FINITE ELEMENT PREDICTION OF THREE-DIMENSIONAL CARBON DIOXIDE DIFFUSION IN STORED GRAIN BULKS

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A stored grain bulk is a man-made ecosystem in which insects, mites, and microorganisms interact with the abiotic environment (grain temperature, moisture content, and the intergranular gaseous composition) to cause quantity and quality losses to the stored grain. The stored grain can be protected from insects and mites using chemicals such as contact insecticides and acaricides and by fumigation. Due to perceived carcinogenicity to mammals several chemicals have been banned by regulatory agencies.

Controlled atmosphere storage (CA) is a potential alternative method of insect control. For successful control of pests using modified atmospheres, gases must be uniformly distributed throughout the grain bulk and maintained at adequate concentrations for the required exposure times. An understanding of the distribution of gases in a stored grain bulk is needed for engineering design and successful application of CA storage to control pests.

A finite element model for predicting the three-dimensional movement of CO_2 in stored grain was developed. Our earlier model predicted high mean relative percentage errors ranging from 5.9% to 39.1% when diffusion was assumed to be the only mechanism of CO_2 movement inside the grain bulk. The model was modified by incorporating forced convective CO_2 transport into the diffusion model. Model predictions were compared with experimental data on movement of CO_2 through wheat contained in 1.45-m-diameter model bins. Experiments were conducted to determine the effect of three different floor openings (circular near the centre, circular near the wall, and rectangular), open and sealed grain surfaces, and different CO_2

concentrations at the perforated openings on the distribution of CO_2 in the stored bulk.