HYDAC INTERNATIONAL

Accumulators Applications

Mobile, Industrial & Process Technology Guidelines

PN#2207585 / 06.21 / ACU1707-1920

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Section:

More Information

HYDAC Accumulators have played a key role in providing innovative solutions resulting in lowering operational costs and increasing hydraulic system performance in mobile, industrial and process applications.

This application guidebook will serve as an overview and allow focus on helping solve customers' problems.

HYDAC

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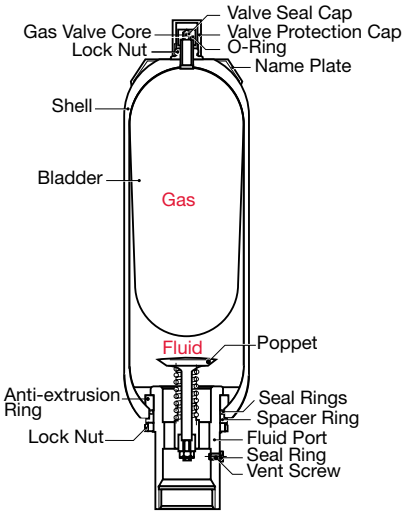
NOTE

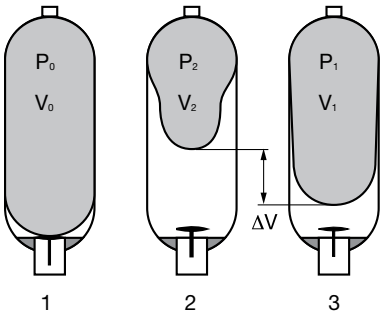
Overview

HYDAC accumulators – a name synonymous with advanced technology, design, manufacturing and application engineering for more than 50 years. HYDAC USA is the only major domestic manufacturer of all three types of accumulators—bladders, diaphragms and pistons and has over 1,000 distributors worldwide with more than 50 wholly owned branches.

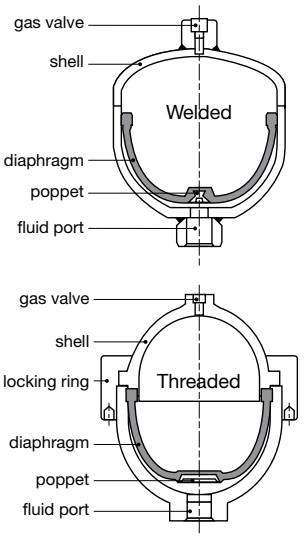
Accumulators are an essential element in modern hydraulics. Hydro-pneumatic accumulators use compressed gas to apply force to hydraulic fluid using different construction elements to separate the gas side from the fluid side. Bladders use a flexible closed membrane, diaphragms use a flexible open membrane and pistons use a moveable piston with a sealing system.

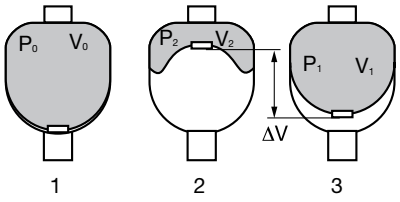
Bladder Accumulators
SB Series



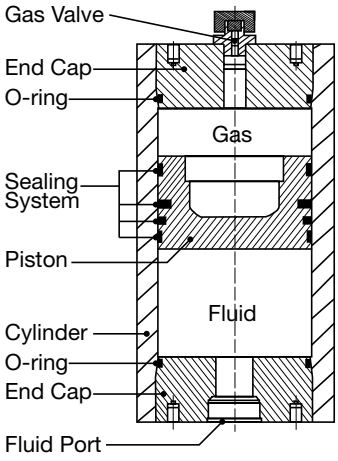


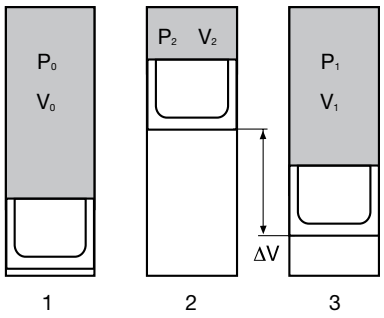
Diaphragm Accumulators
SBO Series





Piston Accumulators
SK Series





Basic Accumulator Terms

P_0 = gas precharge pressure

V_0 = effective gas volume of the accumulator *(this is an internal net volume)*

T_0 = temperature at precharging

P_1 = min. working pressure

V_1 = gas volume at P_1

T_1 = min. ambient temperature

P_2 = max. working pressure

V_2 = gas volume at P_2

T_2 = max. ambient temperature

$P_0@T_0$ = gas precharge pressure at precharge ambient temperature

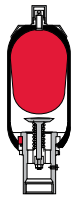
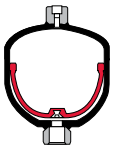
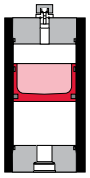
$P_0@T_1$ = gas precharge pressure at minimum ambient temperature

