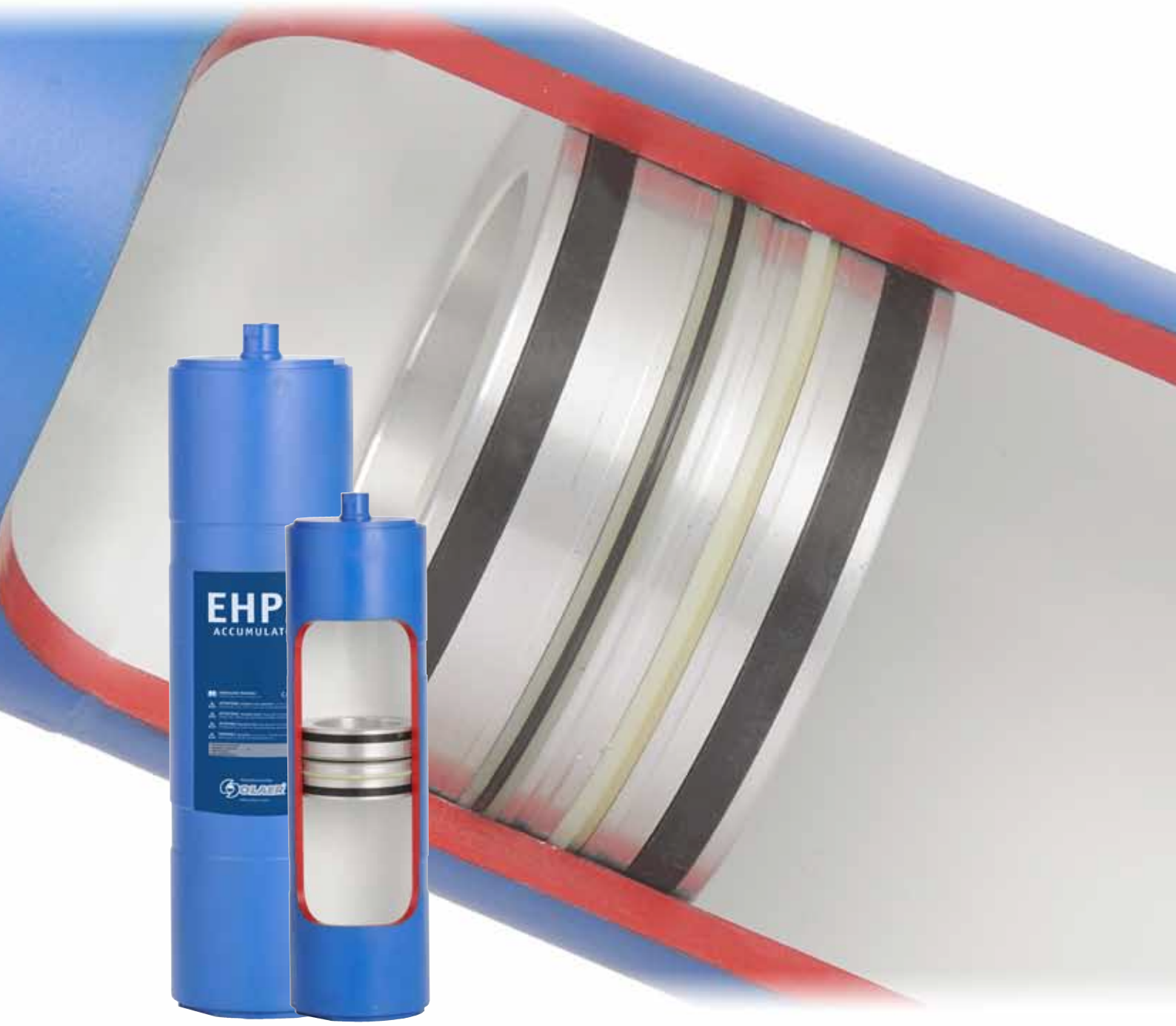
OLAER®

The Professional Choice

Piston Accumulator



General

Olaer, pioneer of high pressure equipment, was founded in 1938 by Jean Mercier. Since then the level of technical expertise and experience has grown considerably and Olaer have now been manufacturing piston accumulators for over 40 years. Ranging from small, light piston accumulators used in race cars to large, stainless steel, high pressure units used at 3-4000 m water depth, Olaer has done it all. This has lead to Olaer becoming one of very few global presences in piston accumulator technology.

