Performance of Zeolite Based Products in Ethylene Removal

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Introduction

Zeolite impregnated films, paper liners, and packing foam blocks are being sold or are in commercial development to market to the horticulture industry. Among the benefits promoted is the removal of ethylene from the airspace surrounding and external to packed commodities. We have evaluated several zeolite-based products or prototypes being targeted to the floriculture industry for the protection of ethylene-sensitive potted plants and cutflowers during short-term storage, transportation and distribution.

Zeolites are a large and diverse class of volcanic aluminosilicate crystalline materials which have many useful applications. They are used in oil cracking, adsorption of nuclear waste, production of controlled-release fertilizers for agriculture, adsorption of ammonia and other odor-volatiles, as cation absorbers in household detergents, as molecular sieves, and for many other uses. There are over 600 natural mineral and synthetic forms with over 118 characterized crystalline structures.

Zeolites have been used primarily for their cation exchange properties and their structure has been studied for many years. Cation exchange requires a zeolite that is open and porous. Clintoptiliolite or Mordenite are the predominant forms used. Analcime-types and other topographically related types, which have a high density, exchange so slowly they have been found to be of no use for adsorptive removal of cations or volatiles. As the development and promotion of zeolites for removal of ethylene or other deleterious volatiles increases, it will be important for shippers and handlers to carefully assess the performance of the

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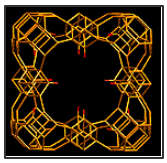

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Natural zeolites vary greatly in their structure and topography which may have critical implications to absorption or adsorption of ethylene and other horticulturally important volatiles. A registry of all confirmed zeolite structures, as in the examples above, and properties is maintained by the Intl. Zeolite Assoc.

specific products for the intended application benefit.

Methods and Procedures

Ethylene removal was measured by placing each product in a 1 quart jar, then sealing with a gasket and screw-cap lid. Ethylene was injected into the jar to give a concentration of 1.1 ppm. The jars were held at 68ºF (20ºC) with ambient relative humidity (about 40%) and ethylene concentration in the jars was measured periodically over 48 hours using gas chromatography. The following amounts of each product were individually tested in each jar: 1 sheet of PEAKfresh® carnation sleeves (Chantler Packaging, Inc.), 0.11 to 0.14 ounces (3 to 4 grams) of zeolite-foam measuring 2x2x4 inches (665 cm^3), 0.11 ounces (3 grams) of unrefined or refined bulk zeolite particles, and 1 packet of Ethylene Control (Ethylene Control, Inc.) containing about 0.25 ounces (7 grams) of potassium permanganate formulated material. Triplicate samples of each product were tested. For the zeolite foam liners, 5 formulations were tested containing varying amounts and milling specifications of zeolite. Replicated, sealed ethylene-containing jars without product were also evaluated (data not shown) over the same time period.

Results and Discussion

In this test system, only the potassium permanganate-based product, Ethylene Control, could be shown to remove ethylene from the enclosed air space (Fig. 3). None of the zeolite-based products caused a measurable reduction in ethylene under these conditions. These results are exactly consistent with those of Faubion and Kader (Perishables Handling Quarterly 86: 27-28) in their evaluation of PEAKfresh® film produce bags. In their tests, ethylene removal by PEAKfresh® bags was not affected by conducting the tests in a high humidity condition.

Based on the results of this study, ethylene removal by a commercial film, prototype zeolite based products, and one type of unrefined or refined natural zeolite granules (used in the foam liner prototype) has not been demonstrated. The rate of ethylene removal from highly sensitive flowers, such as carnations, is critical to prevent concentrations that exceed the threshold for ethylene injury. Thus far, current zeolite formulations cannot be expected to achieve this performance standard for protecting floricultural commodities.

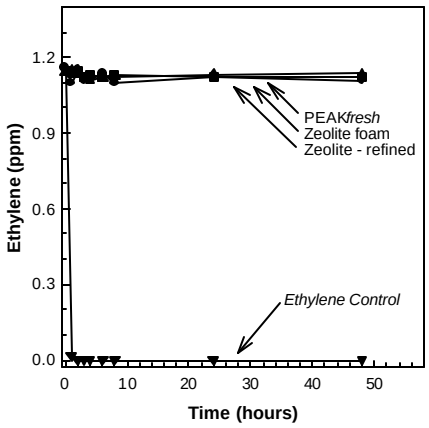

Figure 3. *Ethylene removal from a static jar system was only measurable for a potassium permanganate-based product, Ethylene Control. For simplicity, not all products tested are shown.*

Additional References for Zeolites

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