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COMPUTATIONAL FLUID DYNAMICS STUDY ON THE INFLUENCE OF AIRFLOW PATTERNS ON CARBON DIOXIDE DISTRIBUTION IN A SCALED LIVESTOCK BUILDING

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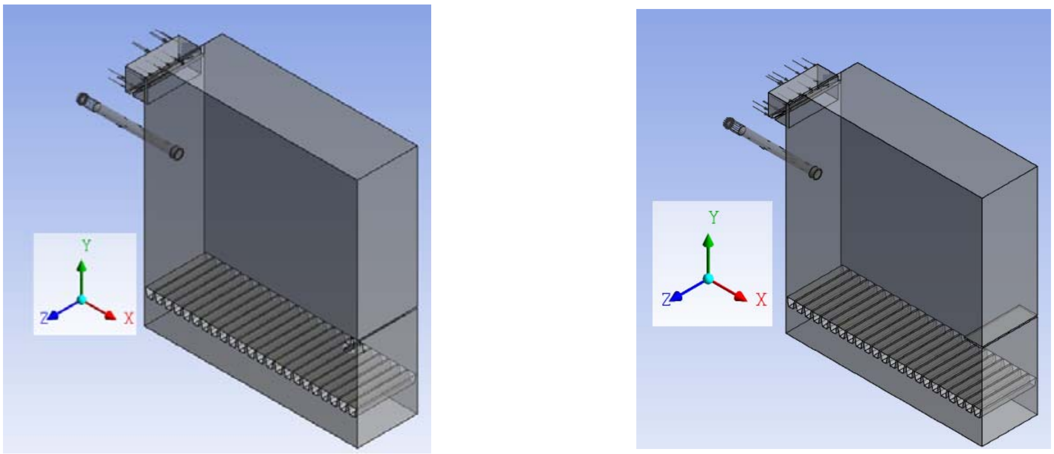
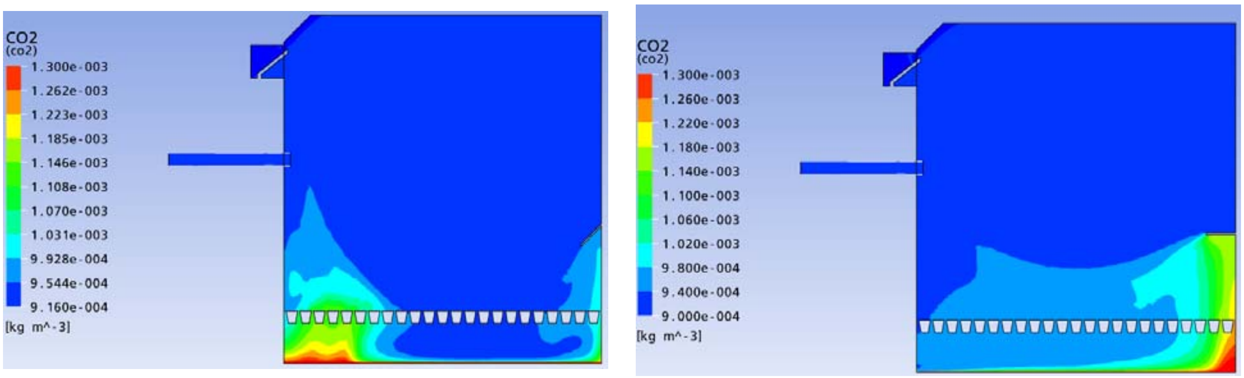
Airflow patterns and airflow rate have an important influence on contaminant distribution in swine buildings. The objective of this paper is to model and evaluate the effect of airflow rates and airflow patterns on CO_2 concentration distribution. Contaminant sources are assumed to be modeled as a constant concentration on the manure surface. Three different ventilation rates and three different deflector degrees are studied, in which the deflector is used to change the airflow patterns. A CFD (Computational Fluid Dynamics) commercial software code has been applied to simulate the air velocity and contaminant distribution. Experimental data of tracer gas concentration distribution in the chamber are obtained to validate the turbulence model in CFD software. Simulation results show that different ventilation rates and airflow patterns effect the contaminant distribution within the room. With increasing the airflow rate, the emission of CO_2 will increase and the dimensionless CO_2 concentration above the slatted floor will also increase slightly, while the absolute CO_2 concentration in the room will decrease with increasing the airflow rate. Here the dimensionless CO_2 concentration is defined as: $c^* = \frac{c - c_0}{c_r - c_0}$, and $c*$ is the dimensionless CO_2 concentration, c is the CO_2 concentration in the room, c_0 is the inlet CO_2 concentration, c_r is the outlet CO_2 concentration.



(a) 45 degree's deflector (b) 90 degree's deflector

Figure 1 model for simulation



(a) 45 degree's deflector (b) 90 degree's deflector

Figure 2 CO_2 concentration distribution in the middle plane with Z=0.31m

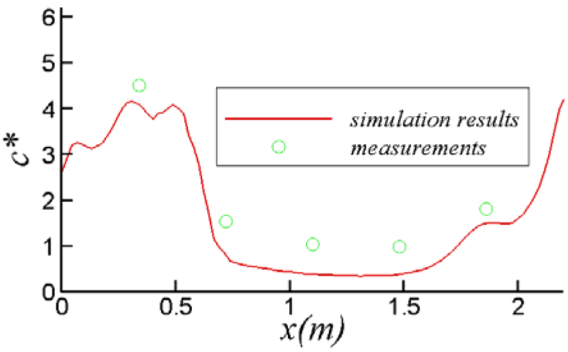


Figure 3 Comparison of dimensionless CO_2 concentration between simulation result and measurement above the slatted floor of y=0.51m with 45 degree's deflector

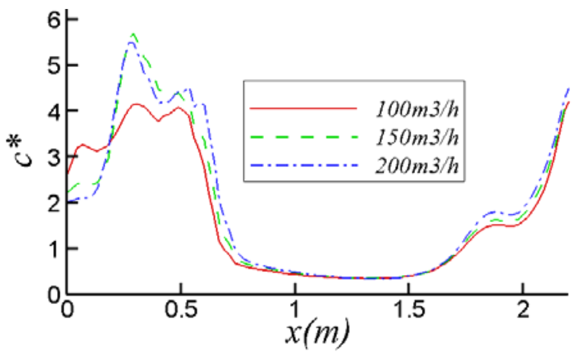


Figure 4 Comparison of dimensionless CO_2 concentration among three various airflow rates along the line y=0.51m above the slatted floor with 45 degree's deflector

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