1. HYDAC ACCUMULATOR TECHNOLOGY FLUID ENGINEERING EFFICIENCY THROUGH ENERGY MANAGEMENT.

HYDAC Accumulator Technology has over 45 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
- Mounting 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.

CONTENTS		Page	Catalogue section	Page
1.	**HYDAC ACCUMULATOR TECHNOLOGY**	2	**E 3.000**	**2**
2.	**QUALITY**	2		
3.	**SAFETY INFORMATION**	4		
4.	**REGULATIONS**	5		
5.	**PRODUCT OVERVIEW**	6 – 8		
5.1.	BLADDER ACCUMULATORS			
5.1.1	**Standard**		**E 3.201**	**19**
5.1.2	**Low pressure**		**E 3.202**	**27**
5.1.3	**High pressure**		**E 3.203**	**35**
5.2.	PISTON ACCUMULATORS			
5.2.1	**Standard**		**E 3.301**	**39**
5.2.2	**Series SK280**		**E 3.303**	**51**
5.3.	DIAPHRAGM ACCUMULATORS		**E 3.100**	**55**
5.4.	METAL BELLOWS ACCUMULATORS		**E 3.304**	**61**
5.5.	HYDRAULIC DAMPERS		**E 3.701**	**67**
5.6.	SPECIAL ACCUMULATORS			
5.7.	ACCUMULATOR STATIONS		**E 3.653**	**85**
5.8.	ACCUMULATOR ACCESSORIES			
5.8.1	**Hydraulic accumulators with back-up nitrogen bottles**		**E 3.553**	**91**
5.8.2	**Universal charging and testing unit**		**E 3.501**	**97**
5.8.3	**Safety and shut-off block**		**E 3.551**	**107**
5.8.4	**Safety equipment for hydraulic accumulators**		**E 3.552**	**129**
5.8.5	**Supports for hydraulic accumulators**		**E 3.502**	**135**
5.8.6	**ACCUSET SB**		**E 3.503**	**143**
6.	**INDUSTRIES AND APPLICATIONS**	9 – 10		
7. / 8.	**WEBSITE / SPECIFICATION FORMS**	10 – 16		
9.	**SIZING**	17 – 18		
10.	**NOTE**	18		

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 pressurized 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 exclusively 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 incorporating 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. PRESSURE EQUIPMENT DIRECTIVE REGULATIONS

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 ≤ 1 litre**, a maximum permitted pressure **PS ≤ 1000 bar** and a pressure capacity **PS • V ≤ 50 bar • l** 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.

4.1. OVERSEAS

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

HYDAC pressure vessels can be supplied with virtually any test certificate. Please note that the permitted operating pressure can differ from the nominal pressure.

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

4.2. CERTIFICATE CODE = S (U STAMP)

HYDAC Technology GmbH has had authorization since 1985 to use the Code Symbol "U STAMP" 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“.

4.3. 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.

4.4. 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.

In conjunction with this approval, it is absolutely essential to provide the details of the end user/dealer when placing the order.

4.4. CERTIFICATE TABLE

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

European member states		Certificate code (AKZ)
AT	Austria	U
BE	Belgium	
BG	Bulgaria	
CY	Cyprus	
CZ	Czech Republic	
DK	Denmark	
EE	Estonia	
FI	Finland	
FR	France	
DE	Germany	
GB	Great Britain	
GR	Greece	
HU	Hungary	U [3]
IE	Ireland (Republic)	U
IT	Italy	
LV	Latvia	
LT	Lithuania	
LU	Luxembourg	
MT	Malta	
NL	Netherlands	
PL	Poland	
PT	Portugal	
RO	Romania	
SK	Slovakia	
SI	Slovenia	
ES	Spain	
SE	Sweden	