Solutions developed by Olaer are used in a large number of industrial sectors: chemistry, defence weaponry, mining, railway equipment, Formula 1, machine tools, agriculture, oil and gas, marine equipment, metallurgy, renewable energies, etc. Olaer EHP piston accumulators are used everywhere.

This variety of applications requires extensive knowledge of the products and their major components, particularly the piston sealing system, but also advanced accessories and materials for extreme pressures.
For either a standard application or designing solutions for a specific requirement, Olaer engineers have extensive experience in the latest technological developments for metal and composite shells. This allows Olaer to propose reduced weight accumulators and other design innovations.

We provide cost effective solutions based upon our customer's needs. Olaer utilizes comprehensive tools and resources including an applications database, CAD, finite element analysis, reliability studies and simulation software which enable us to optimize design and performance. All this theory is backed up by physical testing, such as: fatigue testing of the pressure envelope and wear tests on our sealing systems with a variety of fluids and at extreme temperatures. For subsea installations we can also perform hyperbaric testing for protoype designs.

Operation

The OLAER gas loaded accumulator is an essential component for the optimum operation of a hydraulic circuit. In hydraulic circuits, the accumulator enables:

- An energy reserve which is instantaneously available to the system
- Compensation of pressure fluctuations and spikes
- Pump pulsation dampening

Advantages/Your benefits

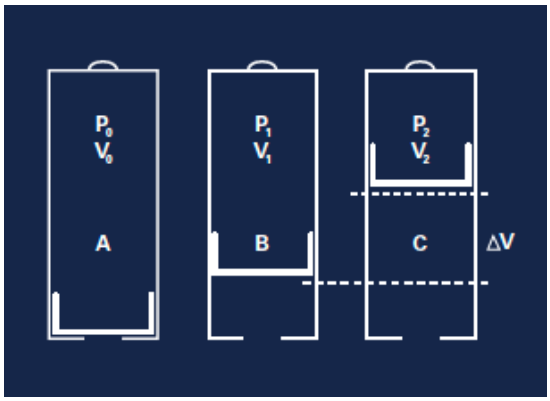
The gas loaded EHP piston accumulators provide major advantages in terms of the energy output of the system and maintenance of the installation:

- **Reduction in working costs**
  - Reduces installed electrical power
  - Significant energy saving
- **Increased lifetime of equipment**
  - Reduces pulsations
  - Protects against pressure peaks
- **Reduction in maintenance cost**
  - Reduces wear of hydraulic components
  - Requires minimum maintenance of the installation

Operating principle

Operation of the OLAER gas loaded EHP piston accumulator is based on the considerable difference in compressibility between a gas and a liquid, enabling a large quantity of energy to be stored in an extremely compact form. This enables a liquid under pressure to be accumulated, stored and recovered at any time.

When fluid under pressure enters the fluid side of the accumulator, the piston is pushed towards the gas side and the Nitrogen gas is compressed. Olaer's EHP piston accumulators can be supplied with a large variety of seals suitable for high and low pressures and temperatures as well as special fluids. This is part of the flexibility of the EHP, materials in all components can be chosen to best fit the application.



V0 = Capacity in nitrogen of the accumulator
V1 = Gas volume at the minimum hydraulic pressure
V2 = Gas volume at the maximum hydraulic pressure
ΔV = Returned and/or stored volume between P1 and P2
P0 = Initial preload of the accumulator
P1 = Gas pressure at the minimum hydraulic pressure
P2 = Gas pressure at the maximum hydraulic pressure

A - Piston in the precharge position, which means that the accumulator only contains nitrogen. The piston rests against the fluid end. The piston can be made from many materials, it is important to keep it light weight in order to reduce moment of INTERTIA.

