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Carbon dioxide movement monitoring in a lab-scale grain bin

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ABSTRACT

Increased level of carbon dioxide (CO₂) in stored grain is one of the early indicators of spoilage. Carbon dioxide concentration of 600 to 1000 ppm in the bulk stored grain indicates early signs of spoilage due to increased microbial activity. A study aimed to simulate the CO₂ movement in a grain bin and to determine the rate of CO₂ movement from its point of origin (at the center of the study bin) to the headspace and the plenum was conducted. To introduce controlled amount of CO₂ into the small grain bin (2 m³) a CO₂ gas cylinder was used. A regulated amount of approximately 0.075 L/s of CO₂ was introduced into the grain bin using a flexible tubing (3.2 mm opening) connected to the CO₂ cylinder. The flexible tube was inserted into a rigid metal pipe (12.7 mm diameter) which was then inserted together into the grain bin so that CO₂ was released approximately at the center of the bin. The equivalent ppm of CO₂ corresponding to the duration of injection was calculated using the Poiseuille Equation. The concentration of CO₂ in the headspace and near the bottom opening of hopper bottom bin was recorded using CO₂ sensors during and after the CO₂ injection. The concentration of CO₂ at the headspace was 0.1 to 0.2 times lower than at the plenum up to the injection time equivalent to 1500 ppm. Both plenum and headspace showed increased concentration within 3-5 min of release of CO₂. This preliminary study reflected the idea of monitoring CO₂ concentration in grain bin either in plenum or headspace that could be utilized as a potential tool for early detection of grain spoilage.

Keywords: Grain storage, Grain spoilage, CO₂ monitoring, Microbial activity