Rest of the World		Certificate code (AKZ)
DZ	Algeria	U [3]
AR	Argentina	U [3]
AU	Australia	F [1]
BS	Bahamas	E [3]
BB	Barbados	U [3]
BY	Belarus	A12
BM	Bermuda	U [3]
BO	Bolivia	U [3]
BR	Brazil	U [3]
CE	Canada	S1 [2]
CL	Chile	U [3]
CN	China	A9
CR	Costa Rica	E [3]
EC	Ecuador	U [3]
ET	Egypt	U [3]
HK	Hong Kong	A9
IS	Iceland	U [3]
IN	India	U [3]
ID	Indonesia	U [3]
IL	Israel	U [3]
JP	Japan	P
JO	Jordan	U [3]
KR	Korea (Republic)	U [3]
KW	Kuwait	U [3]
LB	Lebanon	U [3]
LY	Libya	U [3]
MY	Malaysia	U [3]
MX	Mexico	U [3]
NZ	New Zealand	T
NG	Nigeria	U [3]
NO	Norway	U
PK	Pakistan	U [3]
PE	Peru	U [3]
PH	Philippines	U [3]
PR	Puerto Rico	E [3]
RU	Russia	A6
SA	Saudi Arabia	U [3]
SG	Singapore	U [3]
ZA	South Africa	U [3]
SD	Sudan	U [3]
CH	Switzerland	U
SY	Syria	U [3]
TW	Taiwan	U [3]
TH	Thailand	U [3]
TN	Tunisia	U [3]
TR	Turkey	U
UA	Ukraine	A10
US	USA	S [3]
YU	Yugoslavia (former)	U [3]

[1] approval required in the individual territories

[2] approval required in the individual provinces

[3] alternative certificates possible

5. PRODUCT OVERVIEW

5.1. BLADDER ACCUMULATORS

5.1.1 **Standard**
Nominal volumes:
0.5 ... 200 l
Permitted operating pressure:
330 ... 550 bar

5.1.2 **Low pressure**
Nominal volumes:
2.5 ... 450 l
Permitted operating pressure:
up to 40 bar

5.1.3 **High pressure**
Nominal volumes:
1 ... 54 l
Permitted operating pressure:
5 ... 1000 bar

Benefits of HYDAC bladder accumulators:

- High discharge speeds,
- No pressure differential between fluid and gas sides,
- Compact, maintenance-free,
- High charging and discharge frequencies.

5.2. PISTON ACCUMULATORS

5.2.1 **Standard**
Nominal volumes:
up to 3300 l
Permitted operating pressure:
210 ... 350 bar
(higher pressures on request)

5.2.2 **Series SK280**
Nominal volumes:
0.16 ... 5 l
Permitted operating pressure:
280 bar

Benefits of HYDAC piston accumulators:

- Minimal pressure differential between the fluid and gas sides,
- Large usable volume,
- Variable installation position,
- Monitoring of the piston position possible using various systems,
- Particularly suitable for back-up configurations,
- High flow rates possible,
- No sudden discharge of gas when seals are worn.

5.3. DIAPHRAGM ACCUMULATORS

5.3.1 **Diaphragm accumulators**
Weld type
Nominal volumes:
0.075 ... 4 l
Permitted operating pressure:
50 ... 330 bar

Screw type
Nominal volumes:
0.1 ... 4 l
Permitted operating pressure:
210 ... 750 bar

Benefits of HYDAC diaphragm accumulators:

- Design optimised for function and weight,
- 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 accumulators for heavy diesel engines**

Nominal volume:
3.8 l

Permitted operating pressure:
50 bar

Series: SM50P-...
other models on request

Benefits of the HYDAC metal bellows accumulator:

- Gas-tight
- Maintenance-free
- Media resistance over a wide range of temperatures

5.5. HYDRAULIC DAMPERS

5.5.1 **Dampers**

Nominal volumes:
0.075 ... 450 l

Permitted operating pressure:
10 ... 1000 bar

5.5.2 **SILENCER**

Permitted operating pressure:
330 bar

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 the system,
- Reduces noise level in hydraulic systems,
- Reduces maintenance and servicing costs and
- Extends service life of the system.

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**

These are fitted with a spring. The energy is produced from the spring force, instead of gas.

Further information on request.

5.7. ACCUMULATOR STATIONS

HYDAC supplies fully assembled accumulator stations which are ready for operation, complete with all the necessary valve controls, fittings 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 expansion of 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 makes of accumulator, up to 350 bar.

