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Fuel Filter Element Life Extension Trial.

1. Executive Overview.

Your initiative in exploring filter element life is applauded.

However, like many of the filter trials undertaken, what controls, monitoring and validation have you considered?

Have you considered the business risk?

Have you determined what parameters and indicators you need to monitor, to minimise risk to the business and to demonstrate an economic business benefit?

1.1 Under performing or stopped engines.

Attempting to extend the service life of a fuel filter element without monitoring the differential pressure can result in under performing or stopped engines. (ie: the filter blocks unexpectedly) Monitoring the differential pressure across the element and indicating the element requires replacement in the near future can avoid this risk.

1.2 Ruptured Filter Element

Unless you monitor the differential pressure continuously, the filter may block, collapse and rupture. The filter will no longer provide any protection to the components downstream, nor will it again generate sufficient differential pressure for it to block or cause fuel starvation.

1.3 Unacceptable fuel cleanliness delivered to the injector pump.

The performance of many filter elements degrades as the service life increases. Filtered fluid may not meet the required cleanliness level resulting in worn and damaged components. The filtered fuel may get dirtier as the service life is extended.

Unless you measure the cleanliness level you will never know.

Monitoring the cleanliness level in conjunction with the differential pressure will validate any suspected filter element collapse, or filter element performance degradation.

1.4 The risk verses business benefit.

Given the relative low cost of the filter elements being used, the small dollar value saved by extending the service life of the elements to say 750 or 1000 hours is insignificant in comparison to the increased risk of costs associated with equipment downtime due to blocked filters and premature failure of injector pumps due to dirty fuel.

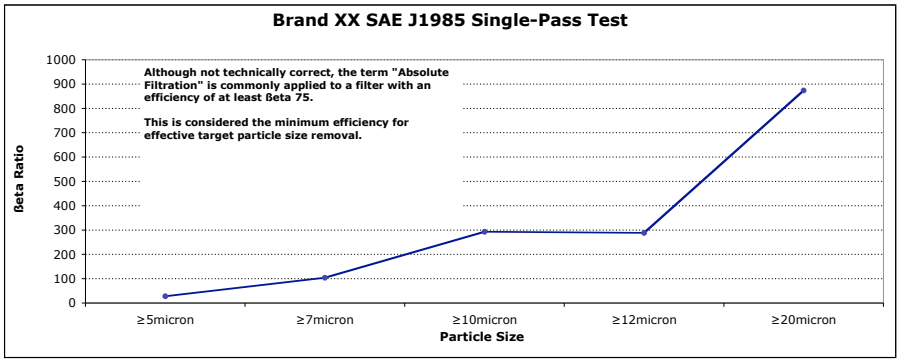
I suspect the cost to install filter differential indicators and regularly monitor the processed fuel cleanliness would significantly outweigh any savings gained.

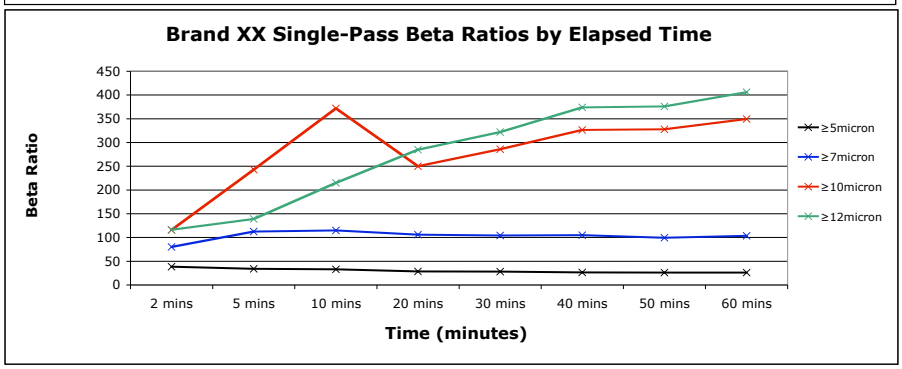
I also suspect you will obtain a greater business benefit through increased injector and injector pump life and performance issues if these filter elements were replaced more frequently, rather than attempting to extend their service life.

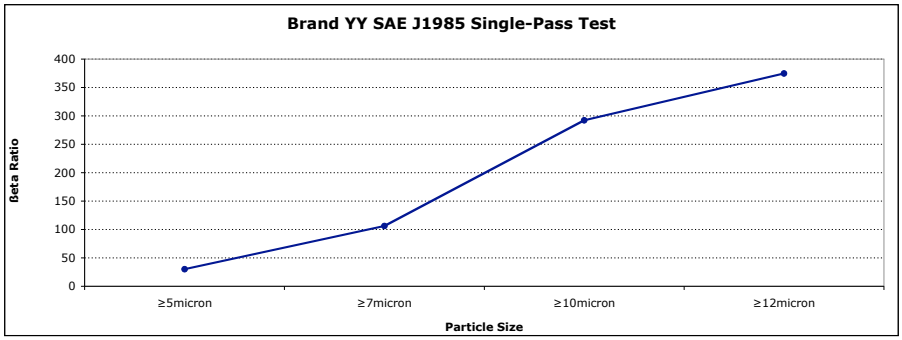
1.5 Validation of Filter Performance Characteristics.

