532f Coalescence Filter Model Performance of Glass Fiber Media with and without Nanofibers

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Nanofibers, owing to their ultra small diameters, have high surface areas that are advantageous in fibrous filtration. By augmenting micro glass fiber media with nanofibers, a wide range of micron and sub-micron (0.3 to 0.8micron) particles can be effectively captured.

The primary objective of this paper is to predict the steady state performance of coalescing filter media made of glass fibers with or without polymer nanofibers. Coalescence filtration involves the capture of small liquid droplets from an air stream. The filter performance can be characterized by the Quality Factor (QF) which accounts for pressure drop and capture efficiency of the media.

This work is motivated from experimental data showing a monotonic increase in the quality factor with the amount of nanofiber added to the filter. The experimental work is limited to amounts of nanofibers with surface areas equivalent to 40% of the area of the glass fibers. The model is developed to allow us to predict the performance of filter media with greater amounts of nanofibers. The model assumes a constant uniform liquid saturation of 10% (similar to saturations observed in our laboratory experiments) and the model assumes that the capture efficiencies and drag forces around the individual fibers are not affected by the presence of neighboring fibers.

The model calculates single fiber capture efficiencies, filter coefficient, pressure drop, outlet particle concentration, and the quality factor (QF) of the fiber media. The model accounts for aerodynamic slip of the gas flow around the nanofibers.

The model results show the QF curves have a maximum at nanofiber concentrations corresponding to nanofiber surface areas equivalent 500% of the glass fiber surface area. At concentrations greater than this amount the pressure drop increases faster than the capture efficiency and the QF decreases. The model shows that the QF depends upon the particle size and the nanofiber size and significant increases in the QF (by a factor of 100 or more) are possible with the correct nanofiber diameter.