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VIEWPOINT

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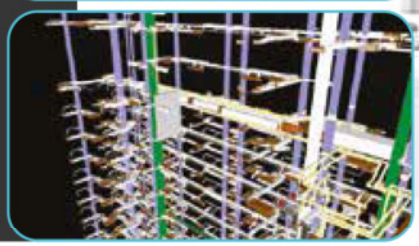

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BUILDING SERVICES

HIGH PRESSURE WATER MIST SYSTEM - SAFE PROTECTION FOR MUSEUMS, ARCHIVES & LIBRARIES

Jackson Jose
Director
FOGTEC Fire Protection Pvt. Ltd.

INTRODUCTION

Conventional fire fighting technologies continue to have disadvantages in terms of resulting water damages, environmental compatibility, toxicity, or refilling costs. Often, the consequential damages caused by the extinguishing agent are greater than the potential loss by the fire.

The benefits of fire fighting with water in the form of smallest droplets have been known since the 1930s but only have been identified for protection of historical buildings, archives, libraries and museums during the last decades. For many applications, high pressure water mist technology is a good alternative which avoids the disadvantages of other fire fighting agents.

The high-pressure water mist fire protection system uses very fine water sprays (i.e. water mist). The small water droplets allow the high-pressure water mist to control, suppress or extinguish fires by:

- cooling by heat absorbtion by creating a larger surface area,
- displacement of oxygen by local inerting effect, and
- attenuating radiant heat by cooling.

The effectiveness of a water mist system in fire suppression depends on its spray characteristics, which include the droplet size distribution, flux density and spray dynamics, with respect to the fire risk. For many applications, high pressure water mist technology is used as an alternative, reducing and avoiding the disadvantages occurring with other fire fighting methods.

PRINCIPLE

Water is the most effective cooling agent to fight fires. Conventional water-based systems require large quantities of water to control or extinguish fires, mainly making use of the cooling effect. The primary reason for the large water amounts required is that the majority of the water is not effectively used to fight the fire, resulting in large water runoff. This is due to the limited surface area of the water droplets getting into contact with the heat from the fire.

If water is atomized into very fine droplets, as it is in the high pressure water mist technology, a substantially larger surface area comes in contact with the fine droplets to absorb energy and consequently fight the fire. The fine droplets convert into steam in the vicinity of the fire. Due to vaporization, the energy and the combustion rate of the fire are effectively reduced.

Once the fire has been suppressed or extinguished, the droplets being discharged continue the effect by removing heat from the fuel source i.e. plastics, fabrics, wood, paper, etc. and prevent re-growth or re-ignition of the fire.

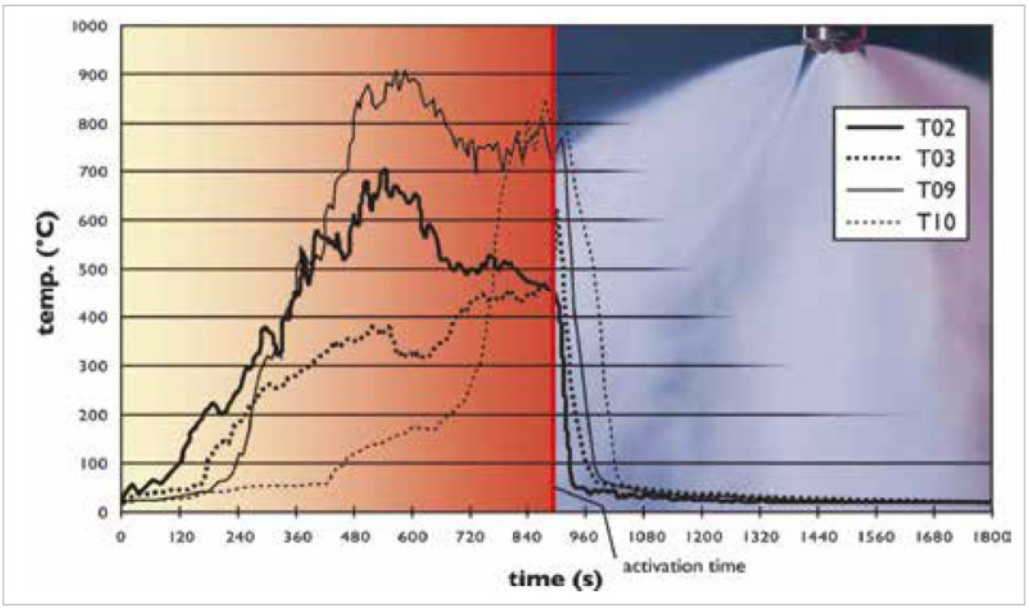

Illustration of cooling effect of a High-Pressure Water Mist System

In addition, to the cooling effect, the fast vaporization results into a local inerting effect caused by volume increase of water resulting in depletion of oxygen in the direct vicinity of the fire. The difference with respect to other inerting agents is the local effect at the fire source and not reducing the oxygen concentration in the entire space.

