Hydraulic Fluid Filtration and Contamination Control

Presented by: Ernie Parker
Fluid Power Engineering Technology Instructor
Hennepin Technical College
Where do we install filters?

- Inlet strainer/filter to a pump
- Pressure line filter (high pressure)
- Return line filter
- Kidney loop filter
Advantages of an Inlet Filter

Usually a strainer

Catches the nuts and bolts that are dropped into a reservoir

Cheap
Disadvantages

Causes cavitation

Increase risk of aeration due to weak shaft seals or worn bearings.

Many are be very difficult to clean

Many don’t have a bypass for cold or dirty oil

Filter would need to be size twice as large as a strainer
Bypass valve and indicator need to be set at 3 PSI or less.

A typical filter may have the bypass spring as high as 50 PSI.

A vacuum will never open it.
Filters that are mounted on the top of reservoirs cause cavitation by being mounted within 10 diameters of the inlet plumbing to the pump. You draw the oil up and spin it around inside the element and send it out at a right angle all turbulent.
The best inlet plumbing will have all of the valves, strainers, elbows and the like at least 10 diameter of the inlet hose from the pump.

If not, you could still have a positive inlet pressure and still cavitate causing contamination and excesses wear.
Submerging a pump in the reservoir without any plumbing will still cause cavitation.

Inlet acts as an orifice.

One needs at least a 10 diameter inlet line of laminar flow prior to the pump. If tubing is used in the tank, flare the end and don’t use any elbows.

Normal tube bending is ok.
Try to never use an elbow, tee or anything that will cause turbulence right at the inlet.

Proper plumbing will quiet the system by at least 3 DBa and I have seen a 10 DBa drop and then can pull upwards of 27 inch of Hg without cavitation.

Flange fittings work the best at the pump.
If possible, use charge pressure filtration instead of an inlet filter.

Major corporations suggest an inlet filter of 10 microns without a bypass.

In theory that would be great, but in reality, as the filter starts to load up, it causes cavitation and you put all of the contaminates right into the pump that you are trying to protect.
By using charge pressure filtration in your hydrostatic system, you don’t destroy the charge pump from cavitation and you can catch particles just before entering your expensive pump.

Charge pressure filters need a littler higher pressure rating as they may see between 50 to 500 PSI.
Many times the charge pressure relief dumps excess oil into the case of the hydrostatic giving a constant and steady flow through that filter and that makes for better filtering.
Advantages of a pressure line filter

Catches contaminate before it enters the system of critical components. Strongly recommended for servo systems, load sensing, proportional and other expensive components.

Helps to maintain a system working at it best.
Disadvantages of Pressure Filters

Cost

With pressure compensated pumps, your filtration is limited to the flow of the pump and doesn’t work in the standby conditions.

As valves shift the flow will also change and shock the filter, reducing the efficiency of the filter.
Advantages of a Return Line Filter

Inexpensive

They can filter oil returning from cylinders with poor wiper seals.

Also filters contaminates that enter through the use of quick disconnects when they are connected.

Helps to keep the reservoirs cleaner.
Disadvantages of Return Filters

Does not catch contaminate from the reservoir breather/vent.

The velocities vary greatly with large pressure spikes.
Calculate the return line flow with a 4” x 20” x 3” cylinder that is supplied with a 10 GPM pump.

Cap end area = 12.566 sq. in.

Rod end area = 12.566 - 7.068 = 5.5 sq. in.

Ratio is 12.566/5.5 or 2.286:1

10 GPM x 2.286 = 22.86 GPM
If using a fixed displacement pump, the flow would change as the directional valve is shifted from:

Neutral 10 GPM  
Extension 4.368 GPM  
Return 22.86 GPM
Kidney Loop or Off-line Filtration
Kidney Loop Filtration

Most efficiency and cost effective in the long run.

The pump could be piggy back on other pumps or electric motor shaft.

Better yet is a small electric motor to run additional hours over the regular system.

Flow is constant
I have seen circuits using a gear type proportionator to step up the flow with a small amount of return line flow.
I have built a pressure fatigue bench that cycled from 0 to full pressure between 3 - 7 Hz running 24/7 that ran for over 20 years at 122 degrees F with over 15,400,000,000 documented cycles (multiple stations with one pump).

It contained a inlet filter, pressure, return line, & kidney loop filters rated close to 1 micron
It takes extra filtration to super clean a system, but once it is clean and without outside contaminates entering the system, the filter will last much longer than normal.

Keeping the oil truly under 140 degrees F. and clean, you will not normally need to replace the oil.
Additional Contamination Control

Reservoir Breather
Filter-desiccant breathers
Water Removal
Tank drain at bottom for water
One company has a system with multiple large air tanks attached to the reservoir to keep all contaminate out of their system without have much of a change in reservoir pressure that would affect case drain back pressure.
Filter Buggy with Filters in Series

3 Micron

10 Micron

25 Micron
Filter Buggy with Filters in Parallel
And you thought your job sucked.
Additional components to help keep a system clean

Cylinder boots or bellows

Reservoir membranes

Seals around reservoir covers, plates, and plumbing coming out of the top