

Kanlaya Nukham 2014: Prediction of Gas Leakage Rates During Empty Grain Silo Fumigations by the Superposition Method. Master of Engineering (Agricultural Engineering), Major Field Agricultural Engineering, Department of Agricultural Engineering. Thesis Advisor: Mr. Watcharapol Chayaprasert, Ph.D. 90 pages.

The objective of this thesis was to evaluate the feasibility of using the superposition method for predicting gas concentration decay rates during silo fumigations. Three fumigation experiments in 0.2285 and 2.160 m³ model silos were conducted with carbon dioxide as a tracer gas. The result of the first experiment confirmed that fumigant concentration decay followed a first-order kinetic characteristic of which the half-loss time (HLT) is inversely proportional to the air infiltration rate. For the 0.2285 and 2.160 m³ silos, the differences (i.e., %error) between the theoretically calculated HLT (HLT_t) and the actual HLT (HLT_a) determined from gas concentration readings were 4.92 – 21.04% and 5.60 – 31.92%, respectively. The values of wind (C_w) and stack (C_s) coefficients of both model silos, which were later on used in calculations in the third experiment, were determined in the second experiment. The wind coefficients of the 0.2285 and 2.160 m³ silos were 1.08±0.07 – 1.41±0.04 (10⁻³) and 1.09±0.07 – 1.34±0.18 (10⁻³), respectively, while the stack coefficients were 1.20±0.11 – 1.52±0.0204 (10⁻³) and 1.12±0.03 – 1.31±0.12 (10⁻³), respectively. In the third experiment, fitting fumigant concentration decay curves with the first-order kinetic equation yielded coefficients of determination (R²) of at least 0.990 and the concentration decay curves of the 0.2285 and 2.160 m³ silos had HLT_a's of 3.21±0.47 – 6.16±0.35 h and 4.49±0.67 – 18.74±0.24 h, respectively. The superposition method yielded HLT predictions (HLT_p) with percent errors (i.e., %error) ranging from 1.65±0.50 to 15.70±1.10% for the smaller silo and from 1.76±1.21 to 10.43±1.36% for the larger one. The majority of %errors of prediction were less than 10%. The HLT_a and HLT_p of the third experiment were linearly correlated with slopes close to 1. The results of this thesis illustrated that fumigant concentration decay rates can be satisfactorily predicted by the superposition method.

Student's signature

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