997 by using program routines for real gas behaviours, HYDAC revolutionized the process of calculating and simulating hydraulic accumulators.

The ASP - Accumulator Simulation Program was launched. After years of experience, continuous improvement and the inclusion of new functions, ASP has developed into calculation software which enables the user, with great accuracy, to simulate the behaviour of accumulators.

ASP 5 has five elements:

- simulation, with the familiar advantages but in a completely new format and additional visualisations of the most important parameters,
- pressure shock damping, clearly arranged in one program window,
- pulsation damping, including corrected pump factors, also clearly presented in a program window.
- volume compensation and
- integration of the stand-alone, simplified software ASPlight.

Printing, export and saving of results has been improved. The current version is clear and convenient to use thanks to visualization of the simulation and the volume, pressure and temperature displays.

9.4. ACCUMULATOR CALCULATION SIMPLIFIED – ASPlight

Das ASPlight is an intelligent application which takes into account real gas behaviour. This simplified software from HYDAC Accumulator Technology enables you to calculate all the necessary parameters such as pressure, volume and temperature in different units for gases such as nitrogen or helium. The maximum input for pressure is 2500 bar. Additional information fields help to evaluate the result and to determine the type of accumulator.

ASPlight is aimed at the user who is tasked with determining the essential accumulator parameters within a short time. The software will be a particularly useful tool in your role as sales consultant in the field, by providing quick, straightforward calculations for hydraulic accumulators.

ASPlight is operated via a single window and is language neutral. The design is comparable to a pocket calculator. Simulation curves are not shown.

ASP 5 and ASPlight can be found on the Web at hydac.com, and can also be operated via smartphone.