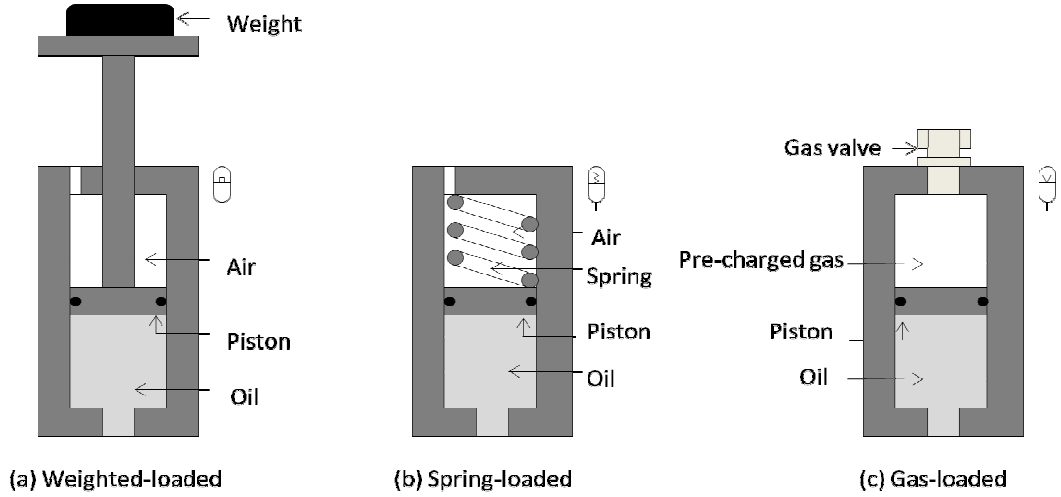
Hydraulic Accumulators

As we are aware, accumulators are used for storing energy, absorbing shock pressures and/or dampening pulsations in hydraulic systems. Apart from these functions, they are also used for leak compensation. The use of an accumulator in a system with intermittent duty cycle permits the use of a smaller capacity pump. The article attempts to refresh the salient features of accumulators for stimulating your thoughts on this important hydraulic component. You may accumulate more information on the topic from the textbook as mentioned under the reference.

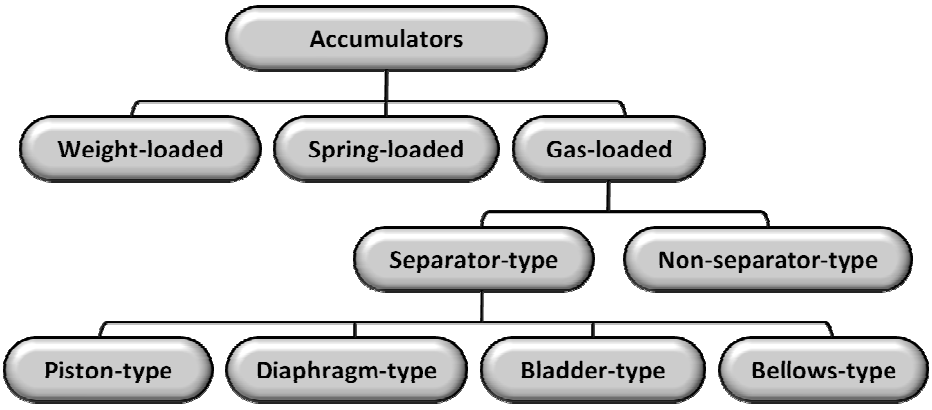
Basic Working

An accumulator mainly consists of a pressure vessel (shell) in which a fluid is held under pressure by a spring or a raised weight or a volume of compressed gas. It is, thus, possible to store potential energy in the accumulator, when the associated system pressure is greater than that of the accumulator. The accumulator can release the stored energy back, when the system pressure falls below that of the accumulator. Steel, aluminium, or composite materials can be used for the construction of the accumulator parts.

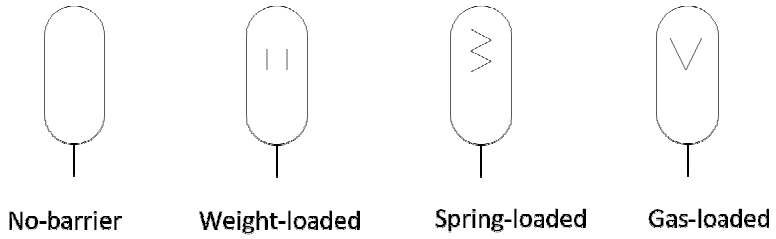


(a) Weighted-loaded (b) Spring-loaded (c) Gas-loaded

Accumulator Types



Accumulator Symbols



General Constructional Features

It consists of two chambers separated by a piston/ diaphragm/ bladder (bag). One chamber is for admitting the fluid, and the other one for maintaining a weight/ spring/ pressurized gas.