B - Position at the minimum operating pressure. There should be a certain amount of fluid between the piston and the opening during normal operation. It is preferable that the piston does not hit the fluid end every time it operates. Usually the need for this fluid volume is smaller in a piston accumulator than in a bladder accumulator.

C - Position at the maximum operating pressure. The volume difference between the minimum and maximum positions of the operating pressures represents the working fluid quantity.

Technical Characteristics

The accumulator comprises of a pressure vessel, a piston and its seals.

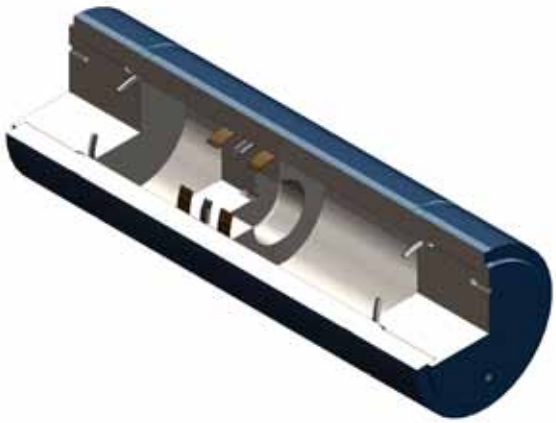
- Shell material options include standard carbon steel, alloyed steel, stainless steel, aluminium, titanium and composites. The main requirement is that the material is suitable and approved for use in pressure vessels.
- For most standard industrial and mobile systems the piston is made from light weight aluminium. To improve resistance to certain fluids, this is sometimes anodized. In special applications, the pistons are made from the same material as the pressure vessel. In some special applications, Olaer EHP piston accumulators can also be supplied with pistons made from composite materials.
- The sealing systems in the EHP piston accumulator are the key working components, and also where we have focused resources selecting the correct type and material. Depending on the customer application, our engineers will choose the most optimum solution.

Taking into account the different needs of various applications, Olaer proposes different corrosion protections external and/or internal: Bare metal, electroless nickel plating, standard primer, epoxy paint etc. This extensive range enables us to offer accumulators operating from – 45 to +200°C with pressures of up to 3000 Bar and capacities in excess of 1000 litres.

As one of few global companies in the piston accumulator market, Olaer has participated in the development of the EN 14359:2006 standard, which specifies the material, design, manufacturing, tests, safety devices and documentation (including the instruction manual), for pressure accumulators and gas bottles for hydraulic applications.

Basic accumulator design

The standard EHP accumulator consists of a tube with internally threaded ends. Into these are screwed end caps. These form the pressure envelope and are the components that make up the pressure vessel approval.



Threaded ring design

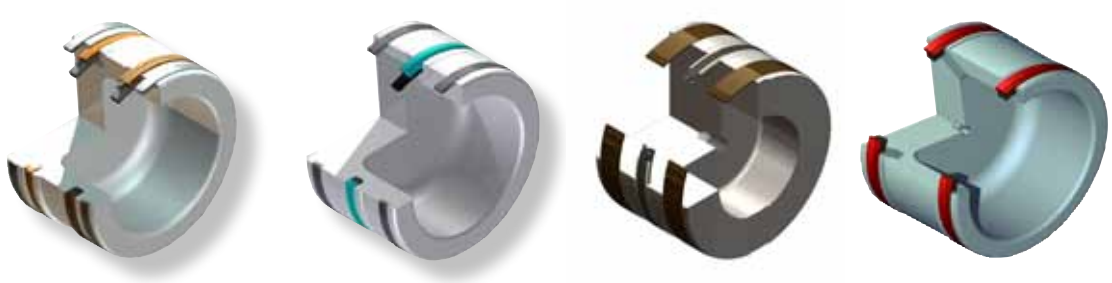
In some models (more common in large diameter EHP pistons) the end caps are retained in position using a threaded ring design. The tube or barrel is threaded on the inside as mentioned before, but the end cap itself has no threads. In large units this means that the end cap is recessed inside the ends of the tube. This helps reduce weight and in some models, cost. In some smaller diameter units where this solution is used, the end cap is flush with the threaded ring. This makes it easier to connect to the fluid side.

