ETHYLENE CONTROL FOR EXTENDED PRESERVATION OF FRESH FRUITS AND VEGETABLES

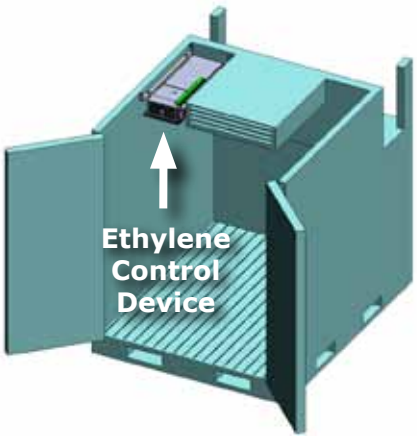
PURPOSE:

Fresh Fruits and Vegetables (FF&V) are an essential dietary supplement to operational rations and are typically packed, transported and stored in refrigerated containers to extend their shelf life. As produce respires, a number of gaseous by-products are released, to include water vapor, carbon dioxide, ethylene, and potentially other volatile organic compounds. Some fruits such as apples produce very high levels of ethylene and can greatly accelerate ripening and spoilage of other FF&V within the container. Ethylene gas levels as low as 1ppm can destroy an entire shipment in a single day. Temperature imparts the greatest impact on the ripening, yet produce continues to respire after being harvested and some produce generates a large amount of ethylene. Controlled ethylene storage can extend the life of FF&V from days to weeks. The use of ethylene and moisture sorbent blankets and pellets to control this problem poses significant logistic challenges associated with stocking, maintaining, and disposing of these materials. Accordingly, a non-consumable, low-cost device that can be placed or installed in a refrigerated container is needed to control ethylene and optimize the quality and freshness of FF&V as it is delivered to field units.

TECHNOLOGY:

An ultraviolet (UV) enhanced ozone device has been developed to provide an ethylene control device (ECD) that is compact, lightweight, and low cost. Ethylene is safely and rapidly oxidized to carbon dioxide (CO_2) and water vapor by:

$$C_2H_4 + 4O_3 \Rightarrow 2CO_2 + 2H_2O + 3O_2$$

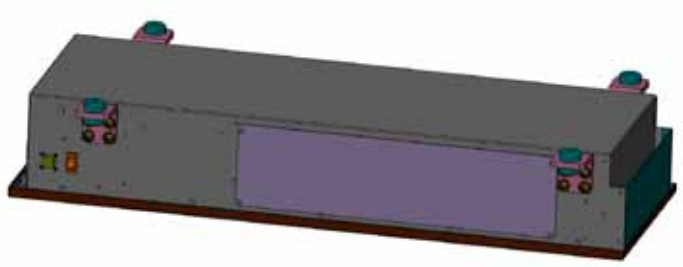


TRICON REFRIGERATED CONTAINER

The device has been demonstrated to reduce ethylene concentrations to below 0.1 ppm, destroying 38% of ethylene in air at a rate of 50 cubic feet per minute. Recent testing has demonstrated that a 2000 pound mixed load in a 270 cubic foot refrigerated container of apples, iceberg lettuce, broccoli, cantaloupes, and honeydew melons reduced the ethylene concentration from 60 ppm to below 2 ppm and provided a 7+ day shelf life extension with sustained quality and freshness over the control group.

APPLICATION AND BENEFITS:

The ECD is being designed as a modular enhancement kit for use in both Military and commercial refrigerated containers including the TRICON Refrigerated Container (TRC), Army Single Temp 8x8x20 refrigerated container system (RCS), and may benefit other refrigerated container applications including the Multi-Temperature Refrigerated Container System (MTRCS) and standard walk-in refrigerators. Since ethylene concentrations as low as 0.1 ppm can affect the ripening process, the ECD converts the ethylene to harmless products and maintains the container atmosphere to less than 0.1 ppm ethylene. The UV light further acts to sanitize the air in the container by inactivating microbes, spores, and fungus. The ECD will provide fully automatic operation with maintenance intervals of 12 months or longer, requiring the simple UV-lamp and screen replacement. The ECD-300 requires 100 Watts of power, weighs 16 lbs, has a 1.5 cu ft low-profile configuration, and a target production cost of $500. The ECD-2400 requires 330 Watts, has a 3 cu ft configuration suited to large storeroom application.



ETHYLENE CONTROL DEVICE

TECHNOLOGY TRANSITION:

In FY11, ethylene control prototypes were fabricated and tested to validate the performance/operational effectiveness of the device in the target applications. The technology will be transitioned to PM Force Sustainment Systems for initial application to the Military TRC, to the Systems Equipment and Engineering Team for potential implementation in the Navy Refrigeration Program, and to the Defense Supply Center – Philadelphia for specification with temperature-controlled commercial 20 and 40-foot containers used to transport fresh fruits and vegetables to the theater.

- Completed first and second generation configurations, validated performance in TRICON, MTRCS and walk-in/storeroom applications
- Scaling factors defined and proven and target performance achieved/exceeded

POINT OF CONTACT:

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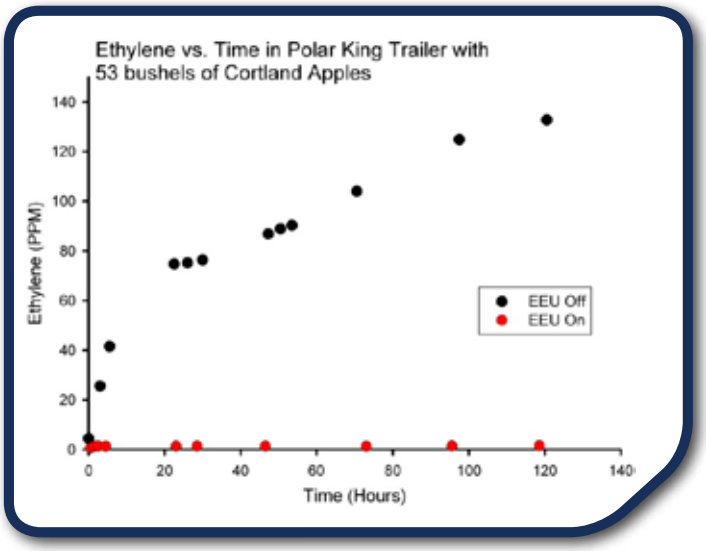

PERFORMANCE CHARACTERISTICS		
Model:	300	2400
Power:	100 Watts	330 Watts
Weight:	~15 lbs	~30 lbs
Mounting:	Ceiling, Wall, Travel Case	
Performance:	Maintains ethylene concentration below 0.5 PPM	

Reduced Russet Spotting of lettuce associated with ethylene exposure when stored with apples

Reduced molding of strawberries stored with apples

Reduced softening/yellowing of broccoli when with ethylene exposure when stored with apples

Broccoli stored with the EEU in operation was visibly fresher and quantitatively firmer (right image above) than broccoli stored without the ethylene removal technology (left image above).