Weight-loaded Accumulator

The piston along with the dead weight is raised when the fluid under pressure works against the piston. The weight exerts a downward push on the piston due to gravity. It produces a constant fluid pressure throughout the volume output of the unit. It is bulky/cumbersome/expensive.

Spring-loaded Accumulator

The piston in the chamber is pre-loaded with a spring. As the pressurized fluid enters the chamber, the spring gets compressed. The pressure does not remain constant, during its period of operation. It is suitable for low-pressure, low-volume hydraulic application.

Gas-charged Accumulators

A hydro-pneumatic accumulator consists of a cylinder with two chambers that are divided by a piston/ diaphragm/ bladder. Accordingly, the basic types are: Piston Type, Diaphragm type, and Bladder type. A fill port in the gas accumulator is provided to supply nitrogen gas and another port for the hydraulic connection at the opposite end. The piston/bag type accumulators are cylindrical; diaphragm accumulators can be spherical or cylindrical in shape. Before proceeding to the explanation about these types of accumulators, a brief account of the accumulator pre-charging is presented.

Accumulator Pre-charging

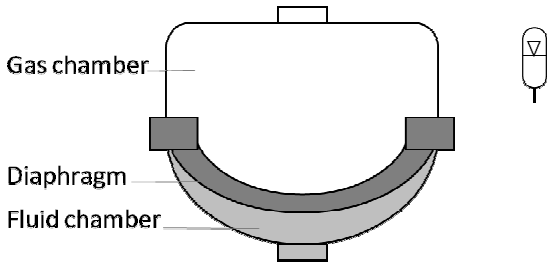
A hydro-pneumatic accumulator must be filled with nitrogen gas while there is no fluid in the fluid chamber. The pre-charge pressure along with the accumulator volume determines the maximum stored energy. In general, it is pre-charged to a certain percentage of the minimum system pressure. Typically, the pre-charge pressure of an accumulator for the energy storage application is 80% to 90%. The pre-charge pressure for a pulsation compensator or a shock absorber is typically 65% to 80%.

Piston-type Accumulator

It consists of a cylinder (or shell) with finely finished internal surface and a freely floating and light-weight metal (typically aluminium) piston. The movable piston separates the cylinder into a fluid section and a gas section. The gas section is pre-charged with dry nitrogen gas. Compression ratio (the ratio of the maximum system pressure to the pre-charge pressure) is high, that is about 10.

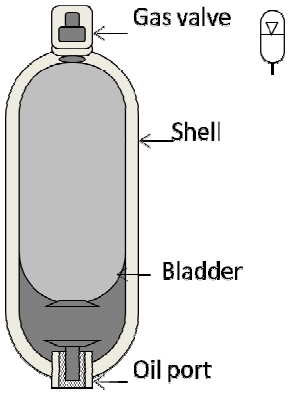
Piston type accumulators provide higher flow rates than other types of gas accumulators. They are portable and can handle a broad range of temperatures. They have better damping capability. However, they are susceptible to the fluid contamination, and they exhibit hysteresis due to the seal friction.

Diaphragm Accumulator



It consists of two steel shells (hemispheres) and a flexible synthetic diaphragm. The diaphragm is used to separate the gas and the fluid sections. The diaphragm is typically made of Buna-N, Viton, Butyl, or Hydrin. Where contamination is a serious problem, a vertical mount is preferred. It is fast acting and does not exhibit hysteresis. It reacts quickly to changes in the system pressure. The compression ratio is about 8.

Bladder Accumulator



It consists of a pressure vessel (shell) and an elastomeric bladder (bag). The bladder divides the shell into a fluid chamber on the system side and a gas chamber inside the bladder. The gas chamber is pre-charged. Materials for the bladder: Buna-N (Standard material), chloroprene, nitrile, Viton, Butyl, and Hydrin. Bladder accumulators are fast acting and do not exhibit hysteresis. The compression ratio for bladder accumulators is limited to 4.

Safety Requirements

A hydraulic accumulator is a pressure vessel that stores an enormous amount of potential energy. Accumulators can be dangerous to personnel and property if they discharge stored pressure inadvertently. They are subject to regulations applicable to the one's region. It is necessary to isolate the accumulators from the associated systems and discharge pressures from the accumulators, during periods of maintenance or emergency. Typically, safety devices must be incorporated to provide a shut-off, pressure-limiting, and pressure relief features.

Application Areas

For the purpose of shock suppression, they are used in presses, vehicles, and equipment used in the construction, offshore, and mining fields. Accumulators can supplement the pump flow in aircraft landing gear, which require a large volume of fluid.

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Reference: JOJI PARAMBATH, Industrial Hydraulic Systems – Theory and Practice, Universal Publishers, Boca Raton, USA, 2016. Please visit: http://www.universal-publishers.com/book.php?method=ISBN&book=1627340580

Note: A comprehensive account of the topic is given in the textbook on 'Industrial Hydraulic Systems-Theory and Practice' by Joji Parambath.