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Air cleaner test – ethylene degradation

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Life Science

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1 Purpose

Testing of the ability of a Jimco air cleaning unit to degrade ethylene in the foil chamber at DTI. The testing was performed on June 14 to 19, 2018.

2 Setup

Air cleaning units

- One Jimco unit (MAC500) was tested. The power to the units was controlled using a timer. The device was grounded and placed on top of a table in the room.

Figure 1: Panoramic view of the climate chamber

The climate chamber

- Airtight 20 m^3 room (background decay of ethylene per hour < 0.6%), shown in Figure 1
- The ventilation was blocked during the entire test to ensure no exchange of air
- All surfaces on the inside of the chamber are coated with a foil specially designed for minimal adsorption of chemical compounds
- A fan in the chamber mixes the air several times per hour
- The ethylene level was measured using proton-transfer-reaction mass spectroscopy equipment (PTR-MS) from Ionicon

3 Measurement cycle

The timer controlling the air cleaner was programmed so the air cleaner was on for 12 hours followed by 12 hours where it was off and so on. The test was performed over a period of approx. five days.

<u>Step 1: Pre-cleaning – day 1</u>
The air cleaner was placed in the chamber. For the first 12 hours the air cleaner was off. Then it was on for 12 hours.

<u>Step 2: Ethylene test – day 2 to 4</u>
After 24 hours of pre cleaning, ethylene was added to the chamber by pumping approx. 20 L of 0.5% ethylene in N_2 from a gas sample bag into the chamber through a small tube. For the first approx. 10 hours the air cleaner was off. Then it was on for 12 hours, off for 12 hours and so on.

4 Results

Previously performed measurements of the decay of the ethylene concentration in the closed chamber with no air cleaners present show that five to six hours after adding ethylene to the chamber, the decay rate is stabilized at about 1% per hour.

The ethylene concentration determined using the PTR-MS as a function of time during the air cleaner test is shown in Figure 2. Only data after addition of ethylene is shown in the figure. Initially a small decay in the ethylene concentration is seen – in agreement with the background measurement performed without any air cleaning. When the air cleaner is turned on after approx. 10 hours, the concentration drops more rapidly.

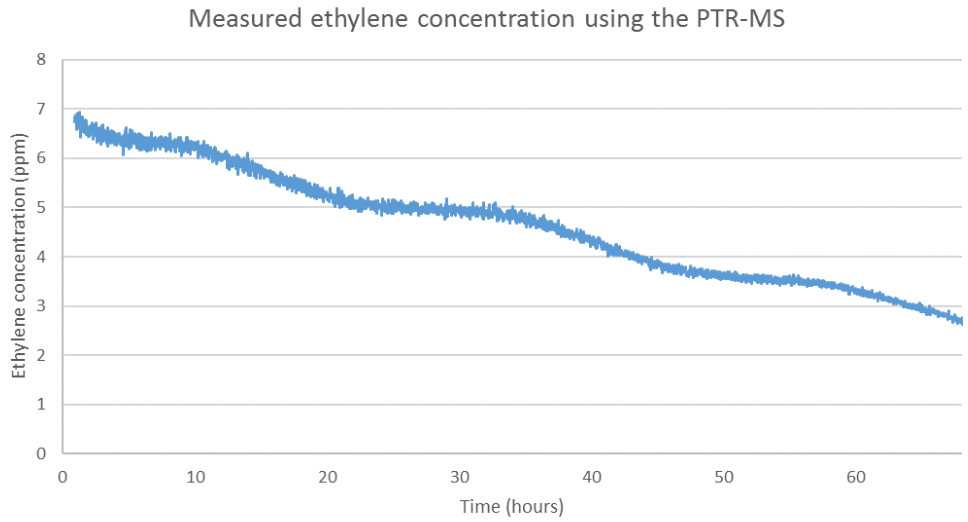

Figure 2: Ethylene concentration determined by PTR-MS as a function of time after addition of ethylene

Figure 3 shows linear fits to five segments of the graph. The yellow segments correspond to times when the air cleaner is on while the blue segments are when the air cleaner is off. The slope, indicating the magnitude of the ethylene decay rate, is significantly higher when the air cleaner is on compared to when it is off. Hence it is concluded that the Jimco unit degrades ethylene. The degradation rate is estimated to be between 0.058 ppm/hr (the lowest observed decay with the air cleaner on minus the highest background decay) and 0.082 ppm/hr (the highest observed decay with the air cleaner on minus the lowest background decay).

0.082 ppm in 20 m^3 at atmospheric pressure and room temperature corresponds to approximately 1.6 mL and hence the degradation rate is estimated to be up to 1.6 mL/h. The decay rate in percentage of the total ethylene level is between 1.5% and 2.0% per hour.

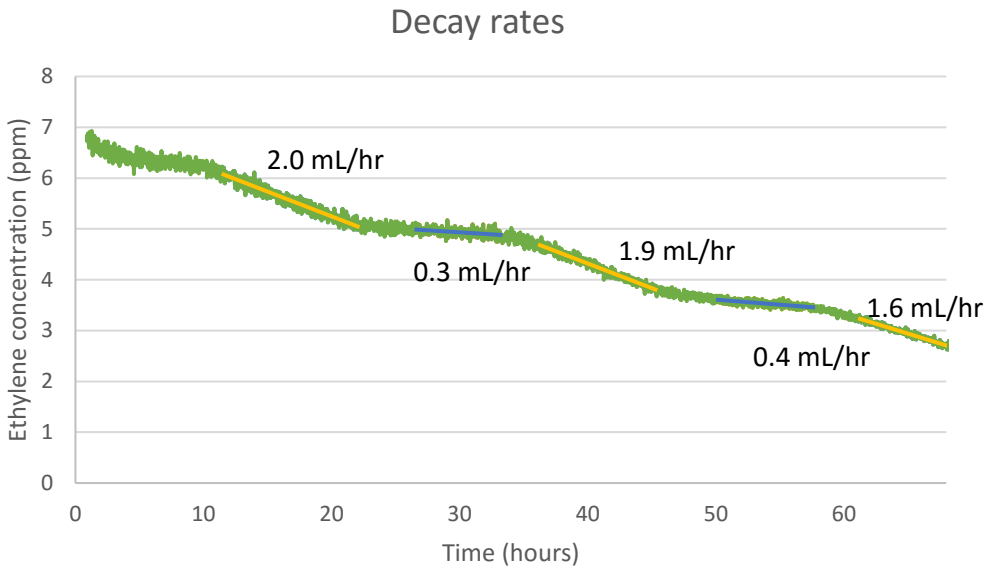

Figure 3: Decay rates in milliliter per hour determined for when the air cleaner is on (yellow) or off (blue). The decay rate in percentage is between 1.5% and 2.0%.

5 Conclusions and comments

The investigated Jimco air cleaner is able to degrade ethylene. The degradation rate is estimated to be up to 1.6 mL/h in a 20 m^3 room with ethylene concentrations between 6 ppm and 3 ppm. The corresponding degradation in percentage is between 1.5% and 2% per hour.

The investigated ethylene concentrations are higher than would normally be expected in storage facilities for fruit and vegetables, where levels below 1 ppm are standard.

To put the obtained degradation into perspective, a ton of apples produces approximately 10 mL/ton/h[1].

[1] Depending on storage conditions (e.g. temperature), time since harvest, type of apples etc.