Empirical research on electric fire extinguishing performance by application of water-based fire extinguishing agent

WANG Shuai1, WANG Xiaojun2

1 Tianjin Fire Research Institute of MEM, Tianjin, 300382, China
2 Tianjin Fire Research Institute of MEM, Tianjin, 300382, China

Abstract. This paper illustrated a test conducted recently about the application of fire agents in Class E fires. This research carried out the chemical analysis of different agents, and made comparison among water and different fire agents. This research also successfully achieved a good result that cable fire could be put out using extinguishers while the power source is not cut off. This paper also illustrated some prospects about future research.

1. Introduction
This research is conducted based on a global literature review of fire performances assessment of water-based fire extinguishing agents on electric fires. The researcher reviewed current literatures as much as she can and figured out a possible test method for empirical research. The researcher combined the test method to the current status of application in China and did a research based on that. As for the glowing development of economy and electronic information technology, electric products are applied more and more widely. Accordingly, the volume of electric consumption is growing rapidly, and the electric fires happened due to sophisticated reasons.

Cables are basic need for construction facilities in cities and rural areas, especially for the large scale application in national industries, electric plants and electric transmission. According to state statistics analysis, the number of electric fires (Class E fire) has been amounted to one third of the total fire events in China, and the cable fire is more than 50% of the total electric fires.

Water-based fire extinguishing agents have own advantages and have been widely applied in many public places. As to the growing need for more fire products to extinguish electric fires, more and more agents manufactures claim that their water-based fire extinguishing agents could extinguish Class E fire.

This research aims at developing a test method to evaluate the fire performances of extinguishing electric fires, with a view to offer more test data and technical input for future national-scale research.

2. Test
2.1. Samples preparation
This test is going to collect kinds of test samples as much as we can with a view to test application of different agents to the electric fires.

The researcher collected almost all kinds of water-based fire extinguishing agents currently available in the market, including synthetic foam agents (S), aqueous film-forming foam agents (AFFF) and gel-like water-based agents.

The scenario of this research is for the cable fire at early stage.
In routine practice, the way to extinguish cable fire is to cut off the power source at once and use fire extinguishing agents (such as foam agents) to extinguish the cable sheath. The theory is to put out Class E fire by way of extinguishing Class A fire. However, the early cable fire underground is very hard to locate the exact place and is very difficult to extinguish before the propagation of the fire from early stage to the big fire. The sudden power cut-off will lead to a large amount of economic losses of national economy and society.

This test is going to extinguish the fire rapidly by fast recognition of the fire place.

2.2 Chemical analysis of fire agents

| Sample | Ph  | Corrosion rate (steel) | Corrosion rate (aluminium) |
|--------|-----|------------------------|---------------------------|
| 1      | S₁  | 6.2                    | 3.2                       | 2.8                        |
| 2      | S₂  | 5.9                    | 2.5                       | 1.8                        |
| 3      | AFFF₁| 7.0                    | 1.2                       | 1.3                        |
| 4      | AFFF₂| 7.2                    | 1.5                       | 1.0                        |
| 5      | 0.3%| 5.9                    | 0.8                       | 1.0                        |
| 6      | gel | 6.0                    | 1.0                       | 1.1                        |

This test data indicates that the chemical performances of all the samples tested are within the scale of national standard of China, GB 15308 and also ISO 7203. [1][2]

The sampled tested are of great characteristics and have many succinct performances in fields of the pH values, corrosions and other chemical performances. These samples are chosen in the even part of the sample bottle and can be sure of having the common performance of the sample as a whole. These analysis are tested with a view to find some relationship between the chemical data and the direct fire performances of Class E fire of the samples.

2.3 Conductivity

| Sample | Temperature | Conductivity |
|--------|-------------|--------------|
| 1      | water       | 21.4°C       | 7.13μs       |
| 2      | S₁          | 21.0°C       | 59.9μs       |
| 3      | S₂          | 20.2°C       | 62.2μs       |
| 4      | AFFF₁ [2]   | 20.1°C       | 70.2μs       |
| 5      | AFFF₂       | 20.0°C       | 60.6μs       |
| 6      | 0.3%        | 20.9°C       | 50.1μs       |
| 7      | gel         | 20.5°C       | 40.2μs       |
2.4 Test
Conductivity is to test the degree to which a specified material conducts electricity, calculated as the ratio of the current density in the material to the electric field that causes the flow of current. It is the reciprocal of the resistivity. This test is to use the fault arc devices to enlighten the fire of cable, and using the special-designed extinguisher to apply the agents to the cable fire. During the fire test, the combustion of cables has accompanied by fire sparks, and fireman used the extinguisher to put out the fire with a very close distance with the burning cable. During the whole test, the power is not being cut off. The test temperature is 15°C.

2.5 Relative research
The researcher has once explored that an American lab has conducted similar test. [3] The lab used new aluminum cables and the fault arc is 2kA. The test is to immerse the cable in the fire agents and then create a fault arc. The lab also conducted a test by creating the fault arc first and then applying the agents to the cables. [4]

3. Conclusion
This paper can be considered as one of first research to conduct the fire test regarding to Class E fire by application of water-based fire extinguishing agents. The meaning of this research is more important than the test result per se. [3] This paper collected as many samples as we can and has achieved a great achievement that the electric fire has been put out while the power is not cut off. This paper also some more limitation of the study due to the limited resources and time expenses, we can figure out by this paper that there will be more space to explore for future research to form a systematic method.

References
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