Different sealing solutions

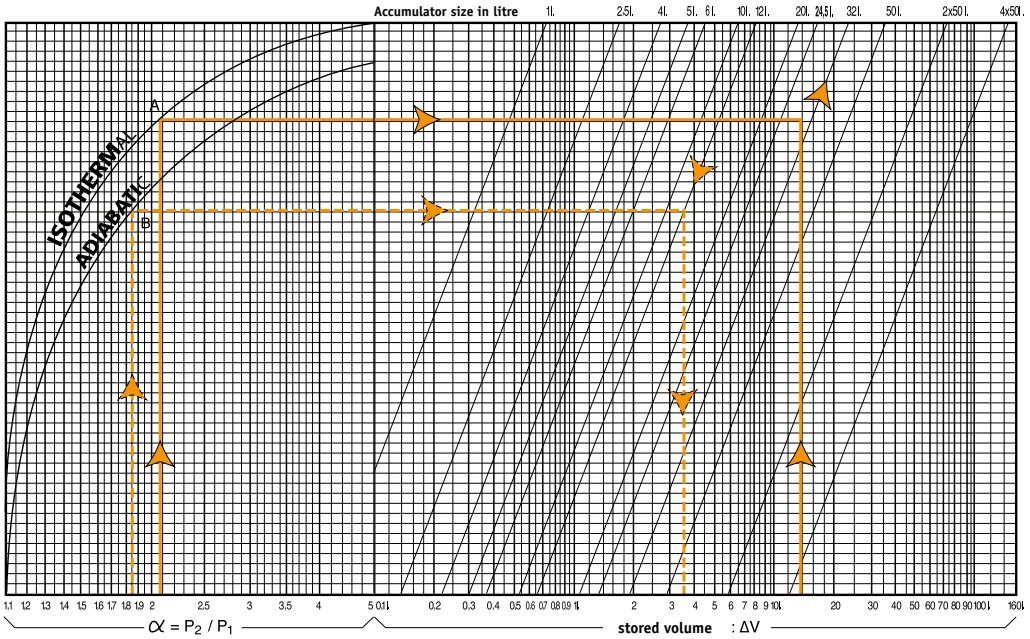
Olaer can offer many different sealing options depending on the application. There are many parameters that must be considered before deciding which system and which materials to use:

- The minimum and maximum operating temperature to be used in the system. It is important to have elastomers that can operate safely at the extreme temperatures of the application.
- The fluid type in the system also decides what elastomers to choose. There are water based fluids, mineral oils, synthetic oils and bio-degradable oils. They all have different characteristics.
- Required flow in and/or out of the accumulator. We will choose a system that can accept the necessary piston speed. Piston seals can experience hydroplaning. High speed systems are available.
- The maximum working pressure of the system. Some systems have a maximum pressure of 350 bar, but we also supply piston accumulators that operate up to 2500 bar. We can also supply sealing systems for this pressure range.

Also, please note that even if you have a sealing system that can accept a very high or very low temperature, it is important that you have a pressure vessel rated to these same extreme temperatures. The material properties change at extreme temperatures, therefore it is essential to select the appropriate piston to ensure safe and efficient operation.



How to size?



Basic sizing chart for acccumulator used in energy storage.

Olaer has developed very sophisticated simulation software to optimize accumulator sizing recommendations. The behaviour of accumulators used in applications such as pulsation dampening, surge alleviation, thermal expansion and energy storage can be simulated. Our software is available on CD-Rom and can be downloaded from our website. You may also contact your local Olaer office for sizing assistance.

The above graph is useful to estimate the size of an accumulator used to store or deliver a specific volume of liquid within a given pressure range. These curves are the graphic representation of an adiabatic* cycle (fast cycling rate - N = 1.4 perfect gas assumption) or isothermal* cycle for an accumulator working at 20°C with a precharge **P0 = 0,9 P1.**

They do not take into consideration the real gas compression correction factor, the real adiabatic coefficient and the polytropic rate of the application. Depending on the application data, the influence of these factors may be significant, and require that some calculations adjustments be made. The Olaer simulation software takes all these factors into account.

