Performance analysis of a cyclone separator using CFD

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DECLARATION OF THE CANDIDATE AND SUPERVISOR

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ABSTRACT

Cyclone separator is a well-recognized, cost effective procedure of particle separation which used in many industrial works. As in cement industry, this cyclone separator used in order to separate calcium carbonate ($CaCO_3$) particles from hot gas. Apart from that, it also used to pre heat $CaCO_3$ particles by cyclone riser duct and to produce calcium oxide (CaO) (calcinations). Both of these procedures take place within the cyclone separator simultaneously. The efficiency of the cyclone separator determined by many factors such as cyclone dimensions & geometry, particle diameter & density and gas velocity. In this study, we considered about the effect of following 2 parameters on the efficiency of our fabricated cyclone separator. They are, Air flow velocity (inlet velocity) and Particle diameter. Experimental data were taken from the INSEE cement plant at Puttalam. Our experimental setup was the four stage preheater cyclone zone at the INSEE cement plant. Experimental data were taken from the bottom cyclone of the, Four Stage Pre Heater Cyclone Zone at the INSEE cement plant and figured the optimum values for those parameters to enhance the efficiency of the cyclone separator. CFD (Computational Fluid Dynamics) analysis also involved in to figure the optimum values for same parameters. In CFD analysis, for two phase air & calcium carbonate dust mixture, both multiphase ((k-epsilon, RNG (Re Normalization Group), wall function)) & discrete phase models have been used. Using multiphase model, we could plot contours of velocity, volume fraction and etc, of the individual phases. The Discrete model enabled us to track particles. This helped us to study collection efficiency by changing particle diameters & inlet velocities. It appeared that the final results of the experimental data and the CFD analysis were quite similar.

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LIST OF ABBREVIATIONS

Abbreviation	Description
$CaCO_3$	Calcium Carbonate
CaO	Calcium Oxide
F_c	Centrifugal force
E_{ij}	Component of rate of deformation
CFD	Computational Fluid Dynamic
ρ_f	Density of the fluid
DPM	Discrete Phase Model
ϵ	Dissipation
Y_p	Distance from point to the wall
V_r	Distance per time
F_d	Drag force
μ	Dynamic viscosity of the fluid
μ_t	Eddy viscosity
E	Empirical constant
g_i	Gravitational acceleration
LES	Large Eddy Simulation
U_p	Mean velocity of the fluid at the near- wall node
V_r	Outward radial velocity
ρ_p	Particle density
d_p	Particle diameter
PSD	Particle Size Distribution
U_{pi}	Particle velocity
RNG	Re Normalization Group
R_e	Reynolds number

RSM	Reynolds Stress Model
RSTM	Reynolds Stress Turbulence Model
rpm	Rounds per minutes
q	Specific heat consumption
V_t	Tangential velocity
k	Turbulence kinetic energy
k_p	Turbulence kinetic energy at the near- wall node
U_i	Velocity component in corresponding direction
V_p	Volume of the particle
K	Von Carman constant

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