DuPont™ FE-25™

fire extinguishing agent

Thermal Decomposition of DuPont™ FE-25™

Introduction

Since the days of Halon 1301, the fire protection industry has been concerned with the formation of toxic decomposition products from the use of halocarbons as fire extinguishants. It is well documented that fire alone will produce toxic products, due to thermal decomposition. When exposed to a fire, fluorine-containing fire suppression agents can also contribute toxic products, such as hydrogen fluoride (HF), due to thermal decomposition.

A study was conducted to assess the levels of thermal decomposition products produced during "real-world" fire hazards when DuPont™ FE-25™ is used to extinguish the fires. DuPont identified FE-25™ (HFC-125, pentafluoroethane, or CHF_2-CF_3) as a retrofit alternative for existing Halon 1301, an ozone depleting product used in total flood fire extinguishing systems. The objective of the study was to quantify the amount of HF formed when FE-25™ was used to extinguish fires typically encountered in electronic data processing and telecommunications applications.

For this assessment, the ECARO-25™ system, developed by Fike® Corporation, was used to discharge the FE-25™ agent. The ECARO-25™ system is designed to detect and rapidly extinguish a fire. It is a system that is ideally suited to replace Halon 1301 systems. Two different agent discharge times were studied. The first was a standard 10-second discharge and the second, an extended 20-second discharge.

This is a summary of the level of HF formation generated from the tested fire extinguishing scenarios. Rapid detection and extinguishment of the fire will control the levels of HF produced from thermal decomposition. The study results indicate that when a fire is extinguished with DuPont™ FE-25™, HF concentration levels are not damaging to high value assets being protected against fire and are well below the Dangerous Toxic Level (DTL) calculated for humans.

DuPont™ FE-25™ Extinguishing Mechanism

DuPont™ FE-25™ uses unique mechanisms to prevent or extinguish a fire compared to conventional extinguishing agents such as water, dry chemical and carbon dioxide, which are unacceptable because they may either cause collateral damage, significantly interrupt business productivity or present a life safety risk. The unique mechanism FE-25™ relies upon is its ability to absorb, at a molecular level, the heat energy from the combustion reaction. The ability of FE-25™ to absorb heat faster than the amount of heat generated by the combustion reaction essentially ceases the combustion reaction since it cannot sustain itself. The ability of FE-25™ to form free radicals, which chemically interfere with the chain reaction of the combustion process, is another mechanism that aids in the extinction of the fire. While FE-25™ relies primarily on heat absorption as the method of extinguishment, Halon 1301 relies predominately on the ability to generate free radicals to cease the combustion reaction.

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Fire Test Description

Hughes Associates, Inc. was contracted to quantify the amount of HF formed during fire extinguishment utilizing FE-25™.[1] Fire scenarios posing the greatest threat in computer room environments were tested during this assessment. It is estimated that 90% of clean agent suppression systems are installed in electronic, high value asset type environments, classified as Class A type fire hazards. The testing measured the concentration of HF in parts per million (ppm). Four types of fuel configurations were studied. They were:

1. Wastebaskets with Shredded Paper
2. Printed Circuit Boards
3. Electrical Cables
4. Magnetic Tapes

These four materials represent the most frequently encountered fire hazards among electronic and data processing applications. To obtain realistic HF readings, system design parameters such as actuation delay, system discharge times, and the implementation of a detection system with ionization and photoelectric detectors were applied. Each fuel configuration was tested with an ECARO-25™ system utilizing FE-25™ as the fire extinguishing agent. The system was designed for a 10-second discharge time at a 8.7 vol% design concentration (standard discharge) and also for a 20-second discharge time at a 9.25 vol% design concentration (extended discharge). HF level recording commenced at the time of fuel ignition.

Fire Test Results

Hydrogen fluoride levels varied by the type of fuel configuration and by discharge times. All fires were extinguished at the minimum design concentrations for the 10 and 20-second discharge times. HF levels were continuously monitored from material ignition to 10 minutes after extinguishment.

- *Wastebasket with Shredded Paper* fires provided an evaluation of a deep-seated fire scenario. At both the standard and extended discharge times, the fire was rapidly suppressed and extinguished. The standard 10-second discharge produced a maximum recorded HF concentration of 121 ppm. The extended discharge produced a maximum recorded HF concentration of 336 ppm.
- *Printed Circuit Boards* fires were rapidly suppressed and extinguished in both the standard and extended discharge tests. The HF concentration generated during both the standard and extended discharge times were below the instrument detection level and were recorded at zero (0) ppm.
- *Electrical Cable* fires were rapidly suppressed and extinguished in both the standard and extended discharge system tests. The standard 10-second discharge produced a maximum recorded HF concentration of 245 ppm. The extended discharge produced a maximum recorded HF concentration of 150 ppm.
- *Magnetic Tape* fires were rapidly suppressed and extinguished in both the standard and extended discharge system tests. The extended discharge system generally extinguished fires more rapidly. The standard 10-second discharge system produced a maximum recorded HF concentration of 92 ppm. The extended discharge system produced a maximum recorded HF concentration of 105 ppm.

Test results reveal that by increasing the FE-25™ design concentration from 8.7 vol% (Class A MEC [Minimum Extinguishing Concentration] plus 30%) with a 10-second discharge time to 9.25 vol% (Class A MEC plus 38%) with a 20-second discharge time, the production of HF is not significantly increased.