Sizing of an accumulator to be installed in the following example conditions:

P2 : Maximum available pressure : 210 Bar

P1 : Minimum working pressure : 100 Bar

P0 : Nitrogen precharge : 90 Bar

Condition : Isothermal (No temperature variation)

A/Compression ration α = P2/P1 = 210/100 = 2,1

B/From the value 2,1 on the α axis, draw a vertical line that intersects the isothermal reference curve in A.

C/From the value 14 on the ΔV axis, draw a vertical line. The intersection point of this line with the horizontal line meeting A indicates a required accumulator size of 32 L.

Calculation of the volume drawn off from an accumulator.

Accumulator size = 12 L

P2 = 185 Bar; P1 = 100 Bar;

P0 = 90 Bar; Adiabatic condition

α = P2/P1 = 185/100 = 1,85

*Reminder

Isothermal: The transformation is said to be isothermal when the compression or expansion of the gas occurs at a rate slow enough to allow a good thermal exchange, allowing the gas to remain at constant temperature.

Adiabatic: The transformation is said to be adiabatic when the cycle is quick and does not allow a temperature exchange with the ambient media.

Regulations

Olaer designs and manufactures gas loaded accumulators for use in all countries, as well as other industry specific approvals including oil & gas, naval and nuclear. The main regulations in force are PED for European market, ASME for US market and SELO for Chinese market and GOST R for Russian market. Others are also available.

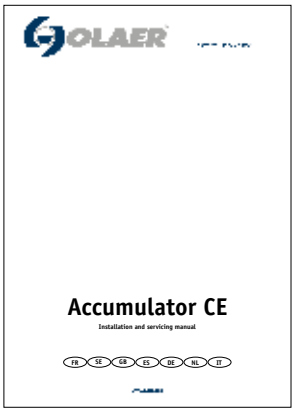
As a service, Olaer can recommend the appropriate regulations applicable if customers know the country where the accumulator will be installed.

When operating in dangerous and explosive environments, Olaer has designed an ATEX Group 2 cat. 2 range of piston accumulators.

Some of these regulations call for the use of safety devices to protect the accumulator against over pressure. Solutions may include hydraulic safety blocks, relief valve, gas side safety devices such as burst discs and fuse plugs.

Olaer has designed and proposed a complete range of safety devices suitable for the applicable regulations.

To meet the needs of our customers, Olaer can supply accumulators with multiple approvals.



Installation

Position: Preferably vertical (liquid connection downwards) to horizontal, depending upon application. If the accumulator is installed in the horizontal position, it is important that the system is clean and void of particles. These could potentially get lodged in the seals and cause wear on the inside of the cylinder.
Mounting: A 200mm clearance is required above the accumulator to allow for gas charging. Each accumulator is delivered with a user instructions leaflet.

Gas filling

For safety reasons, use only pure nitrogen, minimum 99.9% volume. In most of the cases the pre-charge pressure can be P1-5 Bar. But since a piston accumulator is not damaged by the pressure differential, it is possible to go very low compared to max pressure. Your local Olaer office can calculate the correct pre-charge pressure for your application. Olaer offers a range of devices for checking nitrogen pressure as well as pre-charging accumulators.
Please note that various adaptors are required to interface with different accumulator filling valves and nitrogen (N_2) cylinder connections throughout the world.

Labeling and Marking

Important identification on an accumulator:

Note: For some special approvals, the markings and name plate may be different due to regulation requirements.

The part number defines the accumulator and the material construction.

Information contained on the labelling/manufacturer's plate:

- Olaer logo
- Product description
- Date or year of manufacture
- Reference information of the accumulator
- Allowable temperature range of the accumulator

Additional information on certain models:

- Warning messages and safety instructions ("Danger", "Use nitrogen only" or similar message)
- Maximum inflation pressure P0 max in bar
- Allowable pressure amplitude ΔP max in bar
- Fluid group (1 or 2 according to the Directive 97/23/EC)
- Total dry mass in kilogram

Maximum allowable operating pressure

The maximum pressure (PS) is indicated on the accumulator. Check that the maximum allowable pressure is greater than that of the hydraulic system. For any other pressure, please contact Olaer.

