LUBRICATION FUNDAMENTALS

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The basics of filters and filtration

Establishing a good relationship with your supplier is the best strategy to using these materials successfully.

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KEY CONCEPTS

- There are three major types of filters that can be found in a hydraulic system.
- Develop a good relationship with your filter supplier, as he can guide you in making the right choice of filters and how best to use them.
- Don't skimp on the quality or number of filters. You should get what you need to insure your hydraulic system is working properly.

Filters and filtration are subjects that seem simple to understand on the surface but, like so many things, are much more complex in detail. And, of course, the devil is in the details. It is well beyond the scope of this article to delve too deeply, as there just isn't enough space in this issue.

For example, there are a wide variety of filters used in the chemical industry to separate a crystalline product from its reaction mass; we are all familiar with various air filters, starting with those used in our home heating systems or automobiles, and there are a large number of liquid fluid filters ranging from beer to gasoline.

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filter problems are managed are fundamentally the same, but the details are often unique. So let's try to limit the playing field and just look at the very basics.

First, let's only look at the removal of relatively large (> 1-5 micron) insoluble contaminants via a porous medium, as typically encountered in the lubricants industry. These are also the more common kinds of filtration problems. There are three major types of filters:

1. **Mechanical.** Metal screens or discs that remove only coarse particles.
2. **Absorbent (inactive).** Resin-impregnated paper, cotton, etc., that remove smaller particles and some water.
3. **Adsorbent (active).** Charcoal, diatomaceous earth, which is not used in hydraulics because it may strip additives.

There is also gravity/density filtration (centrifuge and settling), vacuum dehydration (removes water only) and ultrafiltration (removes oil and certain larger particles). These are well beyond the scope of this article.

For this discussion, we are considering absorbent (inactive) filters. Probably the most important recommendation from this article would be to develop a good relationship with your filter supplier, as he can guide you in making the right choice of filters and how best to use them. I hope the wisdom of this will become apparent. There are some terms often used: nominal rating (rates size of pores in filter, for example, 5-micron nominal), absolute (gives largest opening in media) and beta ratio/efficiency (how many times through the filter before all particles of a certain size are removed).

Regarding beta ratio, the idea is to rate the efficiency of the filter. For example, if we pass a fluid (notice I said fluid, because the fluid could be air or hydraulic fluid) with 1,000 particles > 5 microns through a nominal 5-micron filter and we measure 500 particles > 5 microns in the output, then the beta ratio is 1,000/500 = 2, which represents an efficiency of 50%. Or if we pass a fluid with 1,000 particles > 5 microns through a 5 nominal micron filter and 10 particles > 5 microns pass through the filter, then the rating is 100. This is written as:

$$\beta_5 = \mathbf{1000/10 = 100}$$

(Note: this represents an efficiency of 99%)

Already we are beginning to see that all filters are not the same.

In the December 2008 issue, we discussed contamination and the need to set contamination limits for each piece of equipment.[1] With this information, in a system of several operating components such as a hydraulic system, we can select the most sensitive machine (component) in the system. In addition, we can begin to determine the correct filter placement and establishment of a cleanliness target. Further, we need to know the maximum system pressure, the maximum flow through the filter and the viscosity of the fluid. Also, we need to know the temperature range and the pressure range that the system and filter will experience. Starting to get just a little complicated, isn't it?

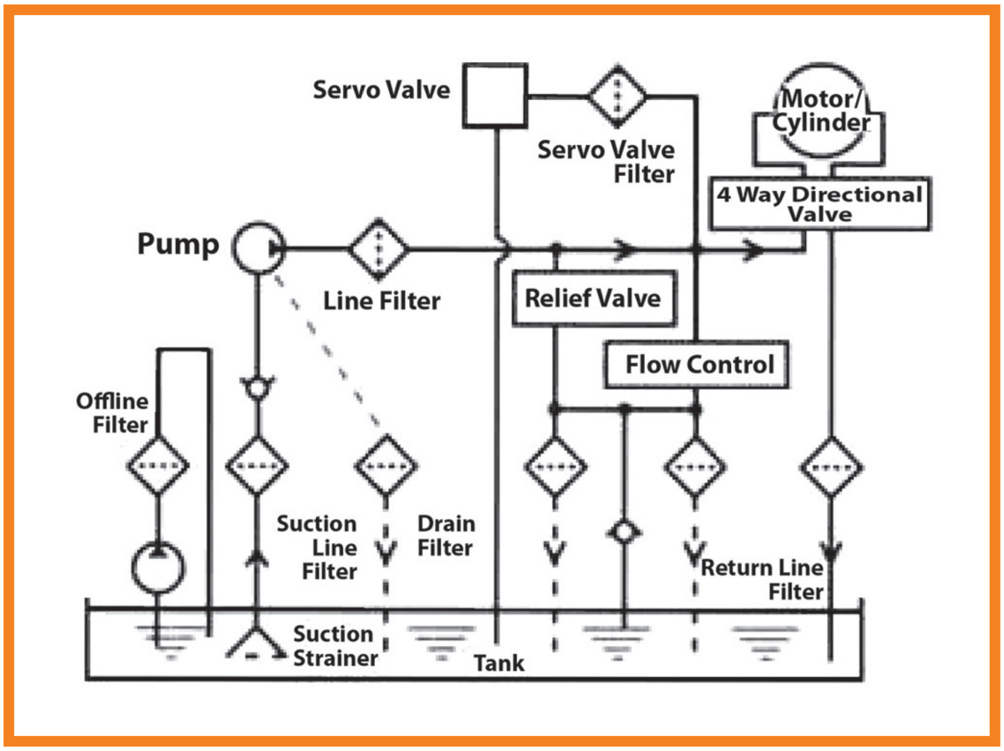

Figure 1 | **Typical filter placement in a hydraulic system.**

Let's think about a hydraulic system: first to fill the reservoir (which we will assume is clean, but in practice don't make that assumption), we should have a filter on the fill line to insure that we don't add contaminants to the reser-

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voir. What's the pressure and flow of the fill pump? After the reservoir is filled, we will need a breather cap fitted with a filter to keep dust and airborne contaminants from entering the reservoir as tank levels fluctuate. Then we should have a filter (often just a screen filter) on the intake line at the bottom of the reservoir (where a lot of big stuff tends to settle) and another finer lower-pressure filter just before the pump to protect it. Then another higher pressure filter on the output side of the pump (the pump tends to grind dirt and generate wear particles, as well).

At this point the actuators and control valves should be seeing pretty clean fluid. However, as the fluid returns from the actuators, the fluid picks up contaminants from rod seal leakage, so we need a filter on the return line to the reservoir. Then, if that is not enough, in some systems it is also necessary to employ an offline filter connected to the reservoir (*see Figure 1*).

How is a poor soul supposed to sort all this out? Well, there are a number of ANCI and ISO tests that assure filter-element quality (burst resistance, element material compatibility, flow fatigue resistance, flow vs. pressure drop, etc.). This is why I think it makes a lot of sense to develop a good working relationship with a credible filter supplier. Don't skimp on the quality or number of filters—get what is needed for the system. The cost of filters is cheap next to the cost of replacing or shutting down a valuable piece of equipment and interrupting production. Once installed, *maintain the filters properly.* If you don't keep the filters working properly, it is as foolish as trying to pull up a stump with a logging chain tied to the stump with a piece of yarn.

It is just like the man from the old Fram automobile oil filter commercials said, "You can pay me now or you can pay me later!" TLT

REFERENCE

1. Gresham, R.M. (2007), "What's The Deal with Contamination Control," *TLT*, **63** (12), pp. 22-24.

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