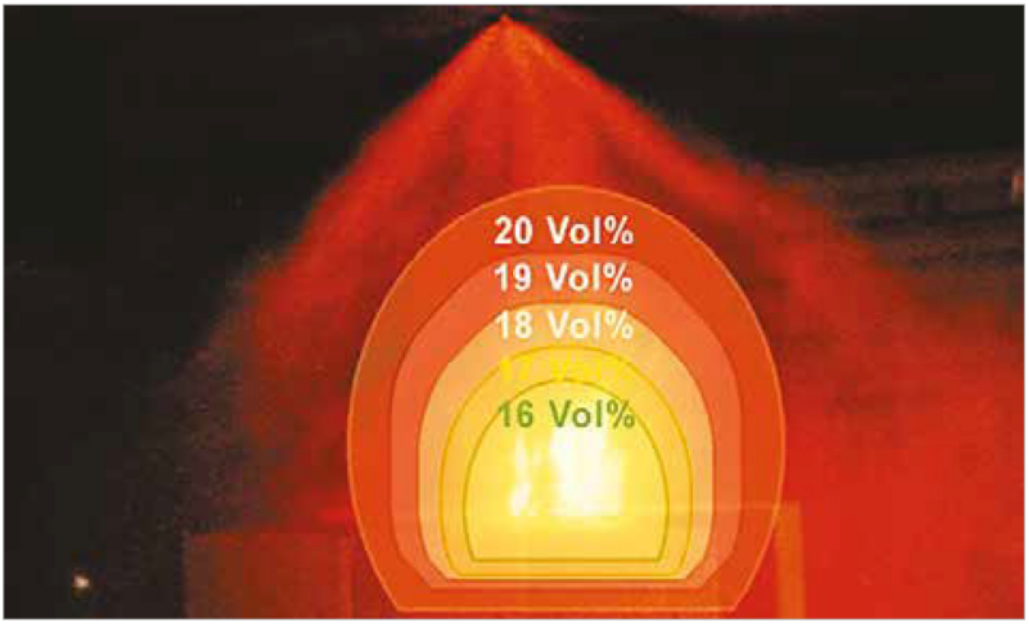

Illustration of cooling effect of a High-Pressure Water Mist System

FIRE TESTS

Water mist is not a gaseous agent and therefore cannot be designed and approved like a gaseous agent. Likewise, water mist cannot be directly compared with conventional sprinkler systems where the design is based on two-dimensional water calculations.

For each application the required nozzle type, droplet distribution, flow rate and discharge time have to be individually determined to provide the optimum protection of the relevant risk.

There are established guidelines and protocols for light and ordinary hazard risk application for the approval and design for water mist systems used in various applications such as Libraries, Museums & Archives. The protocols for light and ordinary hazard risk applications on land have been established by VdS 3188 standard (Verband der Sachversicherer), FM5560 standard (Factory Mutual) and CEN (EN TS 14972 standard). The International Maritime Organization also have established guidelines and protocols in accommodation areas on board ships. There are some independent fire tests which have been carried out according to these guidelines also.

Today, these standards and guidelines are applied to generate design parameters and to approve system components. For some applications like Ordinary Hazard risks, the standards prescribe fire test scenarios to verify the system technology. For the fire load and risk that are not covered by these standards, Individual Fire Test protocols and scenarios have to be developed with fire experts to test the technology and to generate layout parameters.

The fire test for these applications have yielded the following results:

- All the fire tests have shown a rapid control and suppression of the fire as soon as the system was activated.
- No fire spread occurred on the adjacent shelf.
- All temperatures in the area were rapidly reduced to a safe level, most below 50° C.
- The damages to the fire load mainly resulted from the time before system activation. All documents and goods were analyzed for damages after the test duration of 30 minutes. It was found that they were damp on the surface but dry inside.

SYSTEM SET UP

High-pressure water mist systems mainly consist of a pressure generating device, a high-pressure pipe work and special nozzles.