Higher pressures on request

5.8.3 **Safety and shut-off block SAF/DSV**

Nominal size: 10 ... 50

Permitted operating pressure:
400 bar (DSV 350 bar)

Pressure relief valve:
Nominal width DN12

Benefits of the HYDAC Safety and Shut-off Block:

- Minimum of space and maintenance,
- Minimum of installation required (1 SAF replaces as a rule up to 10 individual pipe connections),
- Considerable reduction in installation time,
- Can be adapted to different types and also different makes of accumulator, and
- Additional valves (pilot-operated check valves, flow control valves, etc).

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 provides a means of attaching 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.

5.8.5 **ACCUSET SB**

Nominal volumes:
1 ... 50 l

Permitted operating pressure:
330 bar

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

Machine tools

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

Plastics machinery

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

Forming machines

- Accumulators used to store energy to support the pump

Iron and steel industry

- Accumulator to maintain the pressure in rolling mills
- Blast furnace hydraulics

Thermal power plants

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

Wind turbines

- Accumulators in the pitch control system
- Support of the pitch drive
- Accumulators on braking units

Mining machinery

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

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 servohydraulic axes

6.2. MOBILE TECHNOLOGY

Automotive technology

- Automatic and manual transmission
- Automatic clutch systems
- Engine management systems
- Pump noise damping
- 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 technology

- Noise-damping
- Energy recovery
- Braking system

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

7. WEBSITE

Please visit us at the following address: www.hydac.com.

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

8. SPECIFICATION FORMS

Our aim is to provide optimum 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 internet (www.hydac.com/Hydraulic accumulators) under the Downloads tab. You can then complete them at your convenience on your PC and also send them to your HYDAC contact, e.g. by E-Mail.

HYDAC Technology GmbH
Industriegebiet
D-66280 Sulzbach/Saar
Tel.: +49 (0) 68 97 / 509 - 01
Fax: +49 (0) 68 97 / 509 - 464
Internet: www.hydac.com
E-Mail: speichertechnik@hydac.com

General ACCUMULATOR Specification Form (Page 1/2)

(Subject to technical modifications)

Company: _____ Location: _____

Project name: _____ Originator: _____

E-Mail: _____ Tel. no.: _____

Application: _____ Requirement: _____ pieces/year

Note:
The appropriate accumulator can be calculated using the HYDAC **A**ccumulator **S**imulation **P**rogram **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 diagram 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: ☐

Alternatively:
Fluid demand diagram for several pumps and/or consumers (see Page 2)

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: _____

Colour/finish: ☐ internal _____

☐ external _____

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

* dependent on operating temperature and/or fluid resistance

Comments: _____

_____

_____

Date: _____ Name: _____

HYDAC Technology GmbH
Industriegebiet
D-66280 Sulzbach/Saar
Tel.: +49 (0) 68 97 / 509 - 01
Fax: +49 (0) 68 97 / 509 - 464
Internet: www.hydac.com
E-Mail: speichertechnik@hydac.com

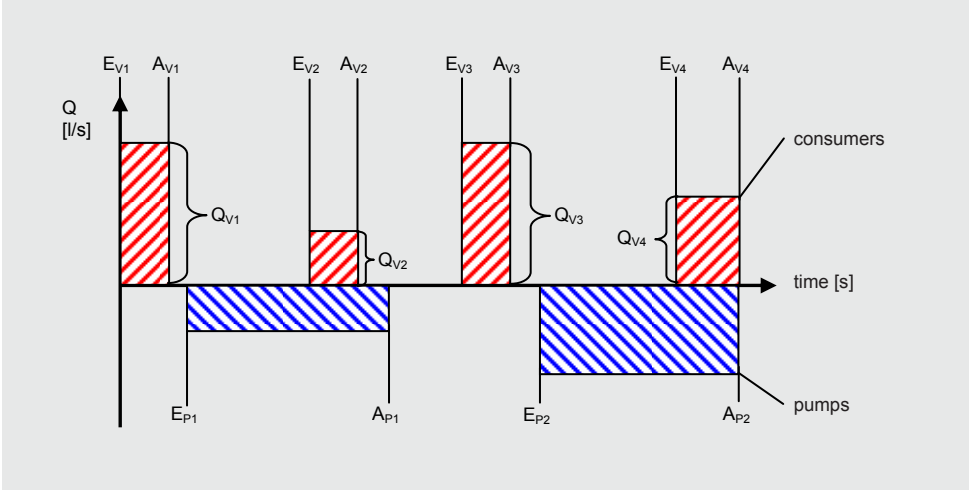
General ACCUMULATOR Specification Form (Page 2/2)