Maximum allowable operating temperature

The temperature range (TS) is indicated on the accumulator. Check that the allowable temperature range covers the operating temperatures (environment and hydraulic fluid temperatures). For any other temperature, please contact Olaer.

Cleanliness

Increasing more and more systems require high levels of cleanliness for new components. This is largely due to either the critical nature of the components and systems (e.g. aircraft) or because of the installations where unscheduled (or even scheduled) maintenance is costly.

Olaer routinely delivers accumulators according to ISO4406, down to 15/13/10. Examples of this include aerospace applications, wind turbines, offshore/subsea oil & gas installations. If required we can also deliver to other standards.

Accessories

Burst disc assembly

All gas loaded accumulators are gas pressure vessels. Depending on the regulation, a burst disc could be fitted to protect the accumulator, in addition to the relief valve protecting the hydraulic system. All Olaer accumulators can be supplied with Olaer burst discs.

Clamps and brackets

A complete range of standard clamps and brackets both in carbon and stainless steel are available. These fit most standard sizes. For certain very large units, special clamps have to be manufactured which are not stock items.

Nitrogen precharge equipment

The universal charging set VGU fits most accumulator models supplied by Olaer and most other manufacturers of accumulators. In addition there are simpler versions available that are manufactured specifically for each type of gas valve.

Gas cylinders

Olaer have a number of different gas cylinders available that can be used as gas back-up bottles. This increases your total system volume at a greatly reduced cost. The cost/volume of most gas cylinders is less than ¼ of a similar sized piston accumulator. If there is a total volume requirement of 100 litres, a considerable saving could be made by having one accumulator and one gas cylinder. Most applications you can normally have 2/3 volume as gas cylinder and 1/3 as accumulator. In some cases it can be as much as 4/5 gas or more. To make sure you get the optimal solution, please use our sizing software. An Olaer representative can also help.

Accessories

Safety Blocks

Olaer has developed a complete range of safety blocks (sizes NG 10 to 50) suitable for all standard and special applications. The blocks are used for isolation and pressure relief and contain a safety valve.

The blocks are in conformity with the European Directive on equipment under pressure (97/23 EC). The safety blocks are designed as compact units, with all the components necessary for the correct operation of a hydraulic system equipped with gas loaded accumulators.

More detailed information about the sizes and the internal valves, etc. are available in our specific data sheet for safety blocks. Special, custom made blocks are also available if your needs fall outside our standard range.

Piston Position Indicators

A great feature of piston accumulators is the possibility to indicate the position of the piston. From a safety perspective this could be extremely useful as the piston position along the with pressure in the accumulator can help to confirm that the piston is operating safely.

There are many versions of indicators, giving a total of 3 different types of information:

1. A visual indication. This allows the operator or maintenance personnel to make sure the piston is in an “allowed” position. This can be in the form of a physical rod extending on one side of the accumulator. The rod is connected to the piston. The visual indication can also be in the form of a coloured indicator operated by magnets in the piston, or on an external tube.
2. On/off indicators. These are normally magnetic switches operated by magnets inside the units or inside tubes outside the accumulator. This will normally be a « yes » or « no » signal, indicating wether the piston is in a « good » or « bad » position. The solution can also be a mechanical switch if the base unit has portruding rods.
3. Analogue indicators. These are normally calibrated to give a 4-20mA signal indicating the extremes of the stroke. The signal can come from a wire indicator mounted inside the piston accumulator or an analogue reader attached to the accumulator or a stainless tube outside the accumulator.

Accessories

Wire & Potentiometer System

This consists of a wire connected to the piston. The other end spools onto a reel connected to a potentiometer. The system is supplied as a complete set with an external electrical box. The output is a 4-20mA signal. The system can be used in most piston accumulators with internal diameter >140mm.

Description of equipment :

- The internal wire system can operate up to a max piston speed of 2,5 m/s.
- The electrical pass-through is used up to 350 bar working pressure.
- The standard version includes an electrical box with a 4-20 mA converter.

