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Investigation of the flow in a flat bottom cyclone

by

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ABSTRACT

The main objective of this investigation was to determine the velocity profiles of a swirling flow in a flat bottom cyclone, a cylindrical vessel with central discharges used for classifying or separating particles in industrial processes. A two component laser Doppler velocimeter was used to measure the axial and the tangential component of velocity. A perspex model of a flat bottom cyclone 310,5 mm high and with a diameter of 102 mm was installed in an experimental rig under controlled water flow conditions. The velocity profiles were measured for two different overflow tube (vortex finder) diameters and three different values of pressure drop Δp in the cyclone. For each cyclone, three different values of both under flowrate through the apex tube and over flowrate through the vortex finder were thus originated, the Reynolds number Re varying in the range $1,37 \times 10^4 \div 2,80 \times 10^4$. Velocity data were measured on four symmetrical vertical halfplanes of azimuthal coordinates $\mathbf{q} = 0^\circ, 90^\circ, 180^\circ, 270^\circ$ respectively. The experimental results have shown that the flow is approximately a forced vortex near the air core and a free vortex in the region between the radial coordinate of $v_{q,M}$, the maximum of the tangential velocity, and the solid wall. The value of $v_{q,M}$ grows with Δp and it is virtually the same for changes in z . The radial position of $v_{q,M}$ varies lightly through the vessel and it moves radially outwards when the feed pressure increases. In the axial direction the velocity field gives two opposite axial flows separated by a cylindrical surface, where the axial velocity is zero. It has been observed that $v_{z,M}$, the maximum of the axial velocity, increases with Δp and decreases linearly with z . The measurements obtained by laser Doppler velocimetry (LDV) have exhibited that both v_z and v_q present greater fluctuations near the solid wall and near the air-liquid interface. Then the turbulence is neither homogenous nor isotropic, since the RMS values of v_z are also greater than RMS values of v_q , except near the air core where they are of the same magnitude. Finally, we have observed that the velocity profiles are axisymmetric with exception of the region near the apex discharge and near the air core. The LDV data obtained varying the Re number have proved that the flow does not depend on feed pressure, since the flow changes only its magnitude, while the velocity and the turbulence profiles maintain a constant pattern. Again, when the experimental tests were developed varying the vortex finder diameter only a change in the magnitude of the flow was detected, yielding similar velocity and turbulence fields.