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Abstract: The use of ozone as a non-chemical alternative in stored product protection of grain was studied by conducting scale-up demonstrations using a fixed bed ozonation system and developing a semi-continuous counterflow and continuous flow ozonation treatment systems. The objectives of this research was to determine the efficacy of ozonation to control insect pests without affecting end-use quality, prove the concept of the semi-continuous counterflow ozonation system to ozonate grain at a faster rate and quantify its effect on mold growth reduction, evaluate the efficacy of a modified screw conveyor for pest control by treating grain in a continuous-flow ozonation treatment system, and to determine technically feasible scale-up configurations of each ozonation treatment system and to determine which is most cost-effective. Ozonation treatment in fixed bed systems resulted in 100% insect mortality for adults of maize weevil (MW) and red flour beetle (RFB) with no end-user quality effect on grain. The semi-continuous counterflow system was proven as an effective system to treat grain by the control of three key variables of airflow, ozone mass flow, and exposure time. Also, it reduce mold in stored grain by more than 50% using a range of ozone cumulative CTP between 340 to 565 ppm-h. The continuous flow system proved to be an effective treatment system with an average grain retention time of 1.8 minutes and ozone concentration of 47,800 ppm that resulted in 100% insect mortality for adult MW and RFB. The scale-up and economic analysis showed that continuous flow and the semi-continuous counterflow systems were predicted to have the lowest treatment cost of 1.21 $/MT compared to fixed bed systems with 1.33 $/MT and are 55% more expensive than traditional fumigation and 29 and 43% less expensive than ambient aeration and grain chilling, respectively.

Application: Three grain treatment systems for using ozone in a fixed bed, semi-continuous counterflow and continuous flow systems were developed and proven to be effectively used for pest control with 100% insect mortality and mold growth reduction without affecting end-use quality of the treated grain at farm-level and grain processing facilities. The semi-continuous counterflow and continuous flow systems had the same the lowest cost of 1.21 $/MT compared to fixed bed systems with 1.33 $/MT and are 55% more expensive than traditional fumigation and 29 and 43% less expensive than aeration and grain chilling that are other non-chemical alternatives for pest control.