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LES Investigation of the Natural Vortex Length in a Small-Scale Gas Cyclone

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Abstract : Small-scale cyclone separators are widely used in aerosol sampling. The flow field in a cyclone sampler is very complex, especially the vortex behavior. Most of the existing models for calculating cyclone efficiency use the same stable vortex structure while the vortex demonstrates dynamic variations rather than the steady-state picture. It can spontaneously 'end' at some point within the body of the separator. Natural vortex length is one of the most critical issues when designing and operating gas cyclones and is crucial to proper cyclone performance. The particle transport along the wall to the grid pot is not effective beyond this point. The flow field and vortex behavior inside the aerosol sampler have been investigated for a wide range of Reynolds numbers using Large Eddy Simulations. Two characteristics types of vortex behavior have been found with simulations. At low flow rates the vortex created in the cyclone dissipates in free space (without attaching to a surface) while at higher flow rates it attaches to the cyclone wall. The effects of the Reynolds number on the natural vortex length and the rotation frequency of the end of the vortex have been revealed.

Keywords : cyclone, flow field, natural vortex length, pressure drop
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