(Subject to technical modifications)

Fluid demand diagram for several pumps and/or consumers

Designation / Example

Q_V = Consumer flow rate [l/s]
E_V = Switch-on time of consumer [s]
A_V = Switch-off time of consumer [s]
E_P = Switch-on time of pump [s]
A_P = Switch-off time of pump [s]



Please indicate cycle data below

Number of consumers: _____

Q_{V1}= _____ E_{V1}= _____ A_{V1}= _____
Q_{V2}= _____ E_{V2}= _____ A_{V2}= _____
Q_{V3}= _____ E_{V3}= _____ A_{V3}= _____
Q_{V4}= _____ E_{V4}= _____ A_{V4}= _____

Number of pumps: _____

Q_{P1}= _____ E_{P1}= _____ A_{P1}= _____
Q_{P2}= _____ E_{P2}= _____ A_{P2}= _____
Q_{P3}= _____ E_{P3}= _____ A_{P3}= _____
Q_{P4}= _____ E_{P4}= _____ A_{P4}= _____

HYDAC Technology GmbH
Industriegebiet
D-66280 Sulzbach/Saar
Tel.: +49 (0) 68 97 / 509 - 01
Fax: +49 (0) 68 97 / 509 - 464
Internet: www.hydac.com
E-Mail: speichertechnik@hydac.com

SHOCK ABSORBER SPECIFICATION FORM (Page 1/2)

(Subject to technical modifications)

Company: _____ Location: _____

Project name: _____ Originator: _____

E-Mail: _____ Tel. no.: _____

Application: _____ Requirement: _____ pieces/year

Note:
The appropriate accumulator can be calculated using the HYDAC **A**ccumulator **S**imulation **P**rogram **ASP**.
Download from www.hydac.com.

Type of accumulator ☐ Bladder accumulator ☐ Piston accumulator ☐ Diaphragm accumulator ☐ _____

Cause of the pressure shock

☐ When pump starts ☐ When pump switches off

☐ When check valve flap (valve) closes

Fluids/media

Fluid [1]: _____

Density: _____ kg/m³

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

* dependent on operating temperature and/or fluid resistance

[1] please send datasheet

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 _____

Standard: _____

Gas connection: _____

Colour/finish: ☐ internal _____

☐ external _____

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

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: _____

Comments: _____

Date: _____ Name: _____

HYDAC Technology GmbH
Industriegebiet
D-66280 Sulzbach/Saar
Tel.: +49 (0) 68 97 / 509 - 01
Fax: +49 (0) 68 97 / 509 - 464
Internet: www.hydac.com
E-Mail: speichertechnik@hydac.com

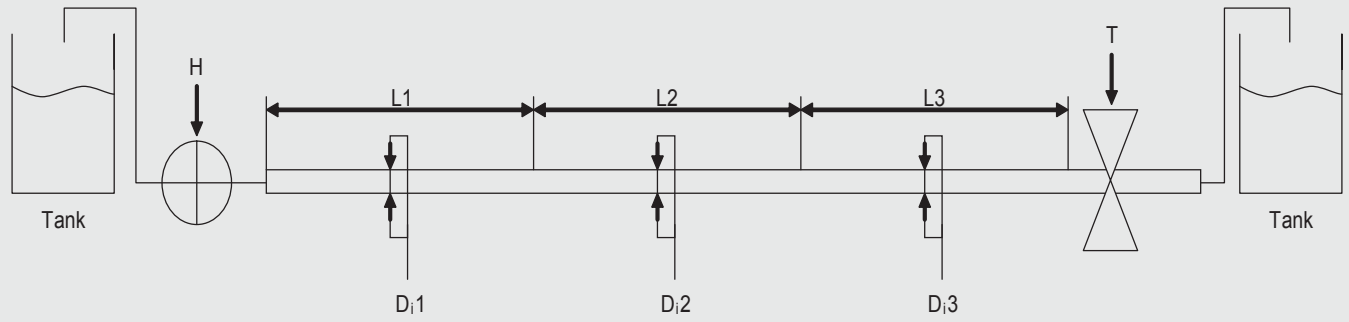
SHOCK ABSORBER SPECIFICATION FORM (Page 2/2)

