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Understanding pore structures in bulk grain for fumigation

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ABSTRACT

Quick diffusion and uniform distribution of the fumigant gas in bulk grain are critical for successful fumigation. Diffusion of fumigant gas in bulk grain is dependent on the pore structure of the grain bulk, including the total pore volume, individual pore size and shape, and connectivity of pores. The pore structure of a grain bulk is extremely complicated and difficult to quantify. This presentation summarizes imaging and numerical modelling methods to investigate pore structures in bulk grain. Molten wax was poured into the grain sample to "freeze" the pore structure of the grain bulk and the sample was then cut to expose the internal structures for image acquisition. The acquired images were then analyzed to quantify the pore structure, such as porosity and tortuosity. The discrete element method (DEM) was also used to simulate pore structures in bulk grain. In the DEM simulation model, a grain bulk was approximated as an assembly of spherical particles, which represented grain kernels. These particles interacted with each other through the forces at contacts, based on which the spatial arrangement of grain kernels in a grain bulk was predicted and the pore structure (pore volume, size and shape; channels connecting pores) was quantified. Based on the simulated pore structure, gas flow through connected pores in the grain bulk could be characterized. It was found that the pore structure generally varied from location to location in a grain bulk, which implied that local distribution of fumigant gas might not be uniform in a grain bulk.

Keywords: Grain bulk, Pore structure, Fumigation, Gas flow, Imaging processing, Discrete element modelling