Session 1: Current status of CA technology in different countries*

Maria Regina SARTORI,
Instituto de Tecnologia de Alimentos, C.P. 139 Campinas, S.P. CEP 13073001 AV, Brazil

Rapporteur's Report

The current status of controlled atmosphere (CA) technology in Western Australia, Canada, The Philippines, China, and India were reported, respectively, by Ray J. Delmenico, Digvir Jayas, Glory R. Sabio, and Jonathan Banks on behalf of Huinai Xu.

In Western Australia sealing of storage structures for introduction of fumigation and CA technologies began in the late 70's. Motivation for this was the escalating development of insect resistance to conventional grain protectants, and increasing market sensitivity to pesticide residues in grain. Following successful trials conducted in 1980 in three 23,000-tonne horizontal structures "Cooperative Bulk Handling Ltd.", elected CA and fumigation to be the principal insect control technique, and the majority of modifications in storage units were undertaken over the period 1982-86. This company considers that the correct decision was made, and it is now in a very favorable position to provide internal and external markets with grain that is insect free with nil/low pesticide residue in the grain.

In Canada, the cold climate, the effectiveness of existing fumigants, low levels of infestation and high costs of CO_2 have limited, in the past, research on modified atmospheres. Work undertaken has focused mostly on the effect of oxygen concentration on fumigant toxicity to insects, on CO_2 synergism with fumigants at low temperatures, and development of resistance to CO_2 in *Sitophilus granarius*, for which a three fold tolerance was reported after only seven generations. However, slowly increasing field resistance by stored-product insects to phosphine, as well as the fear of fumigation hazards to applicators and consumers, has led to the development in Winnipeg of a research program on modified atmospheres for pest control in stored grain. Studies have been conducted on the effects of elevated CO_2 (10-50%) and depleted O_2 (>10%) on stored grain ecosystems at moderate and cool temperatures. A three dimensional computer model to describe CO_2 diffusion due to temperature gradients in silos with fully impermeable walls was developed and tested. Current research is aimed at the development of

---

* Editors' comment: The proceedings includes the paper of Dr. Agboola on CA storage in Nigeria. Dr. Agboola who was planning to attend the conference could not finalize his travel plans. Because of the importance of his report, the Organizing Committee made an exception and agreed to include this paper in the proceedings.

three dimensional models for heat transfer and moisture movement in bulk grain, that integrated with the CO_2 diffusion model, will enable the prediction of the amount of CO_2 and length of time needed for control of all life-stages of stored product insects. Based on these findings guidelines to the farmers will be provided.

In the Philippines investigations into the use of CA as a storage option for pest and quality control have been conducted on rice, maize and groundnuts. Research has been directed towards CO_2 enriched atmospheres and hermetic storage in both indoor and outdoor experiments. Nitrogen has not been used. Investigations have been carried out in sealed sacks, drums and plastic enclosures of stacks of up to 3,000 tonnes. Parameters used for evaluation of grain quality involve weight loss, percent damaged kernels, insect infestation, germination (groundnuts), sensorial analysis (soybeans and rice) and mold infection. Results obtained so far have been considered to be very satisfactory. CA has not, however, been used at a commercial level. Reasons given for non-adoption are high initial capital cost, limited availability of food grade CO_2 and of plastic materials, and lack of training and adequate transfer of technology.

China has been using a concept termed the "Triple-Low" technique. The meaning of "Triple-Low" is low temperature (<15°C), low oxygen (4-12%), and low fumigant concentration (0.5-1.0 g PH_3/m^3). "Triple-Low" is therefore a synthesis of preventative measures in which ventilation is used to lower the temperature, sealing with plastic sheets is used to achieve a natural depletion of oxygen concentration, and a low fumigant concentration is used to inhibit respiration and control grain storage pests. According to the type of grain, moisture content, and storage season, the treatments involving sealing with plastic liners, cooling by ventilation, and fumigation, are arranged in suitable order. For instance for grain entering storage during the cool season, the following treatment sequence is applied: low-temperature, low-oxygen and low-fumigation. However, if the grain is placed in storage in the hot summer, the sequence applied is: low oxygen, low fumigant and lastly, low temperature. Although still in the developmental stage, the reports indicate that the "Triple-Low" technique is considered an ideal way to store grain in China.

In India CA investigations have started with CO_2 fumigation of two stacks of milled rice packed in jute bags with 0.2 mm PVC stack liners. Complete control of *Oryzaephilus surinamensis* (L.), *Ephestia cautella* (Walker) and *Cryptolestes* spp. was reported for an initial CO_2 concentration of 2.5 kg/tonne and an exposure period of 15 days.