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Turbulent Modelling of Airflow Patterns and Ventilation Effectiveness In a Half Scale Office Building.

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ABSTRACT

The concentrations of indoor pollutants should be maintained below recommended values at all occupied locations at any time. A design method based on minimal air change rates may not be satisfactory, since the ventilation effectiveness is determined not only by the nominal air exchange rate but also many other factors, such as the airflow pattern the space, location of contaminant sources, and properties of the contaminants. It is the objective of the present study to investigate numerically the effect of airflow patterns due to the various factors of ventilation effectiveness.

The control volume based finite difference scheme is utilized to solve steady state flow field. a low Reynolds number k-e turbulent model is implemented to calculate turbulent quantities. The mass conservation equation for a contaminant is solved to calculate transient solutions in the concentration field under the steady state flow field obtained. From the transient concentration field, ventilation effectiveness is calculated using two different methods; 1) Local decay rate of concentration: Slope of Log (concentration) v.s. Time curve, and 2) Local mean age: Equivalent to area under Concentration v.s. Time curve.

The simulations are carried out for several different values of air exchange rates and several different intake and exhaust locations in a two-dimensional model of a half scale office room of 57" high x 77" wide. The distributions of local ventilation effectiveness are presented along with the velocity vectors and concentration distributions in the ventilated space. The results show that the ventilation effectiveness around various locations within the room could vary significantly. It suggests that the design method based on nominal air exchange rate may overestimate the ventilation efficiency and thus underestimate the concentration of contaminants in some locations within the ventilated space, especially regions with large recirculations.