Conventional Vacuum Filters

Pluses, Minuses, How They Work

By Polytech-Filtration

Overview

An automatic vacuum filter is simply a device 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 8 – 12 in Hg vacuum or 3-5 PSID) 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.
- Automatic operation with infrequent maintenance required.
- Uses low cost bulk filter roll media
- Simple robust construction with no pressure vessels or tanks.
- Efficient operation requiring only a single pump to provide filtration and clean coolant supply.
- Conveyor to transport media and solids is suitable for heavy stock removal loads and operates at the bottom of the dirty coolant tank to eliminate settling problems and maintenance.
- Pump operates in filtered coolant reducing wear and problems with clogging.
- Relative simplicity and moderate cost compared to automatic pressure and back flushing filters.
- Short length of media indexed on regeneration allows extended time on the discharge ramp to drain coolant from the swarf.
- Short length of media indexed on regeneration means that most of the contaminant “cake” on the media which can enhance particle retention remains in place providing consistent filtration quality.

Disadvantages

- Dirty coolant tanks are typically 36” or higher. Lower elevation of machine tool coolant discharges requires sump transfer pumps or reduced coolant levels and capacity to permit gravity flow of coolant.
- The use of a single pump means pump cavitation may interrupt coolant flow to the machine tool and damage work in progress.
- Centrifugal pumps perform unreliably when there is entrained air in the suction. The use of oil based fluids, foamy or aerated coolants and low coolant entry heights can all reduce performance and lead to pump cavitation.

How They Work

Vacuum filters utilize atmospheric pressure to force liquid through a barrier filter to a lower pressure zone. Conventional vacuum filters used in industry for machine tool coolants are typically flat bed gravity filters where contaminated coolant enters an open top dirty coolant tank with a perforated plate bottom and a lower tank (vacuum chamber). A permanent or disposable media sits between the dirty tank and the vacuum chamber to capture solid contaminants as the coolant flows to the vacuum chamber. A centrifugal pump draws coolant from the vacuum chamber and returns it service.

All pumps require some positive pressure to feed liquid into the impeller. This pressure is known in pump design as the Net Positive Suction Head Required. The pressure required can be provided by a column of liquid above the pump or by air pressure on the liquid. Because the NPSHR may only be a few PSI, the pump can function effectively at pressures well below atmospheric pressure, permitting a restriction like filter media in the suction flow. The Vacuum Filter Pump Graph1.pdf shows the typical relationship between pump suction requirements and the filter's differential pressure capability.

As contaminants are captured by the filter media the resistance to flow increases the vacuum level in the vacuum chamber increases As a contaminant cake builds on the filter media, the trapped particles enhance the particle retention and filtration efficiency improves. Eventually the pressure in the vacuum chamber will drop to the pressure the pump requires to maintain flow to its impeller and the pump will begin to cavitate and stop clean coolant flow to the machine tool. Before this occurs a vacuum switch senses the pressure and starts a regeneration cycle. During regeneration, the filter pump is supplied with clean coolant from a reserve tank, new media is fed into the filter and contaminant bearing media is discharged and filtration resumes. Since only a short length of filter media is indexed each time, the bulk of the filtration enhancing cake remains, providing consistent filtration quality.

The design of vacuum filter means that the system pump, providing both filtration and clean coolant supply to the machine tool operates in filtered coolant improving pump reliability. The media/sludge conveyor removes solids from the dirty tank eliminate the need to clean out settling tanks. The seal between the dirty tank is a simple but reliable hydraulic pressure seal that requires no maintenance. The open tanks (covers are provided to prevent contact with moving conveyors) are simpler to build and maintain than closed pressure vessels and present none of the swarf packing and removal problems pressure filter vessels experience.

Centrifugal pumps do have problems pumping reliably when there is air entrained in the fluid. Since entrained air can lead to filter pump cavitation and loss of flow to the machine tool vacuum filter performance may be compromised or unacceptable. Conditions which contribute air entrainment are operating with low coolant levels to accommodate low machine discharge heights, foamy coolant where

the surface tension of the coolant is reduced or oil based coolants where the air stays in the oil due to its viscosity.

The use of transfer pumps to get coolant into the dirty coolant tanks without lowering the operating level or to allow time for coolant to degas adds cost, increases settling of solids in the transfer pump tank and may introduce transfer pump solids handling capacity problems. Since the effect of air entrainment on pump performance increases as the vacuum levels increase, a common response is to operate the filter at lower differential pressure compromising flow and or particle retention capabilities.

Polytech Filtration Systems recommends against the use of conventional vacuum filters in applications requiring low coolant entry heights or using oil based machine tool coolants. Prior to the advent of vacuum filters designed specifically to operate on highly aerated fluids, various pressure and precoat filters were among the few choices available for automatic filtration on machining oils.