NEAR FIELD SIMULATION OF PM_{10} DISPERSION IN OPEN PIT MINES

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By

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ABSTRACT

Open pit mining operations are responsible for the emissions of PM_{10} in a large proportion. The meteorological conditions within an open pit coal mine are significantly affected by the wind speed, direction and its penetration generating complex fluid flow phenomenon e.g. Separation of atmospheric boundary layer, recirculation, resuspension and settling of PM_{10}. This, in turn, affects to a great extent, the dispersion of PM_{10} within the open pit mine. The complex geometry of the mines and different operations taking place within the open pit coal mines, makes it extremely difficult to measure PM_{10}. Instead, the development of a dynamic numerical based model predicting PM_{10} dispersion within the mine may be an effective and economical. In this dissertation, a two dimensional model for incompressible flow, is formulated to determine concentrations of PM_{10} in the open pit mines. The system of equations have been obtained by transition from complete Navier-Stokes and heat conduction equations to Boussinesq approach by including buoyancy term into that momentum equation in addition to the relationship between density and pressure. Further, the Navier Stokes heat conduction and diffusion equations along with the expansion of model equations by inclusion of heat transfer and buoyancy forces allow us to take into consideration thermal effects on the microclimate of the open-pit mine. The variables that are determined include velocities in x and z directions, temperature and concentration of PM_{10}.

PM_{10} has been predicted within the workzone of the open pit mine which is 50m x 50m by considering the bottom up approach. The in-pit horizontal and vertical velocities have been estimated by considering effect of angle of wind penetration. Further, these in-pit velocities have been considered as an input in estimating PM_{10} concentrations. The central difference scheme of the finite difference method has been used to solve equations to determine PM_{10} concentrations at different heights within the open pit mine. The model predicts PM_{10}

concentrations at height up to 50m from the bottom of the coal mine taking into account effects of wind penetration and gravitational settling. The results describe reductions of 88.9% and 22.6% in PM_{10} concentrations at a height of 5m from the bottom of the coal mine corresponding to wind velocities of 4m/s and 1m/s, respectively. Further, PM_{10} concentrations have also been obtained by varying diffusion coefficients. The factors affecting the performance of the model are also highlighted and suggestions for future research are given.