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## Understanding Engine Oil Bypass Filtration

Noria Corporation

Is your engine's oil filter performing to your expectation? Do you even know the performance of your filter? Most people don't, and if they did, they would be appalled.

Some of the best full-flow engine filters on the market perform at a capture efficiency of 50 percent at a particle size of 10 microns and above. That's a beta ratio of 2 for those of you keeping score, and these are considered "good" in terms of full-flow engine filtration. In comparison, a beta ratio of 1,000 would be considered "good" in terms of industrial hydraulic filtration. Why is there such a performance difference? The following factors contribute to the variance:

### Physical Size

Often limited by physical size, engine oil filters are relatively small when compared to their industrial counterparts. This small size coincides with less filter media surface area through which to pass the lubricant.

65% of lubrication professionals use bypass filtration systems at their plant, based on a recent poll at machinerylubrication.com

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### Pressure Differential

The pressure differential is the change in pressure from the inlet to the outlet side of the filter. If the pressure differential is too high, a valve will open, allowing the oil to bypass the filter. All engine oil filters or heads are equipped with a bypass valve. This valve is needed so the engine does not become starved of oil as the filter clogs with debris.

### The Beta Ratio Test

Oil filters can be tested in a variety of ways, but one of the most common methods is the beta ratio test. This test incorporates online particle counters positioned upstream and downstream of the filter, a continuous flow of test contaminant into the main system reservoir and oil flowing through the filter.

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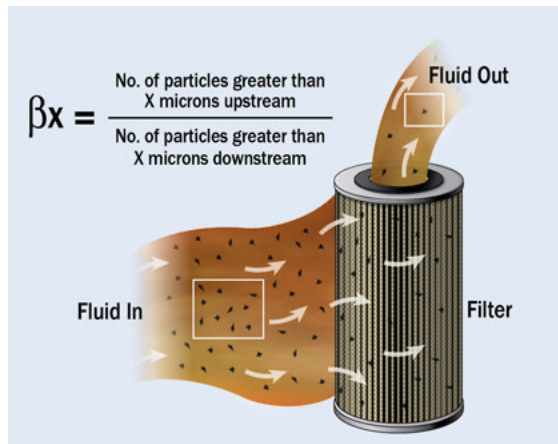
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The beta ratio is calculated by dividing the number of particles larger than a certain size upstream of the filter by the number of particles of the same size downstream of the filter. For example, you may have a beta ratio or a beta sub 5 (meaning particles larger than 5 microns) equal to 10. This means 10 particles upstream of the filter would be divided by 1 downstream of the filter. In other words, for every 10 particles coming in, one gets through.

If you have a higher beta ratio, say a beta ratio of 100 or a beta sub 5 equal to 100, for every 100 particles coming into the filter larger than 5 microns, one makes its way through.

Every filter will have multiple beta ratios. There could be a beta ratio for 2 microns, 5 microns, 10 microns, 50 microns, 100 microns, etc.



You can also use the beta ratio to calculate capture efficiency, which is the average performance over the filter's life, with the following formula:

$$((\text{Beta} - 1) / \text{Beta}) \times 100$$

As an example, a beta ratio of 10 would yield a capture efficiency of 90 percent:

$$((10 - 1) / 10) \times 100 = 90 \text{ percent}$$

Therefore, 90 percent of the particles larger than 5 microns are removed by a filter that has a beta ratio of 10.

## Flow Rate

In most engine designs, oil must flow through the filter before entering the engine components. Therefore, the filter must be able to handle 100 percent of the flow rate needed to feed the moving components of the engine.

## Media Pore Size

The media pore size is the major determinant in how efficient and how small of a particle the filter can remove.

When these factors are combined, a problem arises. The physical size is usually constrained by design. The filter can't be too large because of all the other components that we are trying to fit under the hood. The flow rate must be high enough to feed all the lubricated components. This means you can't make the pore size too small or it will raise the pressure differential and the bypass valve will open, effectively rendering the filter useless.



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**Which of the following best describe your journey to lubrication excellence?**

- ☐ Short-term project with vision of goals, milestones, support from upper management
- ☐ Long-term continuous improvement initiative with unclear vision of goals, future status of the program

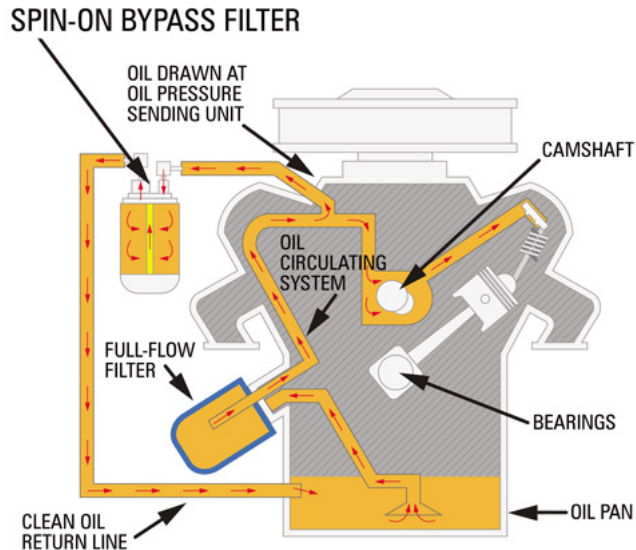
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There are a few things you can do to remedy this problem. Enter bypass filtration. Bypass filtration systems take 5 to 10 percent of the flow that would have gone to feed the engine and cycle it through an ultra-efficient filter and back to the sump.

With bypass filtration, the flow rate can be greatly reduced, allowing for a much smaller pore size while retaining a normal pressure differential. The result is much cleaner oil being returned to the sump. Smaller soot suspension and polar insolubles that are not controlled by the full-flow filter can now be taken out of the system. When combined with a full-flow filter, bypass filtration offers the benefits of lower wear generation rates, lower oil consumption, higher combustion efficiency and longer oil life.

In a case study performed by General Motors and published by the Society of Automotive Engineers (SAE), it was determined that engine service life could be extended eight times when 5-micron filtration is implemented vs. the standard 40-micron filtration.



Obviously, having cleaner oil is better for the reliability of the engine. There's an old saying that oil doesn't wear out; it just gets dirty. Although there is some validity to the idea that dirtier oil will "age" quicker than clean oil, the engine oil will have a finite life. It will need to be changed eventually no matter how clean you keep it.

While it's true that a system can remove the majority of suspended soot, wear debris and dirt, the oil and additives are still being decomposed by oxidation and nitration. The depletion of these additives will ultimately be the reason for the oil change. The system should slow down the rate of this depletion, but it cannot eliminate it. Acids, fuel and coolant are just a few of the contaminants that bypass filtration cannot address. They too can shorten the life of the oil.

If you are shopping for one of these systems, it is vital that you do your homework. Not all bypass systems are created equal, and there is a plethora of marketing material out there to make you feel thoroughly confused. Keep in mind that while testimonials may seem impressive, they are not scientific proof. Make sure the manufacturer has SAE and ISO testing to back up its claims.

When installed and maintained properly, a bypass system can provide great benefits. Just be sure to ask all the right questions and have a firm grasp on the concept before settling on a system.

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