CORROSIVE EFFECTS OF INTERACTIONS OF PHOSPHINE, CARBON DIOXIDE, HEAT AND HUMIDITY ON ELECTRONIC EQUIPMENT

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Introduction

The problem of metallic corrosion in phosphine has been addressed in early work in Canada(l) and more recent studies in Denmark(2) and the U.S.(3,4). However, the exposure conditions which promote attack and the corrosion mechanism are still not well understood. Consequently, this study which has been designed to quantify corrosion kinetics and morphology under carefully controlled laboratory conditions was sponsored by the United States Department of Agriculture and Agriculture and Agri-Foods Canada, Environment Canada and Natural Resources Canada with support from the Canadian National Millers Association, the Canadian food processing industry, the Canadian Pest Control Association and David Mueller of Fumigation Service and Supply, Inc., Indianapolis, IN, U.S.A. This project is being conducted under the auspices of the Canada/U.S. Working Group on Methyl Bromide Alternatives.

Scope of Study

Materials:Corrosion kinetics and morphology will be evaluated on four materials: silver (electrical contacts), copper (electrical conductors), brass (electrical components) and solder. The materials will be tested with both smooth surfaces and with abraded surfaces to increase the probability of water adsorption at a given RH - a condition equivalent to having dust on the surface. The corrosion behaviour of these four materials will indicate where corrosion problems with electrical components are likely to happen. When sufficient data on the conditions leading to accelerated corrosion of the individual metals has been gathered, representative components (possibly a telephone or calculator) will be exposed to aggressive conditions and then subjected to failure investigation.

Testing Parameters:

- three temperatures; 20/30/40C
- up to five concentrations of phosphine in the range 30 to 230ppm
- up to four conditions of relative humidity in the range 15 to 75%
- up to four levels Of C02 in the range 3.5 to 5%
- exposure times of 12, 24 and 36 hours

Methodology

An air stream will be saturated with water at low temperature in one constant temperature bath (to give 100% RH) and then the temperature of that stream will be increased in a second bath to the test temperature (20, 30 or 40C) to give a lower pre-determined RH. In addition, $C0_2$ (from a cylinder of pure compressed gas) and PH_3 (f rom a N_2 0. 5%PH_3 gas mixture) will be bled into the second bath f or pre-heating and mixing. This dilution will lower the RH in the carrier stream and that will be adjusted by trial and error. Concentrations will be monitored as required depending on the reliability of the mass flow meters - PH_3 with a PortaSens meter; $C0_2$ with a Fyrite analyzer; and RH with a wet bulb hygrometer.

Preliminary observations

This study began in August 1997 and the initial focus has been on constructing the experimental apparatus and evaluating the morphology of copper strips which had been exposed at fumigation sites by Fumigation Service and Supply, Inc. Using the scanning electron microscope (SEM) with energy dispersive analysis by x-rays (EDAX), the following observations have been made:

- surface deposits on the copper are mainly colourless, crystalline and deliquescent. A few random dark circular deposits seem to be associated with surface dust
- these deposits are not electrical conductors and charge in the electron beam
- EDAX shows that the elements present are Cu, P and 0. (H cannot be detected using EDAX).
- surface deposits nucleate at surface imperfections such as rolling marks and grow rapidly to increase surface coverage but in a non-linear way
- when the surface deposits were removed in 50/50 HC1, the copper substrate showed areas of no attack, areas of general attack and other areas with pitting.

References

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