$P_0@T_2$ = gas precharge pressure at maximum ambient temperature

Guidelines

Many applications can use any of the three types of accumulators, but it's important to determine the best solution for the application. **Accumulators are typically selected based on system pressure, system temperature, volume need, flow rate, pressure ratio, installation space/position and chemical compatibility. It's important to note any weight, dimensional, cost and lead time restrictions impact the choice, as well.**

Quick Reference Comparison of Standard Accumulators

Type	Design	Nominal Volume	MAWP (psi)	Pressure Ratio	Flow Rate	Mounting Position	Weight	Cost
Bladder 	• best general purpose • wide range of standard sizes • good for shock applications (good response characteristics)	1 qt. to 15 gal	3000, 5000 (up to 10,000)	4:1	up to 480 gpm	prefer vertical	middle	middle
Diaphragm 	• small volume & flow • low weight • compact design • good for shock applications (good response characteristics)	5 in^3 to 1 gal	3000, 5000 (up to 10,000)	8:1 typically (up to 10:1)	up to 60 gpm	any	lowest	lowest
Piston 	• best for large stored volumes • best for high flow rates • not recommended for shock applications • best for use with backup nitrogen bottles	1 qt. to 100 gal	3000, 5000 (up to 10,000)	∞:1	up to 2000 gpm	prefer vertical	highest	middle to highest

Characteristics of HYDAC Accumulators

Bladder Accumulators

- High discharge velocities
- No pressure differential between fluid side and gas side
- Compact and low maintenance
- High charge and discharge frequencies

Diaphragm Accumulators

- Function-optimized and weight-optimized design
- Unlimited choice of installation positions
- Low maintenance and long service life

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

IMPORTANT!

Ask questions to discover the best solution!

Accumulator Functions

Using accumulators improves the performance of the whole system. They can be used for the below functions:

Energy Storage

- Load compensation
- Heave compensation
- Boom suspension power/ stabilization
- Downforce control
- Auto start/stop
- Valve actuation
- Volume compensation
- Leak compensation
- Back-up/emergency braking
- Auxiliary/emergency power deployment
- Energy storage for launching
- Energy storage for presses
- Energy storage for test systems
- Energy storage for flight control
- Supplemental drive power
- Supplemental pump flow
- Boost rate of acceleration
- Peak shaving of power demand
- Track tensioning

Shock Absorption

- Load stabilization
- Bucket stabilization
- Heave compensation
- Ride control
- Pressure/shock control
- Shock absorption
- Downforce control
- Shock absorption on valve opening
- Track tensioning

Pulsation Dampening

- Load stabilization
- Bucket stabilization
- Heave compensation
- Boom suspension power/ stabilization
- Ride control
- Vibration dampening
- Pulsation dampening
- Noise reduction

Benefits Of These Functions

Energy Storage

- Increased energy/fuel efficiency (fuel/energy savings)
- System downsizing - design improvement
- System downsizing - less weight
- System downsizing - less floor space required
- Reduced cost to manufacture
- Increased machine acceleration (quicker to speed)
- Reduced engine size (lower energy, weight, cost, space)
- Improved lifting energy efficiency (load compensation)
- Increased payload per lift
- Availability of emergency / stand-by power
- Lubrication control and seal oil supply
- Improved steering / ease of handling
- Reduced machine cycle time
- Emission reduction
- Increased safety
- Increased machine productivity
- Steady downforce improves attachment performance

Shock Absorption

- Increased machine life (less wear from vibration)
- Pressure shock control due to foreign objects
- Increased driver comfort; reduced fatigue (less vibration)
- Reduced machine cycle time
- Increased safety
- Increased machine productivity
- Steady downforce improves attachment performance
- Compensate for thermal expansion/contraction (shock)

Pulsation Dampening

- Noise reduction
- Even force on shape being pressed
- Increased machine life (less wear from vibration)
- Suction flow stabilization
- Increased driver comfort; reduced fatigue (less vibration)
- Reduced machine cycle time
- Increased safety
- Increased machine productivity

For more information go to **www.HYDAC-NA.com > Products > Accumulators** (button) or contact Accumulator Product Management or Customer Service at 610-266-0100.

