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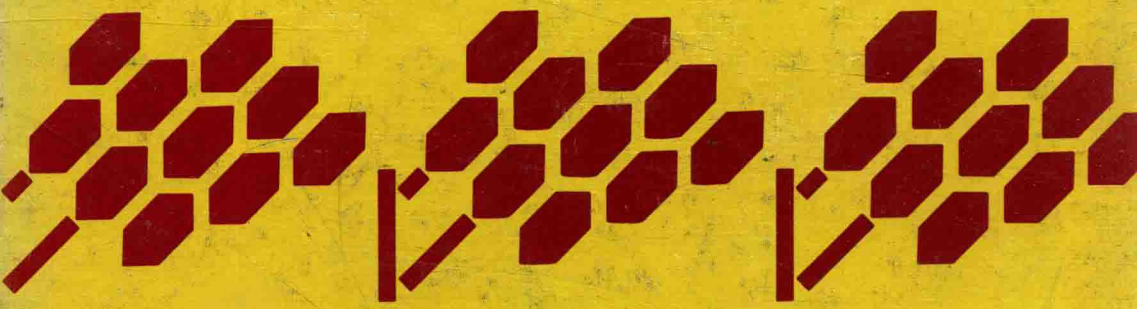

Controlled Atmosphere and Fumigation in Grain Storages

B.E. Ripp et al. (editors)

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Developments in Agricultural Engineering 5

Controlled Atmosphere and Fumigation in Grain Storages

Proceedings of an International Symposium "Practical Aspects of Controlled Atmosphere and Fumigation in Grain Storages" held from 11 to 22 April 1983 in Perth, Western Australia

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PREFACE

The second International Symposium on Controlled Atmosphere Grain Storage held in Perth, Western Australia, was organised by Co-operative Bulk Handling Limited and the Australian Grain Institute Incorporated in collaboration with the Commonwealth Scientific and Industrial Research Organisation and Food and Agriculture Organisation of the United Nations. This followed the first Symposium held in Rome in May 1980 organised by Assoreni. During discussion in Rome, several participants expressed the view that the next meeting should cover more problem loaded aspects of controlled atmosphere storage and disinfestation of grains, gas tight facilities, sealing practices, inert gas production and high moisture grain storage. Dr Shejbal in his preface to the proceedings manual recalled these views and expressed the hope that his Symposium would be followed elsewhere in the world to permit a further diffusion of this environment - friendly, economical and safe preservation technique in modern storage facilities.

This was the call that Co-operative Bulk Handling Limited responded to when this Symposium was organised and leads to its title - "Practical Aspects of Controlled Atmosphere and Fumigation in Grain Storages". As our Chairman Mr H W Gayfer stated during his Keynote address, the reasons we believed we were in the most favourable position to conduct this Symposium were:-

1. Our year round climate is ideal for the development of grain insects.

2. As 95% of our produced grain is exported our control standards must be of high order.

3. C.S.I.R.O. officers have developed their research into C.A. Storage to the commercial application stage.

4. A National Committee of Bulk Handling Authorities and C.S.I.R.O. had combined their resources throughout Australia for the development of sealing technqiues.

5. C.B.H. Ltd had realised that unless the method could be applied to existing storages as well as new storages its potential was seriously diminished.

Considerable funds had been allocated by C.B.H. Ltd for the application of these techniques, sufficient to provide 1.5 million tonnes of sealed storages at the completion of the then current programme.

As this was to be a practical symposium a field trip to visit sites in various stages of the sealing exercise was a necessary part of the demonstration process. This was organised as part of the Controlled Atmosphere and Fumigation Week. Further, to provide coverage of the broad aspects of grain handling, storage, transport and quality control as an added attraction to visitors undertaking the long journey to Perth in a depressed economic climate, a second week was made available.

270 participants from 28 countries attended the Symposium and I have yet to see a more convivial, a more totally committed group of people interchanging freely, giving and receiving knowledge and experience.

The major gap yet to be covered in Controlled Atmosphere Grain Storage is its compatability with grain of very high moisture content. Such aspects could not be demonstrated in Australia by virtue of our climate and demonstration of theories is necessary. This to some extent limits the ideal geographic zone for the holding of the next C.A.F. Symposium. To this end our International Steering Committee have chosen to remain as a body for the purpose of aiding the promotion of the system and guiding the selection of the next venue.

My appreciation is extended to all those organising committees within C.B.H. Ltd, to our field staff whose efforts will be well known by all participants, to the Chairmen of sessions who actually controlled the running of the Symposium, and to the Rapporteurs. There would have been no Symposium on the practical aspects of the transfer of controlled atmosphere and fumigation technology into commercial use, especially on the scale we have seen, had the facilities not been made available and the costs underwritten. "The influence of this event will be felt in grain storage activities throughout the world for many years to come" is a statement made by a speaker at a Stored Grain Protectant Conference. Therefore I find it difficult to find words sufficient to express the degree of attribute deserved to our General Manager Mr Jim Green and our Board of Directors for their full

support both during the Symposium and the years leading up to it. A special recognition is also well deserved for the efforts of Alan Grey and his willing assistance in the organising and the conduct of the Symposium and in the compilation of this manual of proceedings.

