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UNCERTAINTY IN CALCULATING AIR EXCHANGE RATE OF NATURALLY VENTILATED DAIRY BUILDING BASED ON POINT CONCENTRATIONS

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Abstract

Accurate quantification of gaseous emissions from livestock buildings to the atmosphere requires accurate determination of the ventilation rate and the representative gas concentration in the exhaust air. But there is a lack in the investigation of reasons and uncertainties for selecting sampling points and locations in naturally ventilated dairy (NVD) buildings. The objective of this study was to investigate uncertainties in calculating AER based on carbon dioxide (CO₂) balance method. The experiment was carried out in an NVD building located in north-east Germany. Concentrations of CO₂ were continuously measured inside the barn at eight uniformly distributed points and outside the barn at four points. Air exchange rate (AER) per hour was calculated using the concentration difference between inside and outside the barn where inside concentrations of 4 sampling locations left (4PL), middle (4PM), right (4PR) and corner (4PC) of the barn, 6 sampling locations in left (6PL), right (6PR) and randomly (6RS) selected points inside the barn were used, then compared with AER calculated using an average CO₂ concentration of 8 sampling points (8PA) according to the CO₂ balance method. The results showed that the relative AER calculation differences using 4PL, 4PM, 4PR, 4PC, 6PL, 6PR, and 6RS were -49 to 112%, -5 to 26%, -29 to 34%, -12 to 13%, -5 to 44%, -14 to 10% and -8 to 4% compared to 8PA. The variations in relative differences are because of uncertainties involved in point concentration measurement due to the variations of outside wind speed and direction.

Key words: air exchange rate, air velocity, carbon dioxide, natural ventilation, wind direction

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