	Part Description
1	Wire transducer with resistance analogue output signal (Std. 0-1 KΩ)
2	Standard signal converter 4-20 mA
3	Electrical connector for high pressure
4	Wire connector
5	Piston
6	Spacer
7	Cable glands IP 68 or sheath glands IP 65
8	Control cable (3 wire OD 0.5 mm)
9	Sheath

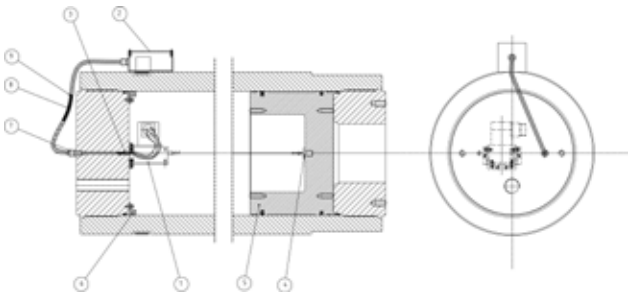


figure 1

Bent Tube Indicator (BTI)

This is a tried and true system that can be used on any size accumulator. It can be fitted with visual indication, magnetic switches to indicate if the piston is in a « good » area, or an analogue indicator, with a 4-20mA output. The system consist of a pressurized tube connected to the gas side of the accumulator. Inside this tube is set of magnets connected to the piston via a thin line. When the piston moves up, the magnets move down.

Different equipment mounted on this tube will give information according to the customer requirements.This system can be used up to several thousand bar.

Magnets inside the piston

This system works for low pressure piston accumulators, usually less than 450 bar. It is a requirement that the accumulator body is made from non-magneting stainless steel (ex. AISI 316). On the outside it is possible to fit visual, digital or analogue indicators.

External rods

These can extend from either end of the unit. This is potentially a hazard, since the rod moves with the piston, and it can move fast. The rod is a visual indicator in itself, it can also be fitted with magnets to operate other indicators.

Stroke or end position switch operated by a pin in a shroud. This can be used for vertical installations only. A pressurized tube is fitted to the gas end of the accumulator. A pin with magnets hangs inside and is pushed up by the piston. The movement can be registered by all three types of indicators.

Systems

Accumulator stations

Olaer can provide an additional service for customers who would like their accumulators and gas cylinders positioned in racking with connecting pipework manifolds and valves. The systems can be load tested, painted and flushed according to customer requirements. The Olaer technical teams are highly experienced with dedicated team members for this service, which can save customers valuable time and resources. Please contact Olaer for further information about this service.

Piston accumulator with supplementary gas bottle rack
Product function : lubricating axial pump / Safety action for turbines

Accumulator rack for a Governor Hydraulic System for a hydro power station to replace original equipment installed in 1932.
Two stations supplied to Ross-shire Engineering Ltd, Ross-shire, Scotland. 2008

Accumulator rack with N2 back up bottles fitted with gas and fluid manifolds, for controlling the safety valves on the Changi Water Reclamation Plant in Singapore, installed in 2003.
Accumulators fitted with end of stroke piston positioning sensors.

Piston accumulator with supplementary gas bottle rack for steelmaker lubricating system
Product function : hydraulic and lubricating system

Accumulator rack used for heave compensation on a ship when lifting in ultra-deep waters using synthetic wire.
Product Function: Heave compensation

The Professional Choice

- in Fluid Energy Management

Global perspective

and local entrepreneurial flair

Olaer is a global player specialising in innovative, efficient system solutions for temperature optimisation and energy storage. Olaer develops, manufactures and markets products and systems for a number of different sectors, e.g. the aircraft, engineering, steel and mining industries, as well as for sectors such as oil and gas, contracting and transport, farming and forestry, renewable energy, etc.

All over the world, our products operate in the most diverse environments and applications. One constantly repeated demand in the market is for optimal energy storage and temperature optimisation. We work at a local level with a whole world as our workplace – local entrepreneurial flair and a global perspective go hand in hand.

Our local presence, long experience and a wealth of knowledge combine with our cutting-edge expertise to give you the best possible conditions for making a professional choice.