A Comparison of Gravity Bed And Vacuum Filters

By Polytech-Filtration

Overview

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Gravity Bed Filters

Gravity bed filters use the weight of the liquid to push the liquid through the filter medium to a reservoir beneath the filter. Typically gravity bed filters use a conveyor chain or mesh to support the filter media and a pool of liquid contained in the paper, much like a drip coffee maker. As contaminants build on the paper the liquid level rises until a switch or sensor advances the conveyor transporting fresh media under the pool.

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The pool of liquid is typically only a few inches deep. A 3” deep pool of liquid would have a differential pressure equal to the weight of the water column; with 1 PSI equal to a column of water 2.31 ft high, this would be 0.1 PSI. A deeper bed filter with side seals might be 6 to 9 inches deep with a differential pressure of 0.2 to 0.3 PSI.

This differential pressure limits the liquid flow per square foot of filter area and it limits how restrictive (and how effective at capturing solid contaminants) the filter medium can be. In practice, gravity bed filters are limited to flow rates of about 3 GPM per square foot of filter area with filter media that is effective in capturing particles in the 40 to 60 micron size range. Finer particle retention requirements or the use of a more viscous fluid, such as oil, requires further flow rate reductions.

Gravity filters are often selected on cost. To be competitive, conveyor designs are light duty, despite the fact they have to support the weight of liquid and solid contaminants. In lower flow rate applications they can be a reasonable solution if they can meet the process fluid clarity requirements. As flow rates increase, the size of the units can become quite large, taking up a lot of expensive plant floor area. They usually have coolant tanks beneath which become settling tanks if low restriction filter media is selected to support higher flow rates. The larger size filter can be quite difficult to move for tank cleaning.

Vacuum Filters

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 sealed lower tank (vacuum chamber). A permanent or disposable filter 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.

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This allows much higher differential pressure capability across the filter media than gravity bed filters. Typical vacuum filters operate at 8 – 12 in Hg vacuum or 3-5 PSI differential pressure, with some of Polytech's high performance designs working at up to twice that range. This allows much higher flow rates per square foot of filter area and allows the use of filter media that is restrictive enough to capture fine particles. For comparable levels of liquid clarity, a vacuum filter might run 5 times more flow per square foot than a gravity bed filter. This can yield big space savings on high flow rate applications. Even running tighter, more efficient media for better clarity, flow rates of 5 to 12 GPM per square foot of filter area are common in vacuum filter applications.

As the filter media captures contaminants the resistance to flow increases, increasing the vacuum level in the vacuum chamber. Ideally a porous contaminant cake builds on the filter media where 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 so no settling occurs there. The seal between the dirty tank and the vacuum chamber 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 simple to build and maintain. The conveyor transports only the spent media and the contaminants and the robust design is suitable for the heaviest stock removal applications.

Additional advantages are less coolant carry-off because the short length of media indexed on regeneration allows extended time on the discharge ramp to drain coolant from the swarf and the ability to run better media improves filtration results and extends vacuum chamber clean out intervals.

The nature of the solid contaminants, their permeability and the required liquid clarity has significant impact on sizing both gravity bed and vacuum filters. As coolant flow rates increase above 40-60 GPM, the application requirements and machine productivity capabilities demand a robust filtration solution that, despite its higher purchase price, tends to favor vacuum filters.