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The Effect of Filter Design and Face Velocity on Air Filter Performance

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Abstract : Air filters installed in HVAC equipment and gas turbine for power generation confront several atmospheric contaminants with various concentrations while operating in different environments (tropical, coastal, hot). This leads to engine performance degradation, as contaminants are capable of deteriorating components and fouling compressor assembly. Compressor fouling is responsible for 70 to 85% of gas turbine performance degradation leading to reduction in power output and availability and an increase in the heat rate and fuel consumption. Therefore, filter design must take into account face velocities, pleat count and its corresponding surface area; to verify filter performance characteristics (Efficiency and Pressure Drop). The experimental work undertaken in the current study examined two groups of four filters with different pleating densities were investigated for the initial pressure drop response and fractional efficiencies. The pleating densities used for this study is 28, 30, 32 and 34 pleats per 100mm for each pleated panel and measured for ten different flow rates ranging from 500 to 5000 m3/h with increment of 500m3/h. This experimental work of the current work has highlighted the underlying reasons behind the reduction in filter permeability due to the increase in face velocity and pleat density. The reasons that led to surface area losses of filtration media are due to one or combination of the following effects: pleat-crowding, deflection of the entire pleated panel, pleat distortion at the corner of the pleat and/or filtration medium compression. It is evident from entire array of experiments that as the particle size increases, the efficiency decreases until the MPPS is reached. Beyond the MPPS, the efficiency increases with increase in particle size. The MPPS shifts to a smaller particle size as the face velocity increases, while the pleating density and orientation did not have a pronounced effect on the MPPS. Throughout the study, an optimal pleat count which satisfies initial pressure drop and efficiency requirements may not have necessarily existed. The work has also suggested that a valid comparison of the pleat densities should be based on the effective surface area that participates in the filtration action and not the total surface area the pleat density provides.

Keywords : air filters, fractional efficiency, gas cleaning, glass fibre, HEPA filter, permeability, pressure drop
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