Hydraulic accumulators

Know your legal obligations

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Users operating hydraulic systems for power transmission purposes may well be inadvertently operating outside of applicable government legislation. Although the applicable regulations are inconsistent, ignorance is no excuse.

1 Before we begin

This article contains abstracts and interpretations of South African legislation. Users of accumulators should ensure that they comply with all applicable legislation and should not rely solely on the contents and interpretations of the authors or publishers of this article.

2 Accumulator Whys & Wherefores

Hydraulic power systems incorporate accumulators to store energy, thus temporarily reducing the pumping capacity requirement of the system.

Sci-Tech Encyclopedia defines a hydraulic accumulator as: “A pressure vessel which operates as a fluid source device or shock absorber. It is used to store fluid under pressure or to absorb excessive pressure increases. The hydraulic accumulator is an energy-efficient component, which allows the use of a smaller pump to achieve the same end results in terms of cylinder rod actuation speeds. In certain circuit designs, the accumulator will permit a pump motor to be completely shut down for an extended period of time while the accumulator supplies the necessary fluid to the circuit.”¹

Accumulators use various techniques to achieve their purpose:

- Deadweights
- Spring-loading
- Hydro-pneumatic systems

“Ignorance of the law excuses no man: Not that all men know the law, but because ‘tis an excuse every man will plead, and no man can tell how to refute him.” John Selden (1584 - 1654)
2.1 **Deadweight accumulators**
In these accumulator designs, system pressure works against a piston which supports a weight, so the energy store is in the form of potential energy.

2.2 **Spring-loaded accumulators**
In spring-loaded accumulators the system hydraulic pressure pushes against a piston which is resisted by the compression of one or more springs.

2.3 **Hydro-pneumatic accumulators**
Hydro-pneumatic accumulators, which are also known as compressed gas (or gas-charged) accumulators, are the most common form of accumulator.

A compressed gas accumulator consists of a cylinder with two chambers that are separated by an elastic diaphragm, a totally enclosed bladder, or a floating piston. One chamber contains hydraulic fluid and is connected to the hydraulic line. The other chamber contains an inert gas under pressure (typically nitrogen) that provides the compressive force on the hydraulic fluid. Inert gas is used because oxygen and oil can form an explosive mixture when combined under high pressure. As the volume of the compressed gas changes the pressure of the gas, and the pressure on the fluid, changes inversely.²

3 **Applicable legislation**
There are two primary sets of legislation that apply to accumulators in South Africa:

- The Vessels Under Pressure Regulations incorporated in the Occupational Health and Safety Act, 1993 (OHSA)
- Section 23 of the Mine Health and Safety Act, 1996 (MHSA)

These deal with the definition of pressure vessels, and their design, construction, manufacture, maintenance, repair and testing.

4 **Most accumulators are pressure vessels**
OHSA defines a pressure vessel as “…any vessel of which the interior or jacket is under pressure or in which a cushion of gas or vapour can form above the liquid at a pressure in excess of that of the atmosphere, including a diving bell …” and then lists a series of exceptions. The main exclusions that concern this article are:
(g) a vessel of which the product of the design pressure in Pascal and the capacity in cubic metres is less than the figure 15 000;
(h) a vessel of which the design pressure is less than 40 000 Pascal gauge pressure;
(i) a vessel with a nominal internal diameter of less than 150 mm;

Hydraulic accumulators are commonly operated in the 200 – 300 bar range (20 000 000 – 30 000 000 Pa). So that would indicate that any accumulator of over 0.75 litres and operated at 200 bar, or over 0.5 litres and operated at 300 bar would be considered a pressure vessel if its internal diameter is 150 mm or greater.

5 Design, construction and manufacture
OHSA requires that a pressure vessel manufactured after 23 October 1991:
- Must be designed and constructed in accordance with a health and safety standard incorporated into these regulations.
- Must be manufactured under the supervision of an approved inspection authority.

It also requires that the user must be in possession of a certificate of manufacture issued by the manufacturer.

6 Appurtenances (Safety block)
Certain fittings are essential for the safe and legitimate operation of a pressure vessel. The vessel must be fitted with:
- At least one pressure gauge and the maximum permissible operating pressure must be clearly marked with a red line on the dial of the pressure gauge.
- At least one safety valve and such safety valve shall be kept locked, sealed or otherwise rendered inaccessible to any unauthorised person.

For practical purposes, although not required by law, it is recommended that an accumulator is connected to its associated hydraulic system via an isolating valve so that the accumulator can be removed for maintenance or tested separately from the overall system. (See fig.1)

7 Inspection and test
OHSA requires regular inspection and test for pressure vessels. The hydraulic test is specified as 1.25 times the maximum permissible operating pressure whereas the MHSA requires that the vessel be tested to 1.3 times maximum permissible operating pressure (MPOP).
At an MPOP of 250 bar the MHSA requirement implies a test pressure of 325 bar.

OHSA inspections and tests must be performed within 36 months of the date of the previous internal and external inspection and hydraulic pressure test and may only be performed by a holder of a certificate of registration issued by an organisation approved by the chief inspector. The S A Institute of Welding refers to such an individual as a ‘Competent Person’.

In terms of OHSA, where a pressure vessel is not subjected to corrosion, the user may dispense with the internal inspection and hydraulic pressure test subject to the written approval of an approved inspection authority. Such an exemption is unlikely for hydro-pneumatic accumulators because they are subject to possible erosion as a result of bladder movement as the pressure changes.

Users are required to keep on the premises the records of all inspections, dated and signed by the competent person and tests, and they must be open for inspection by an inspector.

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**Figure 1. Typical hydraulic safety block for an accumulator.**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QTY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1</td>
<td>TANK</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>ISOLATING VALVE</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>FLOW CONTROL VALVE</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
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<td>5</td>
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<td>RELIEF VALVE</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>PRESSURE GAUGE</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>ACCUMULATOR</td>
</tr>
</tbody>
</table>
8 Repairs
The Competent Person as defined by the S A Institute of Welding may only perform inspections and tests; he may not carry out repairs.

The Approved Inspection Authority (AIA) must approve the original design and inspect the manufactured vessel and all modifications to the vessel.

Because of the regulatory issues involved it is normally cheaper to buy a new accumulator than to repair or modify one where the shell requires maintenance.

9 Imprisonment and fines
Anyone who contravenes or fails to comply with the relevant provisions of OHSA is guilty of an offence and if convicted may be imprisoned for up to twelve months. There are also provisions in the Act for levying fines.

10 Hyflo inspection and test capabilities
Hyflo operates accumulator test and inspection facilities at its Johannesburg and Cape Town branches. Here the company has the facilities and personnel with the necessary competency to perform and sign off on tests and inspections in terms of OSHA and MHSA.

Accumulators are visually inspected and then tested to 1,3 * MPOP. If any permanent plastic deformation is recorded the accumulator is failed and no longer fit for service.

Hyflo have several staff members who have already passed the S A Institute of Welding requirements to become certified as inspectors and several more are currently studying towards this qualification.
Hyflo’s high pressure test facility, which can test up to 450 bar, is located below ground for safety reasons. Here an accumulator is about to be lowered into the test chamber.

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11 References
2. www.wikipedia.com