Automatic Pressure Filters for Machine Tool Coolants

By Polytech-Filtration

Overview

An automatic pressure filter is simply a device using pump discharge pressure to create a differential pressure across a barrier filter medium and transport the contaminated filter media and separated solids from the filter as required while providing an uninterrupted supply of filtered liquid.

Advantages

- Higher differential pressure capability across the filter media (typically 20-30 PSID or more) to support reasonable flow per square foot of filter area and allow the use of filter media that is restrictive enough to capture fine particles.
- Can build thick solids “cake” under good conditions.
- Air blow down before indexing media helps drain the swarf.
- Automatic operation minimizes operator involvement.
- Uses low cost bulk filter roll media.
- Large dirty tank can help de-gas aerated coolants and machining oils allowing pressure filters to be more effective in these applications than conventional vacuum filters.

Disadvantages

- Dirty coolant tanks are typically 24” or higher. Lower elevation of machine tool coolant discharges requires sump transfer pumps.
- Media and transport conveyor must be sealed around the filter septum to prevent leakage which increases cost and maintenance.
- Separate filter and clean pumps are required.
- Large dirty coolant tank promotes settling of solids.
- Removal of the entire solids “cake” during index may reduce filtration efficiency to that of the filter media alone, providing less consistent filtration quality.
- Unused filter media around the perimeter of the filter cake is wasted.
- Filter pump operates in unfiltered coolant increasing wear and potential for problems with clogging.
- Complexity adds to cost.
- Relatively large clean coolant tank needed to supply coolant during filter regeneration and media index.

- Heavy compressed air consumption during blow down cycle prior to indexing the media impacts capital and operating cost and creates the potential of coolant or oil misting.

How It Works

Pressure filters utilize pump pressure to force liquid through a barrier filter. Pressure filters used in industry for machine tool coolants are typically flat bed filters where contaminated coolant is pumped into a pressure chamber with a perforated plate bottom that is located above the clean coolant tank. A barrier filter media sits between the pressure chamber and the filter septum to capture solid contaminants as the coolant flows to the clean tank. A centrifugal pump supplies coolant from the clean tank to service.

Dirty coolant first goes to a dirty tank where it is pumped through the filter. The dirty tank needs enough capacity to accept incoming flow while the filter indexes. The clean tank has to have enough capacity to supply the clean coolant needs while the filter indexes.

As contaminants are captured by the filter media a contaminant cake builds on the filter media where the trapped particles enhance the particle retention and filtration efficiency improves. Eventually the contaminants restrict the flow enough that the filter media must be indexed. During the index cycle, the filter pump flow is stopped, the pressure chamber inlet valve is closed and compressed air used to blow down the pressure chamber to expel the remaining liquid. The blow down continues past the point of liquid expulsion to drive some liquid out of the contaminant cake. The pressure chamber is opened and the entire used media section is advanced so the pressure chamber can seal on new media. The pressure chamber is resealed and the filter pump flow resumes.

During index, process coolant is supplied from the clean coolant reservoir and dirty coolant collects in the dirty tank until the cycle is complete. The size of the tank is a trade off with the time allowed to blow down the contaminants and spent media to discharge adequately dried swarf.

Advantages of Automatic Pressure Filters

The principal advantages that pressure filters enjoy over other types of filters in the advantages list above are the higher differential pressures which can support the use of quite restrictive filter media to filter fine particles and/or achieve impressive swarf cakes in certain applications and the ability to de-gas and pump heavily aerated coolants and machining oils.

Performance Issues with Automatic Pressure Filters

Pressure filters are by their nature complex. The sealing mechanism and the blow down cycle to remove excess coolant reflect this. Complexity adds cost. Complexity can impact reliability and perhaps more importantly, serviceability in a 24/7 plant operating environment. If problems are difficult to diagnose, who supports second and third shift operations?

To keep costs low, the inclination is to use the smallest possible filter area. Pressure filters do have pretty good differential pressure available, but since the differential pressure across filter media varies with the square of the liquid's velocity through the media (which is a direct function of flow per unit area), it is easy to use up this advantage in making the filter smaller. Reducing the filter area 50% increases flow resistance by a factor of 4. Higher velocity flow resistance and restrictive media can quickly negate advantages in the performance envelope due to greater differential pressure.

A second problem related to velocity is that of particle breakthrough. The higher the applied differential pressure, the more likely it is that particles will pass through the media as the filter loads with contaminants as the velocities through the remaining flow passages becomes very high. Ironically, filter cake compression at higher differential pressure can also restrict liquid flow.

In certain applications, the contaminants act as a filter cake to improve particle retention. Pressure filter advocates point to their cake as a great advantage in clarity. However, the entire filter cake area must be removed from the pressure filter each cycle to permit the seals to seal. This means that the filtration quality will vary during each cycle. Vacuum filters index only a very short length of media on each cycle so the filtration quality remains quite consistent.

Pressure filters usually have large dirty tanks which we oppose philosophically. The object is to filter out contaminants, not create additional settling tanks that must be cleaned out periodically. The clean tanks must also be quite large to supply uninterrupted flow to the grinders during the blow down and index cycles.

Pressure filters can consume significant volumes of compressed air during the blow down cycle. The cost of that compressor capacity and energy use is frequently overlooked in cost analyses.

Vacuum filters by comparison are quite simple. The coolant enters the dirty section where the media and flight conveyor transport contaminants out of the filter. The pumps work on the filtered side of the media. The filter only advances a short length of media each time so most the cake remains; promoting more consistent filtration quality when the cake aids filtration clarity. The media, with its contaminant load, sits on the sloped discharge ramp for several index cycles so it can dry. There are no mechanical media seals, the media and flight conveyor form a hydraulic seal.

Because of their relative simplicity, vacuum filters with significantly more filter area generally cost less than pressure filters rated for the same flow. As discussed previously, size does matter.

Finally, some argue that the pressure filter has greater contaminant loading of the media due to the greater pressure differential. If one charts the differential pressure versus time on a typical filter cycle, the curve is pretty flat and then climbs exponentially (due to the plugging of the filter surface and the increase in velocity of the remaining flow paths). The amount of time required to climb the steep part of the differential pressure curve is a small percentage of the overall filtration cycle. Furthermore, this supposed advantage may be offset by the vacuum filter's full use of the media: the pressure filter must have blank unused sections around the perimeter for sealing.

Having built pressure filters, we did not see their advantages outweighing their disadvantages and we stopped offering them for sale many years ago.