(Subject to technical modifications)

Pipeline data for additional sections of pipe

Designation / Example

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



No. of different pipes: 3

L1	= 200 m		D_i1	= 100 mm	
L2	= 50 m		D_i2	= 200 mm	
L3	= 20 m		D_i3	= 500 mm	

Typical values for speed of sound

Water = 1200 m/s
Fuel = 1100 m/s

Please complete below with the pipeline data

No. of different pipes: _____

L1	= _____ m		D_i1	= _____ mm		L5	= _____ m		D_i5	= _____ mm	
L2	= _____ m		D_i2	= _____ mm		L6	= _____ m		D_i6	= _____ mm	
L3	= _____ m		D_i3	= _____ mm		L7	= _____ m		D_i7	= _____ mm	
L4	= _____ m		D_i4	= _____ mm		L8	= _____ m		D_i8	= _____ mm	

HYDAC Technology GmbH
Industriegebiet
D-66280 Sulzbach/Saar
Tel.: +49 (0) 68 97 / 509 - 01
Fax: +49 (0) 68 97 / 509 - 464
Internet: www.hydac.com
E-Mail: speichertechnik@hydac.com

PULSATION DAMPER SPECIFICATION FORM

(Subject to technical modifications)

Company: _____ Location: _____

Project name: _____ Originator: _____

E-Mail: _____ Tel. no.: _____

Application: _____ Requirement: _____ pieces/year

Note:
The appropriate accumulator can be calculated using the HYDAC **A**ccumulator **S**imulation **P**rogram **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

Pump and system data

Oper. press./pump pressure: _____ bar

Flow rate: _____ l/min

Rpm: _____ 1/min

No. of displacements: _____

☐ single ☐ double acting

Pump factor: _____ optional (if available)

Stroke volume: _____ 1 dm³

→ for piston pumps: $V_H = \frac{d^2 \times \pi}{4} \times H \times 10^6$

d = Ø piston: _____ mm

H = stroke length: _____ mm

→ for diaphragm pumps: see manufacturer's specifications

Accumulator data

Pre-charge pressure [1]: _____ bar

Operating temperature: _____ °C

Application: ☐ pressure side ☐ suction side

Required residual pulsation: _____ %

Result: _____ l gas volume [2]

* dependent on operating temperature and/or fluid resistance

[1] see catalogue section: No. 3.000, Sizing

[2] normally pre-charged with nitrogen (N_2)

Additional details on the accumulator

Industry: _____

Country of installation: _____

Design/Certification: _____

Specification: _____

Design pressure: _____ bar

Design temperature: _____ °C

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: _____

Colour/finish: ☐ internal _____

☐ external _____

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

Comments: _____

Date: _____ Name: _____

HYDAC Technology GmbH
Industriegebiet
D-66280 Sulzbach/Saar
Tel.: +49 (0) 68 97 / 509 - 01
Fax: +49 (0) 68 97 / 509 - 464
Internet: www.hydac.com
E-Mail: speichertechnik@hydac.com

SILENCER SPECIFICATION FORM

(Subject to technical modifications)

