

УДК 811.111:614.84

V. Germanovich, V. Ivanov, O. Matusevich

Fire Suppression Systems

Belarusian National Technical University
Minsk, Belarus

Since ancient times fires have caused a great grief to people and have had a devastating impact on the environment resulting in irreparable damage to both nature and man-made items. At all times people searched for ways how to cope with fire - one of the most terrible of four elements.

The research goal of our project is to make comparative analysis and distinguish out of the current fire-fighting methods the agent that will be approved to protect electronic and electrical equipment and items of historical and cultural value. And what is more this agent must be safe for human health and the environment.

There are several extinguishing agents, such as water, foam, gas, powder and aerosol.

Water as an extinguishing agent is used for protecting shopping malls, storehouses, hotels. Its important function is not to let the fire spread across the damaged building before a fire brigade arrives.

The advantages of using water are low cost, availability and human safety.

As for disadvantages, the damage of water extinguishing systems often exceeds the damage caused by the fire itself because the water consumption in the system of water fire suppression is large and the system is running continuously regardless of the fire presence. Moreover, such water systems are impossible to be used in museums, archives, libraries and various institutions with electronic and electrical equipment.

Foam is used for extinguishing fire in aircraft hangars and institutions with technical equipment on the one hand and for coping with fire caused by oil and petroleum products on the other.

Foam has got only one advantage - the high efficiency of extinguishing fire is achieved by the film formation on the burning oil surface and by preventing oxygen access.

The main disadvantages of using foam are high cost and danger to human health, not to mention special cleaning is required afterwards.

Powder is used for protecting garages, car parks and warehouses.

Low cost is the only advantage of applying powder.

As for its disadvantages, it's dangerous for human health, large amount of powder is needed and the process of cleaning is rather complicated.

Aerosol extinguishing systems are mainly used for protecting vehicles engine compartments.

The unique advantage of employing aerosol is low cost.

The disadvantage is in the high corrosiveness of the aerosol particles and as a result - the damage of protected equipment. When the aerosol combustion occurs, the high temperature flow of aerosol particles is being formed (about 800° C) and it may lead to an additional fire.

Gas as an extinguishing agent is used for protecting areas with expensive electronic and electrical equipment, archives, museums, libraries, military equipment, ships and aircraft, air traffic control centers.

As for the advantages of using gas, it doesn't damage the protected values and it is possible to protect the voltage-carrying equipment.

Its disadvantage is high cost, not to mention the decomposition products of some gas agents that are dangerous to human health.

The Fire Extinguishing Agent Novec 1230 was created by 3M Company in the USA in 2002. It is stored as a liquid but is spread in a gaseous state.

Table 1. Main parameters of Novec 1230

Chemical formula	$\text{CF}_3\text{CF}_2\text{C}(\text{O})\text{CF}(\text{CF}_3)_2$
Molecular mass	316
Boiling point	49°C
Freezing point	-105°C
Density	1600 kg/m^3
Vapor density	$13,6\text{ kg/m}^3$

The advantages of using Novec 1230 are the following:

1) Safety for human health and the environment.

According to laboratory and medical research Novec 1230 doesn't cause allergic reactions and its concentration in the air safe for human beings is only 10%. It means that the person who happened to be in the protected area is not affected while the gas is released.

2) Security for documents and museum values.

Unlike water Novec 1230 doesn't make paper wet and doesn't dissolve paint and ink. Moreover, the paper immersed in Novec 1230 dries quickly and doesn't warp.

3) Safety for electrical and electronic equipment.

Novec 1230 is an insulator. Its breakdown voltage in a liquid form is 48 kV. The breakdown voltage vapor of Novec 1230 in the saturation state and at normal conditions with the distance of 2.7 mm between the electrodes is 15.6 kV, which is approximately 2.3 times greater than dry nitrogen has got.

4) Fire Suppression.

The principle of Novec 1230 to extinguish fire is based on the removing heat out of the fire. It has got a very high heat capacity, which gives the lowest concentration required to extinguish any fire.

So, what kind of gas has got the ability to protect electrical and electronic equipment, items of historical and cultural value, and still be safe for people and the environment?

Table 2. Comparative analysis of different agents

Parameters \ Agent	Protection of electrical equipment	Protection of cultural values	Human safety	Environment Safety
Nitrogen N ₂	+	+	-	+
Argon Ar	+	+	-	+
Dioxide carbon CO ₂	+	-	-	+
Halon 125 CH ₃ CHF ₂	+	+	-	-
Halon 227 CF ₃ CFHCF ₃	+	+	-	-
Novec 1230 CF ₃ CF ₂ C(O)CF(CF ₃) ₂	+	+	+	+

The table shows that the only gas that satisfies all the conditions imposed is Novec 1230. Its attractiveness for museums and archives is absolutely obvious: it's safe, it doesn't hurt museum values and documents and has got no impact on the environment and human health. These factors have led to the fact that Novec 1230 was selected to protect some of the most valuable treasures of the world, such as the Library of Congress Home in the USA, Pushkin State Museum of Fine Arts in Moscow, the State Hermitage Museum in St. Petersburg. As for our country, the Republic of Belarus, it is used in the National Art Museum, archives of Nesvizh Castle, the depository of the Belarusian State Museum of the Great Patriotic War, the Belarusian State Circus, the Coca-Cola Plant in Minsk, the Palace of Independence, Minsk Hotels like "the Hilton", "the Plaza", "the Renaissance" and many others.

Nowadays we can recommend using Novec 1230 in the institutions edifice providing custody and preservation of cultural values, as well as buildings where expensive electrical and electronic equipment is installed.