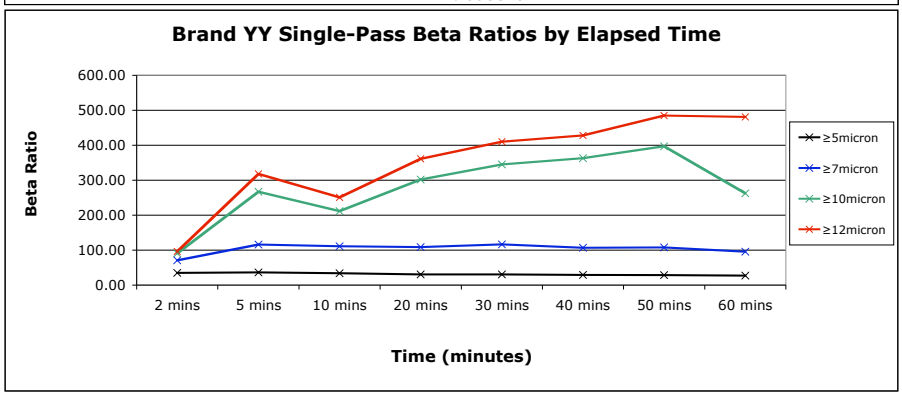
The following graphs indicate the lack of effectiveness of both Brand XX and Brand YY filters (Commonly used in mobile equipment in the mining industy) to target the smaller particle range (silt) that is generally regarded as troublesome for diesel fuel systems. (South West Research Institute was engaged to conduct the tests)

The second graph for the YY fuel filter clearly indicates the decline in performance towards the end of the test.









The elements from both manufacturers perform poorly at the target level of 2 micron. Neither element could be recommended in preference to the other.

2.0 Discussion

2.1 Differential Pressure

The service life of a filter (lube, hydraulic, fuel, water), is directly determined by the differential pressure available for consumption across the filter element as element blockage occurs.

The differential pressure at that which the element collapses dictates the settings:

a. for when a filter blockage alarm should be flagged,

b. what the by-pass valve setting will be,

c. and of course, in the case of a non-bypass (typical fuel filter) ,the collapse rating needs to exceed the system pressure available to prevent collapse or alternatively, is has a collapse rating greater than the differential pressure generated across the filter where starvation affects engine performance.

Because the differential pressure increases exponentially as the element blocks, providing a lower clean pressure drop will significantly increase the service life of an element over that of raising the terminal differential pressure.

The amount of dirt a filter can collect is fixed. The cleanliness of the fuel is the only variable factor determining how many hours until the filter element blocks.

Therefore it is necessary to monitor any filter element (actually all filter elements) for pressure differential especially where extended service change out periods are on trial.

The differential pressure at which the element needs replacing “should” be available from the manufacturer. (It would have been determined when the filter element was tested for efficiency - eg: during SAE J1995 Single Pass Test)

2.2 Fuel Cleanliness Measurement.

Of course, the most important parameter to measure is the cleanliness of the fuel being delivered from the filter.

a. It is well proven that most of the filter elements we are using degrade in performance as the differential increases due to blockage. (not an acceptable characteristic, but unfortunately an all too common finding)

b. Many filters are so inefficient they never develop any substantial differential pressure.

In both cases they “may” provide a reasonable cleanliness level for a number of hours, but there after, the cleanliness degrades.

If the filter element is replaced before any significant degradation occurs this undesirable characteristic may be avoided.

Another common scenario is that the filter blocks, ruptures and there after, does not generate any further differential pressure. Unless the differential pressure is monitored continuously, this failure will be missed.

Unless the cleanliness level is also being monitored this event will go unnoticed and the element considered serviceable because it has not blocked. But of course it is no longer serviceable because it is not doing its job of preventing dirt being passed to the fuel pump.

2.3 Why are fuel filters (and many others) commonly replaced on a scheduled basis and not on differential pressure?

If the available service life is determined directly by differential pressure and not how many hours it has been in service, why does the OEM recommend replacing the element every 500 hours?

The cynical amongst us would suggest that they like to ensure they have a constant revenue stream through the sale of filter elements!

However, the real reason is not doubt far less sinister!

They no doubt have determined by all the statistical data they have gathered over the years, even with the vast variation in fuel quality, that 99% of a particular fuel filter will last 500 hours without blocking or interrupting the operation of the machine.

They may also have determined if they strive for 750 hours then 50% of elements block. They may also have found that a percentage of the elements had actually ruptured. So they choose 500 hours and still have a margin of safety.

They "may" have even recognised the performance degradation issues with the particular element and thus set the scheduled change out point prior to this undesirable characteristic becoming significant.

So to keep it simple for their average end user, the OEM strategy is to periodically replace the element regardless, especially before it causes a problem.

Differential pressure indicator operation is greatly misunderstood, even in the mining industry where a greater level of technical competence and understanding exists.

The general public, contractors and other smaller end users grasp the concept of scheduled replacement much more readily than understanding the concept of differential pressures and the various systems of measuring fluid cleanliness.

Thus, if the strategy is to change out the filters every 500 hours under normal operating conditions, a differential pressure indicator is pretty much an added manufacturing expense with no real purpose to the average consumer. It will in the course of its life probably never have reason to indicate.

Even when filtration is monitored correctly, (primarily on differential pressure) a scheduled change out based on statistically analysis is implemented. (elements are changed at least once a year regardless due to media and bonding degradation through heat, continuous contact with a hydrocarbon liquid, and fatigue from cyclic flow, vibration and flow frequency.)

If it is established that under normal operating conditions a quality element in a particular application blocks at say 1150 hours, organizations will incorporate the element change in the scheduled 1000 hour service for the sake of convenience and practicality.

Scheduled element replacement is an easily controlled strategy with no rocket science attached.

It is clearly the most practical strategy in many instances.

References:

Pall Corporation
Donaldson
Caterpillar
SWRI
Parker