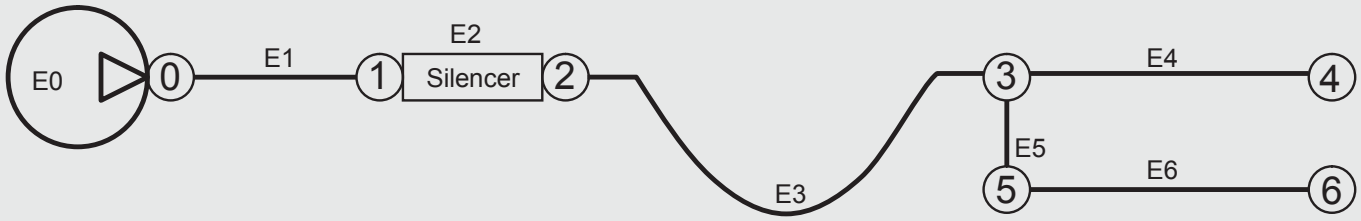
Company: _____ Location: _____

Project name: _____ Originator: _____

E-Mail: _____ Tel. no.: _____

Application: _____ Requirement: _____ pieces/year

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	–

Design data:

Pump: _____ Design pressure: _____ bar Silencer inlet: _____

Pump rpm: _____ 1/min No. of pump pistons: _____ Silencer outlet: _____

Fluid: _____ Fluid density: _____ 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					

Comments: _____

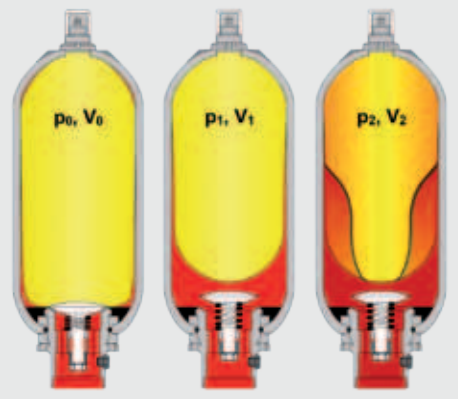
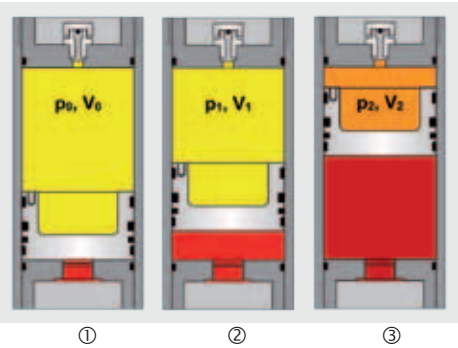
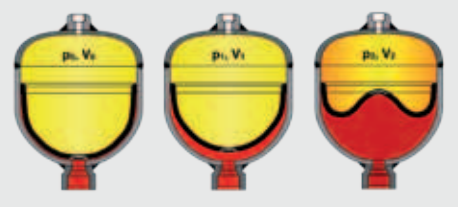
_____

_____

Date: _____ Name: _____

9. SIZING

9.1. DEFINITION OF VARIABLES FOR SIZING A HYDRAULIC ACCUMULATOR

Function principle	Accumulator cycle	Limits for the gas pre-charge pressure
Bladder accumulator  ① ② ③	① The accumulator is pre-charged with nitrogen. The separating element (piston, bladder, diaphragm) 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 ΔV is available in the accumulator: p_0 = Gas pre-charge pressure p_1 = Minimum operating pressure p_2 = Maximum operating pressure V_0 = Effective gas volume V_1 = Gas volume at p_1 V_2 = Gas volume at p_2 t_0 = Gas pre-charge temperature t_{min} = Min. operating temperature t_{max} = Max. operating temperature	$p_0 \leq 0.9 \cdot p_1$ with a permitted pressure ratio of $p_2 : p_0 \leq 4 : 1$ For HYDAC low pressure accumulators, the following must also be taken into account: Type SB40: $p_{0\,max}$ = 20 bar Type SB35H: $p_{0\,max}$ = 10 bar
Piston accumulator  ① ② ③		$p_{0,tmin} \geq 2$ bar (piston type 2) $p_{0,tmin} \geq 10$ bar (piston type 1) $p_{0,tmin} \leq p_1 - 5$ 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  ① ② ③		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) $p_0 \leq 0.9 \cdot p_1$

9.2. SELECTION OF GAS PRE-CHARGE PRESSURE

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

9.2.1 Recommended values for energy storage:

$p_{0,t\,max} = 0.9 \cdot p_1$

for shock absorption:

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

for pulsation damping:

$p_{0,t\,max} = 0.6 \cdot p_m$
(p_m = average operating pressure)
or
$p_{0,t\,max} = 0.8 \cdot p_1$
(for several operating pressures)

During operation the separating element (piston, bladder, diaphragm) must not touch the fluid-side connection.