Precharge Recommendations

For energy storage:

$P_0 = 0.9 \times P_1$

P_1 = minimum working pressure

For shock absorption:

$P_0 = (0.6 \text{ to } 0.9) \times P_m$

P_m = median working pressure at free flow

For pulsation dampening:

$P_0 = (0.6 \text{ to } 0.8) \times P_m$

P_m = median working pressure

Temperature Effect

Due to the Ideal Gas Laws, the precharge pressure of an accumulator is affected by the ambient temperature of the accumulator's operating environment. Given the constant volume of an accumulator shell when the temperature rises, the gas pressure will increase and conversely as the temperature goes lower, the gas pressure decreases. This temperature effect on precharge gas pressure will affect operation of the accumulator in a hydraulic fluid system. Therefore it is critical to consider the precharge pressure at T_2, maximum ambient temperature, and T_1, the minimum ambient temperature, when sizing an accumulator to ensure that the accumulator is sized large enough to operate properly over the entire operating ambient temperature range. The formula below describes the ambient temperature and precharge pressure relationship to any temperature.

Fahrenheit

$$P_0@T_0 = P_0@T_x \times \left(\frac{T_0 + 460}{T_x + 460} \right)$$

T_0 = precharge temperature in °F

T_x = actual ambient operating temperature in °F, where T_x is $T_1 \le T_x \le T_2$

$P_0@T_0$ = gas precharge pressure at precharge ambient temperature

$P_0@T_x$ = gas precharge pressure at maximum ambient operating temperature, where T_x is $T_1 \le T_x \le T_2$

Celsius

$$P_0@T_0 = P_0@T_x \times \left(\frac{T_0 + 273}{T_x + 273} \right)$$

T_0 = precharge temperature in °C

T_x = maximum operating temperature in °C, where T_x is $T_1 \le T_x \le T_2$

$P_0@T_0$ = gas precharge pressure at precharge ambient temperature

$P_0@T_2$ = gas precharge pressure at maximum ambient operating temperature, where T_x is $T_1 \le T_x \le T_2$

B Discovery Questions for Mobile Accumulator Applications

In the following mobile application examples, denoted is a typical accumulator choice. However it is important to thoroughly review the application before deciding on the type and size of accumulator. For mobile applications, necessary questions examples are below:

What is the operating environment of the system (corrosive, etc.)?

What is the installation space and mounting position criteria?

What temperature range will the accumulator experience (min/max)?

Agricultural

Commonly used accumulator for this application.

- Front loader dampening
- Implement down pressure
- Tractor suspension systems
- Pressure spike protection from stone strikes
- Boom suspension on field sprayers

Automotive

Commonly used accumulator for this application.

- Pump noise dampening
- Leakage compensation in transmission
- Brake systems and suspension

Construction

Commonly used accumulator for this application.

- Braking system
- Chassis dampening
- Load dampening
- Track tensioning
- Noise dampening

Cranes

Commonly used accumulator for this application.

- Boom dampening
- Steering systems
- Load compensation

Forestry

Commonly used accumulator for this application.

- Shock absorption
- Load stabilization
- Ride control

Material Handling

Commonly used accumulator for this application.

- Shock absorption
- Ride control

Military

Commonly used accumulator for this application.

- Energy storage for door/lift emergency power
- Ride control

Mining

Commonly used accumulator for this application.

- Steering systems
- Emergency braking

Municipal

Commonly used accumulator for this application.

- Noise dampening
- Energy storage in regenerative circuits (stop and go)

Rail

Commonly used accumulator for this application.

- Braking system
- Noise dampening

Utility Vehicles

Commonly used accumulator for this application.

- Boom suspension in lifts
- Bucket stabilization

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C Discovery Questions for Industrial Accumulator Applications

In the following industrial application examples, denoted is a typical accumulator choice. However it is important to thoroughly review the application before deciding on the type and size of accumulator. For industrial applications, necessary questions examples are below:

What flow rate is required?

