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Hydraulic Power Pack

A hydraulic power pack transforms the power conveyed by its prime mover to hydraulic power, at pressures and flow rates as required for all the system actuators. It is usually a compact, portable, and pre-configured assembly that contains components required to store and condition a given quantity of fluid, and push part of the fluid into the system. A typical power pack can be constructed in a modular fashion with some key and some optional components. The key components are the reservoir, pump-motor unit, relief valve, pressure gauge, and level gauge. The optional components are the filters and control valves. It may also include necessary instrumentation, and other accessories, such as the accumulator, cooler, hoses, and quick-disconnect couplings.

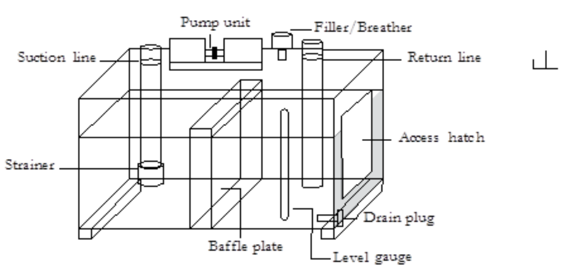
Hydraulic Reservoirs

Any hydraulic system requires a sufficient amount of high-quality fluid at all times for its efficient operation. The fluid is drawn and pushed by the pump, circulated continuously through various intermediate components to system actuators, and then carried back to the reservoir. The circulating fluid is liable to accumulate contaminants and absorb heat from the system. Therefore, the fluid must be serviced before it is pumped again into the system.

A well-designed reservoir:

- allows a reasonable dwell time for the fluid,
- allows most of the contaminants to drop out,
- assists in dissipating the heat,
- allows air bubbles to come to the surface and dissipate,

Constructional Features



A typical reservoir is provided with many components, such as:

- Baffle plate
- Suction line
- Return line
- Breather with air filters
- Suction strainer/filter
- Fluid-level sight-windows/indicators
- Pressure gauges
- Removable cover
- Drain plug
- Magnetic tank cleaners,
- Diffuser
- Thermometers

In order to get a better fluid cooling and eliminate corrosion, reservoirs are made of materials, such as mild steel or stainless steel or anodized aluminium. Reservoir manufacturers also make them from durable polyethylene material with no seams to leak, and no rust and no welding slag to breed contamination.

Baffle Plate

A baffle plate is fitted lengthwise through the middle of the reservoir. Its purpose is to separate the suction chamber from the return chamber. It is usually sized to a height of about 70% of the maximum height of the fluid level in the reservoir. The bottom corners are cut diagonally to provide openings for the fluid to equalize the fluid levels on both sides. This ensures that the return fluid takes a circuitous path through the reservoir, avoiding the same part of the fluid circulating continuously. This also provides more time for the contaminants to settle within the reservoir and assists the reservoir in dissipating heat as quickly as possible. It also assists in de-aerating the fluid.

Suction Line

The suction line is used to carry the fluid to the inlet of the pump. Its bottom end should be located a distance above the bottom floor, so as to prevent the settled contaminants from entering the pump again. A suction line is usually fitted with a strainer and/or suction filter.

Return Line

The return line is used to carry the return fluid from the system back to the reservoir. Suction line and return line may be located at the same side of the reservoir, but, on either side of the baffle plate. The return line must terminate below the fluid level and up to a height two to four times the pipe diameter above the base plate to reduce the turbulence and foaming.

Filler-Breather

The opening provides a path for filling the reservoir during the fluid replacement time. It also allows a passage for the air to breathe in and out of the reservoir during the operating time to equalize the interior & exterior pressures. An air filter of five microns (or better) prevents the ingress of airborne contaminants into the reservoir. The breather may include a quantity of desiccant material (silica gel) for the dehumidification of the inflowing air.

Strainer/ Suction Filter

A strainer and/or suction filter are fitted to the suction line to prevent dirt, grit, sludge, rust, and other contaminants from entering the pump. A suction filter must be fitted in a service-friendly manner so that it is easy to maintain and replace the filter.

Fluid Level Indicators

The fluid level monitoring is assisted by a sight window or a fluid level indicator or by using a level gauge. The sight window/fluid level indicator is provided for a quick visual inspection. The transparent fluid level indicator is made of materials, such as polyamide resin, and is protected with steel guard. Integrated level gauges, such as a dipstick, can also be used to monitor the fluid level.

Pressure Gauge

The use of the pressure gauge is a safety measure as it monitors over-pressures and assists in troubleshooting.

Removable Covers

A reservoir must be designed for easy access to clean out all the residues and rust that may have accumulated in the reservoir, and for flaking paint. The periodic servicing and cleaning activities can be carried out quickly if an opening with a large removable cover is fitted as part of the reservoir.

Drain Plug

The bottom part of the reservoir is usually provided with a downward gradient and a drain plug at its lowest point so that the system fluid can be drained completely without any difficulty.

Diffusers

It is used in combination with return-line filter to slow down the return fluid. The reduced velocity prevents foaming and re-suspension of deposited dirt. It reduces turbulence/noise. A screen can also be installed at an angle to collect bubbles that can go to the surface and get dissipated.

Magnetic Tank Cleaners

Tank cleaners with permanent magnets can be used for attracting and holding the abrasive ferrous particles.

Sizing of Reservoirs

The size of the reservoir must ensure that the fluid in circulation has a reasonable dwell time, dissipate heat quickly, suppress turbulence in the fluid, and release any entrained air. An undersized reservoir is liable to produce higher fluid temperatures. For a hydraulic system, where mineral fluids are used, and medium-to-high frequency demands are expected, a reservoir with a capacity of three to five times the volume flow rate of the system fluid is adequate.

Reservoir size,m^3 = (3 to 5)xQ m^3/min
Reservoir size,litre = (3 to 5) Q lpm
Reservoir size,gallons = (3 to 5)xQ gpm

With this general rule, the fluid returned to the reservoir has three to five minutes of dwell time in the reservoir before it circulates again.

Heat Exchangers

Heat is usually generated in a system due to its inefficiency or poor design. If the cooling effect from the reservoir is insufficient, a heat exchanger (or cooler) must be fitted to increase the heat dissipation rate. Heat exchangers are expensive, and maintenance of them can run high. Types: (1) air-cooled heat exchangers and (2) water-cooled heat exchangers.

Air-cooled Heat Exchanger

When the heat to be removed is comparatively small, an air-cooled heat exchanger can be used. It consists of a blower and a radiator. Airborne contaminants in the atmosphere surrounding the blower, such as heavy dust, water, and coolant vapors can quickly reduce the efficiency of the air-cooled heat exchanger.

Water-cooled Heat Exchanger

When the heat to be removed is high or its surrounding atmosphere is liable to be very hot, a water-cooled heat exchanger should be used. In a typical water-cooled heat exchanger, the fluid is passed through the tubes and cold water is passed through the shell. The heat from the fluid is carried away by the relatively cold water.

Noise Reduction Techniques

It is necessary to design hydraulic systems especially the power units with appropriate noise reduction techniques to reduce the damaging effects of noise. In general, noise can be controlled by (1) using quieter work processes, (2) enclosing the machine to reduce the noise at source, and (3) using sound-absorbing materials. An integrated motor-pump unit has very low sound levels. Many other factors, such as mounting, tank style, and plant layout, affect noise levels.

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.