Since the volume of the gas increases as the temperature increases, the gas 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 right-hand column of table)

9.2.3 Temperature effect

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

$$p_{0,\,t\,charge} = p_{0,t\,max} \cdot \frac{t_{charge} + 273}{t_{max} + 273}$$

$t_0 = t_{charge}$ (gas charging temperature in °C)

To take the temperature effect into account when sizing accumulators, the pre-charge pressure p_0 at min. temperature t_0 must be selected as follows:

$$p_{0,\,t\,min} = p_{0,t\,max} \cdot \frac{t_{min} + 273}{t_{max} + 273}$$

9.3. ACCUMULATOR SIZING ON YOUR PC

ASP - **A**CCUMULATOR
SIMULATION **P**ROGRAM

You want to size an accumulator for your hydraulic system and need to find out the required gas volume? How does the accumulator actually behave in the system?

The formulae required for this are complicated and also have only limited relevance.

The solution: HYDAC **ASP** - **A**ccumulator **S**imulation **P**rogram:

- Accumulator sizing on your PC with Windows interface for bladder, piston and diaphragm accumulators and systems using back-up nitrogen bottles, taking into account isentropic, isothermal and polytropic changes in condition.
- Calculation of accumulator systems with the possibility of adding accumulators, consumers and pumps with their particular switch-on and switch-off times.
- Simulation of pressure, temperature and volume over the given cycle time. Real gas equations are used for this and the accumulator type and its heat exchange behaviour is taken into account in the calculation.
- Sizing of pulsation dampers.
- Calculation of the gas volume and the residual pulsation of gas-filled pulsation dampers.
- Sizing of shock absorbers, calculation of the required gas volume for "Joukowsky shock".

  Complex pipe systems are possible on request.
- Display of the gas compression and the degree of efficiency.

Example
Petrol tanker filling station

When loading fuels into vehicles, ships or barrels, the flow is suddenly interrupted when the valve closes.

This deceleration of mass results in a pressure shock which is also referred to as a “Joukowsky pressure shock”. By using a hydraulic accumulator, the pressure shock can be reduced to a tolerable level.

Given parameters:

● Temperature:	20 °C Fluid: PETROL (Premium leaded) (Density: 0.760 kg/dm^3)
● Pipe length from pump to valve:	900 m
● Pipe $Ø_{internal}$:	Internal diameter = 107.1 mm (DN100 = 114.3 external, wall thickness = 3.6 mm)
● Zero head of the pump:	147.5 m, equivalent to 11 bar
● Pump pressure at operating point:	10 bar (pre-charge pressure p_0 = 9 bar)
● Max. permitted pressure of the pipe:	12 bar
● Flow rate:	500 l/min
● Closing time of the shut-off valve:	1s (0.33 s effectively)
● Pipe material:	Steel E = 2.1 x 10^5 N/mm²

Required:

a. Maximum Joukowsky pressure shock in bar
b. Maximum flow velocity in the pipe in m/s
c. Required accumulator gas volume in litre

Solution:

a. Maximum Joukowsky pressure shock:	18.867 bar
b. Maximum flow velocity:	0.925 m/s
c. Required accumulator gas volume:	41.795 l

10. NOTE

The information in this brochure relates to the operating conditions and applications described.

For applications and operating conditions not described here, please contact the relevant technical department.

Subject to technical modifications.

HYDAC Technology GmbH
Industriegebiet
66280 Sulzbach/Saar, Germany
Tel.: +49 (0) 68 97 / 509 - 01
Fax: +49 (0) 68 97 / 509 - 464
Internet: www.hydac.com
E-Mail: speichertechnik@hydac.com