THE PERMEABILITY OF TARPS AND THE POTENTIAL INFLUENCING FACTORS

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Various agricultural films are used during the fumigation of soils and structures to control the emission of fumigants. The permeability of the films to fumigants varies widely with material type and manufacturing technique. In addition, many factors such as field conditions, temperature, fumigant type, film stretching and gluing during the field application, and moisture under the film can potentially affect the permeability of the films. Because of the lack of a standard test method for classifying the available films according to their permeability to fumigants and because of the limited available data on the permeability of these films, it is currently difficult to systematically evaluate the permeability of all the available films on the market and to reliably determine their effectiveness. In order to address this uncertainty, EPA conducted tests for the film permeability of commonly available agricultural films against several fumigants and established a comprehensive database of film permeability, expressed as a Mass Transfer Coefficient (MTC), for those fumigants.

The objective of this study is to establish a database of MTCs for the commonly used films for various fumigants. The Agency will make the testing protocol available on its website, that is used to develop the MTCs for the agricultural films that it has tested. This will permit the Agency to calculate credits, as appropriate, from data generated in accordance with the protocol for films that have not already been tested/included in the database.

Twenty four (24) different agricultural films from twelve different manufacturers were tested for their permeability to a number of fumigants including, methyl bromide (MeBr), iodomethane (IOM), 1,3-dichloropropene (1,3-D), dimethyl disulfide (DMDS), chloropicrin (PIC), sulfuryl fluoride (SF), and methyl isothiocyanate (MITC). The tested films included low density polyethylene (LDPE), high density polyethylene (HDPE), and multilayer films with barrier materials (e.g. ethylene vinyl alcohol (EVOH), polyamide, and metal). The MTCs of the films were determined under laboratory conditions at 25^{o}C using stainless steel permeability cells as described by Papiernik et al. (2001, 2002). In addition, the permeability of select films was determined at an elevated temperature (40^{o}C) and at an elevated relative humidity (at 25^{o}C) to evaluate the effects of these parameters on the permeability of the films.

The test results indicate that different fumigants permeate through a film at different rates. The permeability of a film is largely determined by the combination of the physical characteristics of the film, the physical properties of the fumigant, and the environmental conditions. For all films sulfuryl fluoride is, in general, the slowest to pass through the film, while MITC is the fastest to pass through the film. MBr, IOM, PIC, DMDS, PPO, and 1,3-D fall between the SF and MITC, with 1,3-D generally being the fastest among this group of fumigants to permeate through a film (Fig 1).

Films with an EVOH core are usually the least permeable to all the fumigants at 25^{o}C. Other virtually impermeable films (VIFs) generally have higher permeability than the films with an EVOH-core, although the permeability of the VIFs varies considerably among different brands. Metalized films have lower permeability than the HDPE and LDPE films but generally higher MTCs than the VIFs (Fig. 2).

Elevating the temperature appears to increase the permeability for some films. The MTC of several tested VIF films increased two to five times when the temperature was raised from 25^{o}C to 40^{o}C. However, the MTCs of some VIFs did not change significantly when the temperature was raised.

In contrast to the variable effect of temperature, the most significant change in the permeability of films appears to be caused by the increase of the relative humidity. When the relative humidity in the source side of the permeability testing cells was increased from the laboratory ambient level (approximately 35-45%) to near 100% (presence of liquid water in the cell), the permeability of tested VIFs increased roughly two orders of magnitude at 25^{o}C. The MTCs of some VIFs at elevated humidity become close to that of the regular PE films of no barrier layer at 25^{o}C. Because it is common for the relative humidity under the tarp to be high in the field, this loss of ability to retain fumigants by the VIFs under high humidity conditions could compromise the usefulness of these VIFs for reducing fumigant emissions in field applications. Further testing is underway to better quantify the effects of humidity on the film permeability.

References

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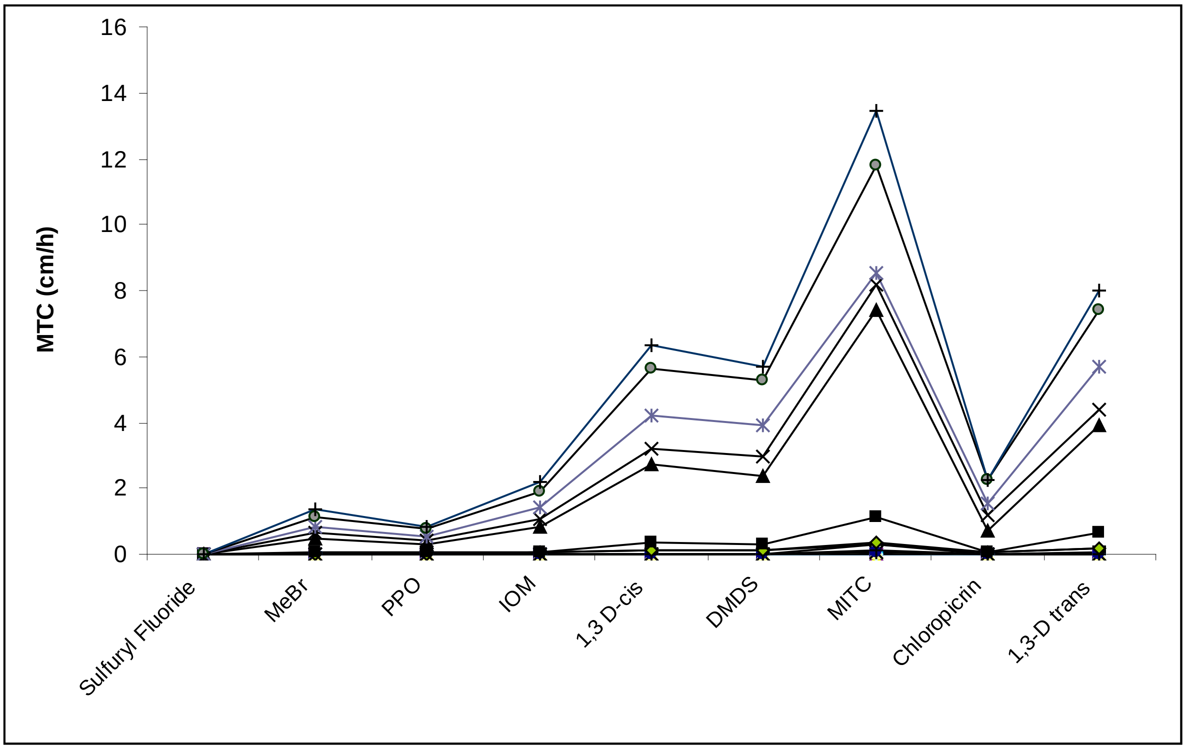

Fig. 1. Permeability (MTC, cm/h) of the twenty four films to various fumigants at 25^{o}C. The MTC of most of the VIFs are very low and not readily visible in the graph.

Fig. 2. Distribution of the MTCs of the 24 tested films for MeBr and IOM. The Y-axis (MTC) is in log scale.