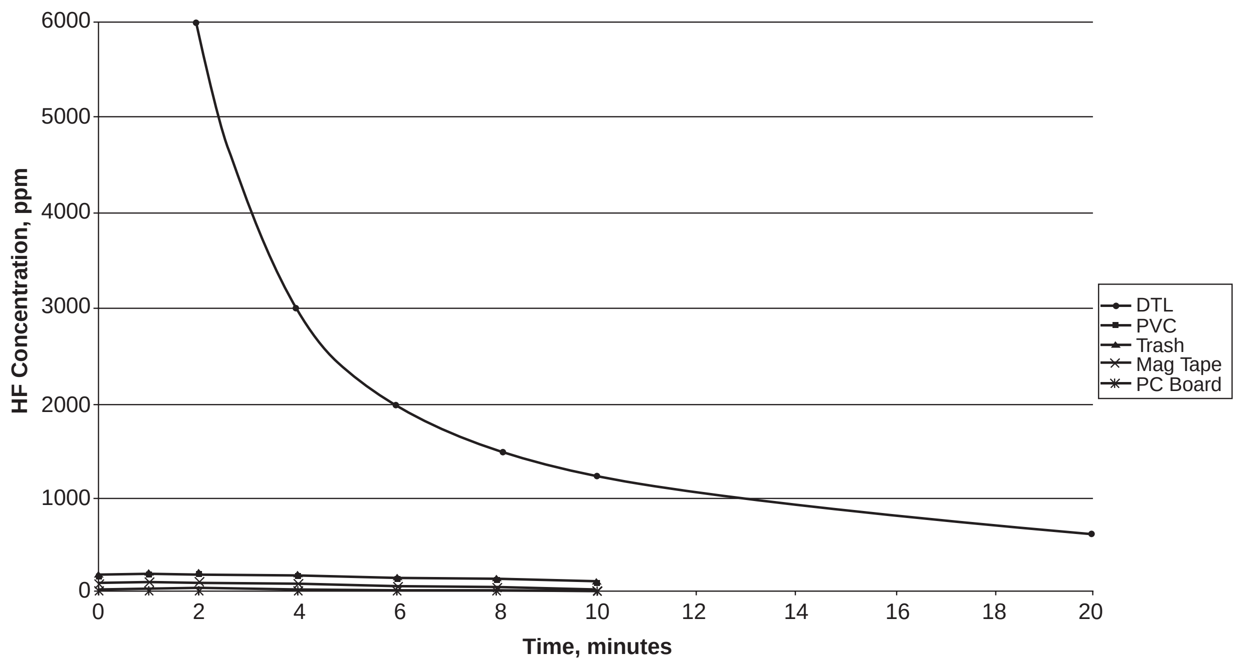
Hydrogen Fluoride Effect on People

Hydrogen fluoride can be formed as a decomposition product when FE-25™ comes into contact with flames or extremely high temperatures.[1] **Figure 1** shows the HF concentrations that resulted when fires were extinguished using FE-25™ with a 10- and 20-second discharge time at 8.7 and 9.25 vol%, respectively. In order to display the HF data in a manner consistent with Appendix A (HF assessment section) of the National Fire Protection Association (NFPA) 2001 document, **Figure 1** also shows the calculated human Dangerous Toxic Load (DTL) for HF.(2) While the DTL is well below the HF LC50, it represents an exposure level that would be highly stressful and irritating to anyone exposed at the DTL level. As can be seen in **Figure 1**, the HF levels produced by extinguishing realistic electronics and data processing facility test fires with FE-25™ are well below the calculated human dangerous toxic load.

HF Effect on Class A Hazard Equipment

Studies have been completed to determine the effect of halogen acids on electronic and other equipment. The threat of exposure is a function of several variables, including the decomposition product concentration, the exposure time to the halogen acids, the deposition rate of acids on the equipment surface, the relative humidity and temperature, the sensitivity of the equipment and the combined effects with

Figure 1. HF Concentrations Relative to Fire Extinguishment with FE-25™



smoke. The National Aeronautics and Space Administration (NASA) and IBM evaluated the effects of decomposition products, such as HF and hydrogen bromide (HBr) on a variety of electronic equipment. The electronic equipment was exposed to atmospheres of 500 and 1,000 ppm for 30-minutes. Both tests concluded no short-term damage, equipment malfunction, or failures occurred within 90 days.[3,4]

Fires consisting of Class A combustible material produce a lower HF concentration as compared to Class B fuels. The size of the fire plays a major role in the formation of toxic products. A smaller fire provides less energy (heat) for thermal decomposition of the suppression agent, and therefore the concentration of thermal decomposition products is lower.[2] Studies concluded that generally the energy generated during a typical fire within a telecommunication or data processing center will be 10 kW at the time of detection.[2] Tests performed by Hughes Associates on FE-25™ recorded an average fire size of 14kW. Implementing a rapid fire detection and control system will inhibit the fire from becoming large, thus preventing the build up of thermal decomposition products.

Summary

Tests reveal extinguishing Class A materials with FE-25™ produces levels of HF equivalent to total decomposition products (HF and HBr) produced by Halon 1301. Tests also prove the levels of HF produced from FE-25™ during several typical Class A fires are not damaging to high value assets being protected against fire and are well below the Dangerous Toxic Level (DTL) calculated for humans. The increase in the discharge time from 10 to 20-seconds and the increase in the design concentration from 8.7% to 9.25% v/v did not cause the levels of HF to increase above life and asset threatening conditions. It was also determined that the HF levels observed for both the standard and extended discharge systems are comparable to those observed for extinguishment with HFC-227ea in previous studies.

References

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