What is the pressure range (min/max)?

What type of maintenance criteria is important to the system design (location of installation, do items get repaired or replaced, etc)?

Aerospace

Commonly used accumulator for this application.

- Energy storage for hydraulic brake system and hydraulic flight controls

Balers, Compactors, Shredders, Crushers, Grinders

Commonly used accumulator for this application.

- Pressure shock control for larger / foreign objects

Die Casting Machines

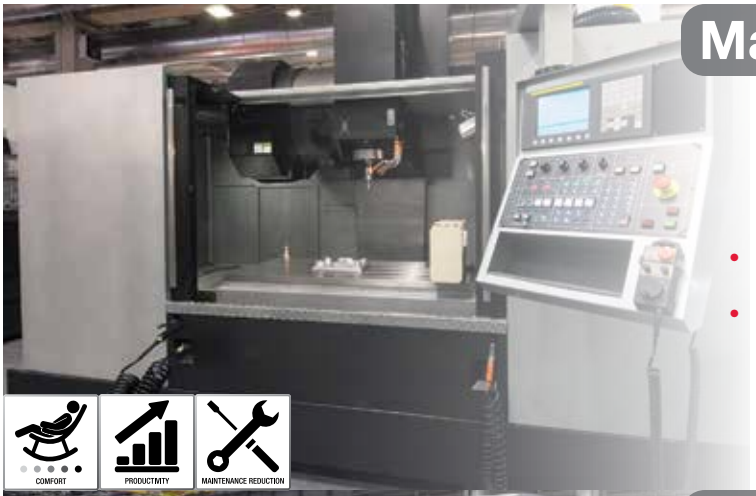
Commonly used accumulator for this application.

- Energy storage during the injection process
- Volume compensation

Iron & Steel Metal Forming

Commonly used accumulator for this application.

- Energy storage in rolling mills
- Pressure shock control in blast furnace hydraulics



Machine Tools (CNC)

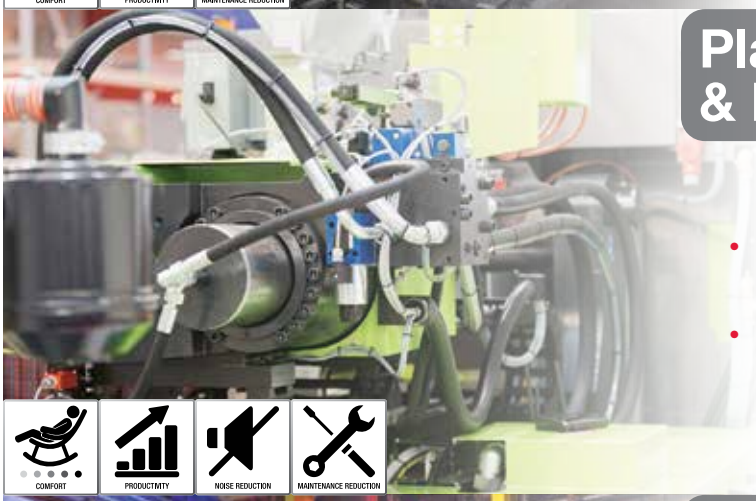
Commonly used accumulator for this application.

- Support for the hydraulics for tool change
- Energy storage for machining

Paper & Pulp

Commonly used accumulator for this application.

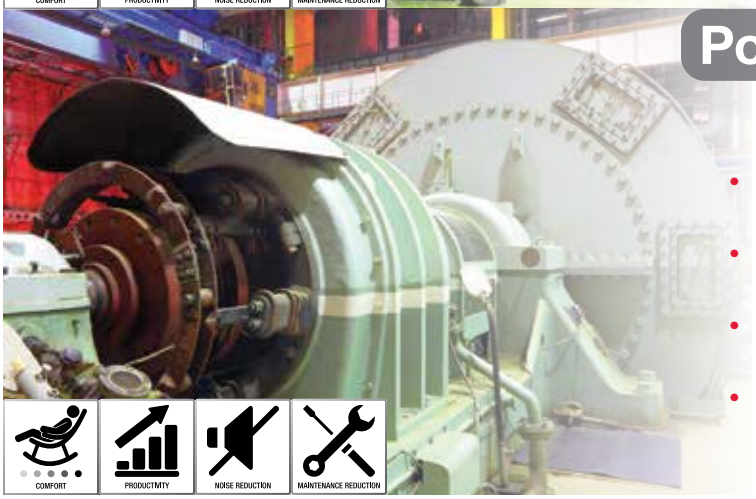
- Energy storage for emergency functions in friction bearing hydraulics
- Energy storage in high/low pressure power units



Plastic Machinery & Molding

Commonly used accumulator for this application.

