

CE 890 Graduate Seminar

DATE: February 11, 2009
TIME: 4:00 p.m. (refreshments served at 3:45 p.m.)
PLACE: Fiedler 2144
SPEAKER: Dr. Ahmed R. El-Sotouhy, Department of Environmental Health and Safety
TOPIC: “Effect of Breathing, Posture, and Air Velocity on Breathing Zone Gas Concentrations for Human Subjects in a Wind Tunnel”

ABSTRACT

Industrial hygienists generally place air-sampling probes on the mid to upper torso of workers when attempting to determine inhaled concentrations. There is no convincing evidence that concentrations measured on the chest are equal to inhaled concentrations. To determine how well surrogate locations matched concentrations at the mouth (C_{mouth}), low concentrations of ethanol in nitrogen were released between the hands of standing and seated human subjects while they moved children’s blocks back and forth over the source.

In all cases, each of four subjects stood or sat with their backs to the airflow in a wind tunnel because previous studies had established that facing downstream produced exposures that were more than 100 times the exposures when facing upstream or sideways to the flow with the source in the subjects’ hands. Sampling probes were placed at the subject’s mouth, nose, forehead, neck, both collars, center chest and both lapels. Airflow was drawn to 3L Teflon™ sampling bags at 0.15 Lpm. Concentrations were measured using a gas chromatograph with a photo-ionization detector, which was calibrated daily over the range of sample concentrations. Subjects were tested at wind tunnel cross-draft velocities of 11.3, 27.2, 47.5, 81.5, and 103.5 ft/min while either exhaling through a tube or not and either sitting or standing.

The results showed that posture and wind tunnel velocity have highly significant effect on sampling location concentration ($p < 0.01$). Exhaling through a tube was less important ($p < 0.04$). As with a previous manikin study, concentrations varied in an inverted-V with velocity. Concentrations across the chest were as much as 22% higher than C_{mouth} when seated and 70% higher than C_{mouth} when standing. Concentrations at the neck and collar were much closer to C_{mouth} but still deviated by as much as 10%. Levels at the forehead were generally lower than C_{mouth} but were highly correlated to it. Levels adjacent to the tip of the nose deviated the least 7%, as might be expected. Based on the study, the best surrogate to mouth location are the collars with an over estimation of 7%.

Previous studies raise strong concerns about the accuracy of samples taken anywhere below the collar when the subject is close to the source and airflow is from the rear. The dramatic effects of posture on concentrations suggest that exposure studies should include both sitting and standing as well as variations of each. The effects of body size and shape and hair length should be investigated in future studies.