Today’s Cummins engines are better than ever before in the areas that matter the most to customers. Drivers are taking notice of the improved drivability of their vehicles due to tangibles such as improved throttle response, control and overall improved performance. These improvements are a result of greatly improved combustion processes – due primarily to selective catalytic reduction – for a much cleaner burn. Cleaner combustion has led to tremendous improvements in fuel economy which means less contamination in the oil.

In addition to improved engines, lubricating oils have improved as well. Today’s engine lubricants contain better contaminant control properties and are actually providing fuel economy gains, all of which translates to less, or lower, contaminants present in the lube system. Therefore, advanced filtration technology is an essential part of the successful relationship between improved lubricating oil technology and improved engine technology.

Emission Regulations are the underlying driver to many of the changes in today’s engines. In the late 1990’s, fuel injection timing in addition to many product changes helped reduce harmful NOx emissions. Additionally, exhaust gas recirculation reduced combustion temperatures, again, lowering NOx, and then the introduction of exhaust after treatment actually lowered both NOx and particulate matter, or PM. While all these changes reduced emissions, they actually contributed to higher amounts of organic contamination in the oil. Then, in 2010, the introduction of the selective catalytic reduction engines, or SCR, using Diesel Exhaust Fluid (DEF) enabled the tremendous lowering of emissions, as well as improvements in fuel economy. In fact, it lowered emissions so much, that some of the earlier adjustments and calibrations were, backed off, so to speak, further improving fuel economy and reducing the amounts of contaminants in the oil.

Likewise, lubricating oils continue to evolve alongside all of these step changes, coinciding directly with the changes in emission regulations. Now the focus is on lowering green-house gasses (GHG), which translates to further improving fuel economy, which further reduces lube oil contaminants.

A balanced design approach is required for having the most effective filtration design.

- First, a high filter efficiency is critical for effectively removing the contaminants that are known to cause engine wear.
• Next, a filter’s capacity must be able to hold this contaminant throughout the desired service interval and beyond.

• Finally, the filter needs the lowest flow restriction possible during all operating conditions to ensure oil continually passes through the filter, which is especially critical under cold start-up conditions. These high viscosity conditions can be due to cold temperatures, but also due to oil oxidation which occurs over time, and also higher contamination due to extreme extended service intervals. Low flow restriction is critical because it means faster oil lubrication to critical components on engine start up, whether in cold conditions or not. If the oil cannot pass through the filter, a safety valve opens and allows unfiltered oil to circulate in order to protect the engine from damage caused by a lack of lubrication.

Consider that contaminant found in today’s lubricants are generally measured in microns. A micron, which is simply a metric term, refers to 1 millionth of a meter, or 39 millionths of an inch. This graphic represents a human hair, which is in the range of 50 to 70 microns. Next, the large dot on the cross section of the hair is pollen, which is in the 30 to 50 micron range.

How Big is a Micron?
Human Hair Comparisons

Human Hair 50-70 Microns
Pollen 30-50 Microns
Ragweed 30-50 Microns

and this is where things start to disappear from human eyesight, and we require magnification to see. The next size down is ragweed, in the 17 to 23 micron size, invisible to the naked eye. The smallest dot is the size of 1 micron. The size of hard particles/inorganic contamination, often referred to as dust, which causes the most wear of vital components is in the 5 to 15 micron size. Knowing the size of these contaminants enables targeted specifications for the efficiency of the lube filter.

Now, with traditional filtration media, what happens if a filter’s efficiency is increased so that it can remove smaller sized contaminants? What if the filter’s capacity is increased and flow restriction is decreased? Furthermore, can these all be improved at the same time, or will there be trade-offs for improving one area as opposed to another?

To conceptualize this, think for a moment about the way a home furnace filter works. Most of these filters are only removing the size of contaminant necessary to protect your HVAC equipment, but not really cleaning the air of particles like pet dander or certain allergens. High efficiency furnace filters that can also remove these smaller particles are available, but do they last as long? In fact they last a shorter period of time because although they do remove smaller contaminants more effectively, this results in the filter becoming full more quickly, which actually increases the flow restriction on the HVAC motor, the opposite of what we are trying to accomplish. Hopefully this is a helpful visualization for the concept of increasing filter efficiency with traditional filtration media.

So, let’s revisit the question of whether or not it is possible to positively alter one, two or all three of a filter’s key performance parameters. Regarding traditional media with all things being equal, increasing a filter’s efficiency may mean capturing more/smaller particles, but the flow restriction also increases and in turn harms the
filter's capacity...very similar to the situation of the high efficiency furnace filter. Increasing the filter's capacity requires opening up the filter to improve the flow restriction; however, this reduces efficiency and allows those 5 to 15 micron sized particles to get through the filter and cause engine wear. Similarly, reducing the flow restriction also increases the capacity, but the filter's efficiency decreases.

Thus, filtration science reveals that improving efficiency, capacity and flow restriction simultaneously is not possible with traditional media.

In response to these findings, Cummins Filtration created a new type of proprietary, multi-layer synthetic media that allows filter performance to progress past the hurdles that traditional media presents. Cummins Filtration first introduced this nanofiber media, NanoNet®, into Fleetguard® fuel filtration products in 2012 and have been testing and exploring the technology since that time. After discovering the merits of NanoNet media in fuel applications, Cummins Filtration developed a NanoNet variant for lube filtration applications beginning with the LF14000NN used in Cummins ISX12 and ISX15 engines.

The NanoNet media used in the new Fleetguard lube filters is actually composed of five layers, each layer increasingly more efficient for finer and finer filtration. Of the five layers, the nanofiber layer has the smallest fibers and provides the optimum in filtration efficiency, capacity and cold flow ability.

Shown below is a scanning electron microscope image of the nanofiber layer. Where traditional synthetic fibers could be in the 5 to 20 micron diameter size range, NanoNet nanofibers are somewhere between two-tenths of one micron, and eight-tenths of one micron, or 200 to 800 nanometers. To put that in perspective, all five layers of NanoNet media are about the thickness of a single dime. The size of these nanofibers means that NanoNet media is less restrictive to oil flow, which translates to improved cold flow ability and optimum capacity, but does not sacrifice high efficiency particle removal.

The Fleetguard LF14000NN filter, on the far left, has the highest capacity and overall efficiency when tested alongside the current market offerings from the industry's major filter manufacturers. To further emphasize the balance of design and the ability of the smaller nanofibers to not restrict oil flow, take note of the data for Competitor B. The test data...
Synthetic Nanofiber Media in Lube Filtration
Product Applications

A cut-a-way visual of the new LF14000NN reveals that it remains a combination filter, like its predecessor, the LF9080. Approximately 80% of the oil flow goes through the Fleetguard StrataPore® media, and the remaining 20% flows through the upper NanoNet section to super clean the oil. With the lowest flow restriction, the LF14000NN ensures that the lubricating oil reaches critical engine components faster to reduce wear over time. The LF14000NN is the best in class lube filter for the Cummins ISX 12 and 15 liter engines.

Increased filter efficiency means reduced engine wear, longer life, and reduced costs. Increased capacity means managing that contaminant for the entire service interval, and beyond. Low flow restriction means faster lubrication on engine start up, continual filtration throughout the service interval, and less effort for the engine to pump the oil. The effects of utilizing a design that balances these three performance attributes are not only noticeable, they are substantial when put in action across a large fleet of equipment.

Cummins Filtration is at the forefront of diesel engine filtration technology and strives to provide the best product available to the market for heavy duty diesel engines.

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Synthetic Nanofiber Media in Lube Filtration Product Applications (03/2015)
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