- Energy storage during the injection molding or blow molding process
- Pulsation dampening on the hydraulic drive



Power Plants

Commonly used accumulator for this application.

- Emergency supply for turbine control system
- Pulsation dampening on pumps
- Lubrication control and seal oil supply
- Water treatment

Press

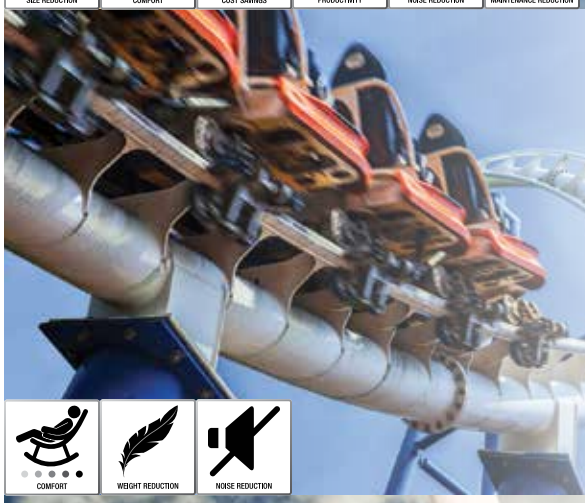
Commonly used accumulator for this application.

- Pulsation dampening for uniform force driving the shaping process

Shipping / Marine

Commonly used accumulator for this application.

- Energy storage for pump support
- Pulsation dampening on large ship diesel engines
- Emergency energy for lifeboat deployment



Simulators & Entertainment

Commonly used accumulator for this application.

- Energy storage on crash test systems
- Pulsation dampening on servo hydraulic axes

Wind Turbines

Commonly used accumulator for this application.

- Pressure shock control in pitch control system
- Energy storage for braking units

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Discovery Questions for Process Technology Accumulator Applications

In the following process technology application examples, denoted is a typical accumulator choice. However it is important to thoroughly review the application before deciding on the type and size of accumulator. For process technology applications, necessary questions examples are below:

What chemical compatibility is needed?

What is the system pressure range (min/max)?

What is the system temperature range (min/max)?

Chemical Industry

Commonly used accumulator for this application.

- Energy storage and pulsation dampening on dosing pumps
- Suction flow stabilization on the suction side of pumps

Loading Stations & Refineries

Commonly used accumulator for this application.

- Shock absorption for valves closing during unloading stage
- Pulsation dampening on pipelines

Oil & Gas / Offshore

Commonly used accumulator for this application.

- Shock absorption for valves closing
- Energy storage for deep sea rams
- Emergency energy for safety systems such as Blow Out Preventers (BOP)
- Energy storage in wellhead control systems

E Discovery Questionaire Forms for the Three Primary Accumulator Functions

These forms are to be used to discover additional information to help diagnose, design and deliver to the customers specific needs.

Energy Storage Form

Name _____ Title _____

Company _____ E-mail _____

Address _____

Phone _____ State _____ Zip _____

Phone _____ Fax _____

Please attach any special requirements or drawings to the fax or e-mail.

Operation of Pump

- ◯ Continuous Operation
- ◯ Emergency Operation

Maximum Operating Pressure	(P2)		PSI
Minimum Operating Pressure	(P1)		PSI
Precharge Pressure at 68˚F (20˚C)	(P0)		PSI
Temperature Range of Environment	(T)		˚F
Temperature Range of Fluid or System	(TF)		˚F
Pump Flow Rate	(QP)		GPM
Total Cycle Time of System	(TE)		Sec.
Number of Actuators *(cylinders, etc.)*	(NV)		

Actuator Time Schedule and Flow

QVi = Required Actuator Flow (GPM) **Ei** = Actuator Start Time **Ai** = Actuator Shut Down Time

(i = 1 for first actuator, i = 2 for second actuator, etc. up to NV)

QV1 =	E1 =	A1 =
QV2 =	E2 =	A2 =
QV3 =	E3 =	A3 =
QV4 =	E4 =	A4 =
QV5 =	E5 =	A5 =

Fluid

Required Mounting Orientation

Country of Final Installation *(for country codes please see inside back page)*

Required Quantity

Annual Usage _____ Target Price _____ Competitor _____ Quantity _____

Additional Remarks

Shock Applications Form

Name _____ Title _____

Company _____ E-mail _____

Address _____

Phone _____ State _____ Zip _____

Phone _____ Fax _____

Please attach any special requirements or drawings to the fax or e-mail.