The required operating pressure is generated by means of high-pressure pumps or pressure cylinder systems. The selection depends on the type of risk and the area to be protected. Larger risk areas such as archives, libraries and museums are normally protected by pump systems. The main design features of high-pressure pump units are similar to conventional sprinkler pumps, whereby positive displacement pumps are used due to the higher-pressure levels required. A difference with respect to the conventional sprinklers is the storage tank requirements.

Due to the substantially lower water consumptions the water storage tanks are only 10% of the capacity required for conventional sprinkler systems. In some cases the high-pressure pump units are directly supplied by the public water main (where the mains are pressurized for 24 hours supply) via a small intermediate tank. Maintenance requirements are comparable to the conventional fire fighting systems.

The low water consumption also has a positive effect on the pipe dimensions required. Not only the flow rates are much lower than the conventional sprinklers, but the allowable hydraulic pressure losses of up to 80 bar allow installation of systems with pipe diameters of 10 mm to 50 mm. These properties permit installations in confined locations and easy retrofits in historical buildings.

The system can be triggered either by a separate detection system or by thermally activated glass bulbs. All system designs as for conventional systems, e. g. deluge and wet systems, dry and pre-actions system can be applied for the water mist technology. Room with heights up to five meters have ceiling mounted nozzles. Higher areas, e.g. such as an atrium, can be protected by installing nozzles at different levels or nozzles approved to be mounted at ceiling level. Beyond that, it is possible to install wall cabinets with water mist extinguishing guns. They offer the possibility of rapidly suppressing initial fires, using the lowest possible consumption of water.

ADVANTAGES OVER CONVENTIONAL SYSTEMS

Historical buildings, those housing archives, libraries or museums usually contain large quantities of valuable documents and goods. Hence all such risks have special requirements for the extinguishing systems. On one hand the earliest possible activation is considered to be necessary; on the other hand, a false alarm must not result in unacceptable damages to the goods protected.

Sprinklers are not the optimal solution for such risks because of the extreme water damage in case of an activation which easily can surmount the damage caused by the fire itself, not to mention a false alarm situation. During retrofitting the large pipework of conventional sprinklers is a disadvantage, rendering the use of sprinklers technology unfeasible in these cases.

Besides, the large water storage tanks for sprinklers system take up valuable space that could more appropriately be used for documents or goods storage areas.

Gas extinguishing systems do not damage the protected goods or documents, but usually require very large storage areas for the gas cylinders. The effectiveness of these systems depends on the effective sealing of the enclosed area. Historical buildings, libraries and museums normally have wide open spaces, hence in most cases it is not possible to use gas systems without large investments for creating partitions for enclosures. Most gas systems can only be activated after a pre-warning time, allowing for growth of the fire during that time. They also are an environmental concern.

High pressure water mist systems use such little amount of water that the resulting water damage usually is negligible. That makes it possible to use early detection systems without a fear of a false alarm. Detectors can be used for activation as well as automatic nozzles with low temperature rated glass bulbs. Water mist systems for archives, museums, and libraries can be designed as total flooding or selectively activated systems with minimal water storage requirements. In some cases the systems are directly supplied from the municipal water supply (where the mains are pressurized for 24 hours supply) using small intermediate tanks.

The fine water mist also reaches hidden spaces like in shelves to a much larger extent than the sprinkler water. At the same time the temperature in the protected area is reduced more efficiently compared to the use of gas extinguishing systems and sprinklers. The latter effect is of particular importance to prevent spreading of the fire to nearby goods or documents and to allow trained personnel to rescue people caught in the area.

Smoke particles are partly washed by water mist systems, reducing the spread of smoke to valuable goods near the fire. Taking into consideration that smoke usually causes the most damage, the reduction of the smoke spread is an important aspect to be considered. Retrofits can more easily be carried out even in buildings with open ceiling structure and special requirements with regards to the architecture due to small pipes sizes required by these systems.

CONCLUSION

The water mist systems initially were mainly seen as an alternative to gas extinguishing systems for machinery and special risk protection, however, now more and more applications in areas that traditionally had been protected by conventional sprinklers are being identified for provision of water mist system.

Due to partly higher initial investment cost and the lack of general design parameters, water mist systems do not substitute sprinklers in the most traditional sprinkler applications, but today there are certain applications, like historical buildings housing archives, libraries and museums for which the benefits of water mist systems over sprinklers are recognized by owners, users, architects and consultants and makes it worth to investigate design parameters and protection concepts for valuable areas where water damage is not acceptable.