The International Steering Committee, who also formed the body of Editors, who assisted from all points of the Compass before, during and after the Symposium, were Ed Jay U.S.D.A., Ed Bond Canada Agriculture, David Calverley T.D.R.I., Geoff Corbett F.A.O., S. Navarro A.R.O., Jonathon Banks C.S.I.R.O.

A particular thank you to Jonathon Banks for his dedication to his work and for his support and guidance over a number of years. It was most unfortunate that JINDRICH SHEJBAL was unable to attend this follow up to his orginal work. I know he would have liked to have been with us.

I have maintained the order of events in this manual of proceedings as they occurred during the period from 11th to the 22nd April 1983.

Perth, Western Australia, April 1984. B.E. RIPP

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Lu Qian Yu	-	Peoples Republic of China
H. Akiyama	-	Japan

PROGRESS IN THE USE OF CONTROLLED ATMOSPHERES IN ACTUAL FIELD SITUATIONS IN THE UNITED STATES

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ABSTRACT

Field research on the use of carbon dioxide (CO_2) for stored product insect control in the United States in the last 3 years is described. Minor efforts were made in sealing the storage structures studied and in 7 tests in upright concrete silos or welded steel bins containing wheat, maize, rice or sorghum the amount of CO_2 used/1,000 metric tonnes (t) grain ranged from 3.1 to 4.5 t. However, treatment costs/t of grain ranged from 0.23 to 0.39 U.S. $ because of the availability and low costs associated with CO_2 marketing in this country.

Additional studies on the use of CO_2 in farm storage situations and in rail hopper cars containing flour are also described. The future of the use of CA in the U.S. is discussed.

INTRODUCTION

Since the last meeting in Rome (Shejbal, 1980) on the subject of controlled atmospheres (CA) there has been an increased interest on the use of this residue-free insect-control technique for pests of grain and oilseeds in storage in the United States (U.S.). This interest cannot be described as an all-out conversion from the use of conventional fumigants to the use of CA. Rather, it can be considered as an inquiry by large grain and oilseed handlers into the effectiveness of the technique with particular emphasis being placed on the economics of the treatment when compared to the costs of using conventional fumigants. This interest is possibly also motivated by the realization that the U.S. Environmental Protection Agency (EPA) may prohibit the use of liquid fumigants containing carbon tetrachloride and methyl bromide for grain treatment in the future in the U.S. This would leave the grain industry with only hydrogen phosphide (PH_3) produced by aluminium or magnesium phosphide formulations for the fumigation of grain or oilseeds in post-harvest situations and with CA for treatment of these commodities.

Laboratory and field research conducted by the U.S. Department of Agriculture has shown that carbon dioxide (CO_2) is the CA of choice for use

in situations where little or no attempts are made to seal the storage structure prior to treatment. CO_2 is effective in controlling storage pests at concentrations of 35% or more (Jay, 1971, 1980; Jay and Pearman, 1973; Jay et al. 1970). Although CO_2 is more effective at concentrations of ca. 60% for most storage pests,it can be allowed to fluctuate in the range of from 35 to 100% and insect control can be achieved. The exposure time needed to obtain high levels of insect control is a function of CO_2 concentration, temperature, grain moisture content, and the species and life stages of the insects which are infesting the grain or oilseeds (Bailey and Banks, 1980; Jay, 1984a,b). Current recommendations state that a concentration of from 45 to 60% CO_2 should be attained and maintained for 5 to 6 days at temperatures above 27°C; for 10 to 14 days at a temperature at or above 21°C and for 21 to 28 days at temperatures at or above 16°C (Jay, 1984a). However, reluctance is encountered when these exposure times are suggested for use in cooperative studies with large grain processors since there is a general feeling that these exposure times are too long when the CO_2 treatment is compared with a PH_3 treatment. Therefore, most field studies conducted in this country have been for a 4-day period after a CO_2 concentration of ca 60% is attained in a storage structure. These treatments generally result in ca 95% control of natural or artificial insect infestations in the commodity being treated.

The U.S. EPA in 1980 granted an exemption from tolerance (approval for use) for the use of CO_2, nitrogen and combustion product gas (effluent from a CA generator) for all raw agricultural products (U.S. Federal Register 45, pp. 75663-64, Nov., 1980) and in 1981 for the use of these treatments on processed agricultural products (U.S. Federal Register 46, pp. 32865-66, June, 1981). This approval has stimulated some companies which produce CO_2 to attempt to introduce their product for use in stored-product insect control to the grain and oilseed industry. This paper describes some of the commercial scale tests that have been conducted in the last 3 years.

METHODS AND MATERIALS

Treatment of cylindrical grain storage bins

Silo and construction material, bin dimensions, commodity and amount of grain and its temperature are shown in Table 1. Trials 1 to 7 were conducted in terminal elevators or inland terminals located in Texas and trials 8 and 9 were conducted in Harvestore(R) bins located on a South Carolina farm. Harvestore bins are fiberglass lined steel bins generally used for the storage of silage.

CO_2 was supplied from pressurized tanks of 3.6 t, 5.4 t, or 10.9 t capacity and were equipped with suitable vaporization equipment. The CO_2 was introduced from the bottom of the bins in trials no. 2, 3, and 8 and