What is the source of the shock? *(i.e. valve closing, pump start, or other - please describe)*

At the instance the shock occurs what is the...

Flow rate: _____ GPM

Normal Operating Pressure: _____ PSI ; Maximum Spike Pressure: _____ PSI

The system's maximum allowable design pressure: _____ PSI

Information is required on all piping from the shock source to the anticipated location of the shock absorber *(accumulator)*.
Please continue to answer the following:

Total Number of pipes: _____ *(up to 10 pipes)*

Starting at the shock source, please answer the following:

Pipe	Inner Diameter (inches)	Length (feet)	Pipe	Inner Diameter (inches)	Length (feet)
1			6		
2			7		
3			8		
4			9		
5			10		

If the vertical height from the shock source to the anticipated location of the shock absorber is greater than 10 feet please state this distance.

Vertical Height: _____feet

Fluid

Required Mounting Orientation

Country of Final Installation *(for country codes please see inside back page)*

Required Quantity

Annual Usage _____ Target Price _____ Competitor _____ Quantity _____

Additional Remarks

Pulsation Dampening Form

Name _____ Title _____

Company _____ E-mail _____

Address _____

Phone _____ State _____ Zip _____

Phone _____ Fax _____

Please attach any special requirements or drawings to the fax or e-mail.

What type of pump is causing the pulsation?

Please name or describe *(ie piston pump, gear pump, etc.)*

What is the...

Flow rate: _____ GPM

Pump: _____ RPM

Pump Piston Diameter: _____ *(inches)*

Pump Piston Stoke: _____ *(inches)*

Number of Rotating Elements: _____ *(3 piston, 13 tooth gear, etc)*

Operating Pressure: _____ psi

The system's maximum allowable pressure: _____ psi

Line Size where pulsation dampener will be fitted into: _____

(The I.D. of the line is what is really required)

Note: A pulsation dampener should be always be installed as close to the pulsation source as possible to optimize its performance. A pulsation dampener should never be placed greater than 10 ft away from the pulsation source.

Fluid

Required Mounting Orientation

Country of Final Installation *(for country codes please see inside back page)*

Required Quantity

Annual Usage _____ Target Price _____ Competitor _____ Quantity _____

Additional Remarks

Certifications

Accumulators and gas bottles are pressure vessels. Each country has their own safety regulations and certifications that govern pressure vessels. The most common certifications are ASME, PED, AS1210 and CRN. HYDAC is able to provide certification for any country and will comply with specific industry standard (ABS, DNV, etc) at time of order.

ASME Certification (HYDAC country code S)
If pressure is greater than 15psi and the ID is greater than 6 in. then the shell will have appropriate stamping.

PED: Pressure Equipment Directive (HYDAC country code U)
If pressure in bar times the volume in liters is greater than 1,000 then the assembly must carry a “CE” mark. If pressure in bar times the volume in liters is less than 1,000 then the assembly is built in accordance with PED but cannot carry a “CE” mark.

AS1210 (HYDAC country code F)
Based on ASME certification criteria but requires additional third party regulation and design verification.

CRN: Canadian Registration Number (HYDAC country code S1)
Based on ASME certification criteria but applying for a registration number in the specific Canadian providence.

Complete Country Code Listing

(European Union Member States listed in bold.)

Algeria	S[3]	Hong Kong	A9	Peru	S[3]
Argentina	S[3]	**Hungary**	U[3]	Philippines	S[3]
Australia	F[1]	Iceland	U[3]	**Poland**	U
Austria	U	India	S[3]	**Portugal**	U
Bahamas	E	Indonesia	S[3]	Puerto Rico	S[3]
Barbados	S[3]	**Ireland**	U	**Romania**	U
Belgium	U	Israel	U[3]	Russia (CIS)	A6
Bermuda	S[3]	**Italy**	U	Saudi Arabia	S[3]
Bolivia	S[3]	Japan	P	Singapore	U
Brazil	S[3]	Jordan	S[3]	**Slovakia**	A8
Canada	S1[2]	Korea	S[3]	South Africa	S[3]
Chile	S[3]	Kuwait	S[3]	**Spain**	U
China	A9	Lebanon	S[3]	Sudan	S[3]
Costa Rica	E[3]	Libya	S[3]	**Sweden**	U
Czech Republic	U	**Luxembourg**	U	Switzerland	U
Denmark	U	Malaysia	S[3]	Taiwan	S[3]
Ecuador	S[3]	Mexico	S[3]	Thailand	S[3]
Egypt	U	New Zealand	T	Tunisia	S[3]
Finland	U	**Netherlands**	U	Turkey	U
France	U	Nigeria	S[3]	United Kingdom	Y
Germany	U	Norway	U[3]	USA	S
Greece	U	Pakistan	S[3]	Venezuela	S[3]

1) approval required in the individual territories
2) approval required in the individual provinces
3) alternative certificates possible

Safety Requirements Overview

Hydro-pneumatic accumulators are pressure equipments subjected to legal pressure regulations. For the operation and the testing of accumulator equipped hydraulics, all local regulations have to be observed to avoid any risks and to guarantee the safety for the whole lifetime of the units.

Therefore “safety devices in accordance with the PED 97/23/EC ANNEX 1:2.11” are available.

HYDAC offers various types of standard “safety devices”, which should be used on the gas and fluid sides to protect against pressures in excess of design parameters.

WARNING!

CAUTION!

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

This document and other information from HYDAC, its subsidiaries and authorized distributors provide product and/or system options for further investigation by users having technical expertise. It is important that you analyze all aspects of your application and review the information concerning the product or system in the current product catalog. Due to the variety of operating conditions and applications for these products or systems, the user, through its own analysis and testing, is solely responsible for making the final selection of the products and systems and assuring that all performance, safety and warning requirements of the application are met.

HYDAC does not assume the risk of and shall not be liable for failure due to fire. HYDAC offers fire safety devices and recommends their use.

The products described herein, including without limitation, product features, specifications, designs, availability and pricing, are subject to change by HYDAC Corporation and its subsidiaries at any time without notice.

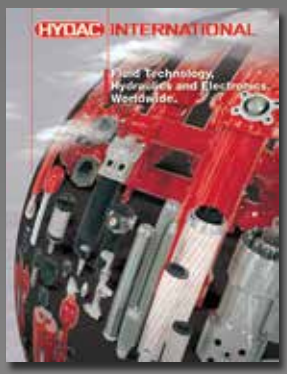
All accumulators should be visually inspected (signs of leakage etc.), tested for functionality and have a complete seal change out within 10 years of service.

Notes

Ordering HYDAC Literature...

HYDAC literature is available for ordering.
Email us at **HYD.catalog@hydac-na.com** using the appropriate Part Number (PN) and name. Other brochures, manuals and technical documents are also available when ordering from our website.

Overview Brochure
PN02088157



Filters Catalog
PN02081318

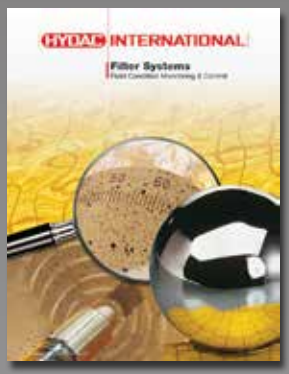
Accumulators Catalog
PN02068195

Compact Hydraulics Catalog* (online only)

Elec. Sensors & Controls Brochure PN2205620

Standard Coolers Catalog - PN02085359

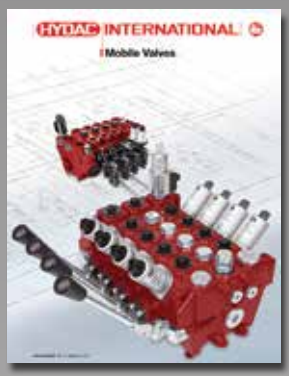
Filter Systems Catalog PN02075860



Control Technology* Catalog (online only)

Accessories Catalog PN02080105

Mobile Valves Brochure PN02092408



Hydraulic Cylinders Brochure PN2204454

Process Technology* Catalog (online only)

***These catalogs are digital file versions only.**

Various market and product brochures are also available for ordering.

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