IFP

10th Anniversary Edition

2000-2010

Issue 41 - February 2010

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INTERNATIONAL FIRE PROTECTION

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High Pressure Water Mist

– Safe Protection for Archives and Libraries

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Conventional fire fighting technologies such as sprinklers, gas, powder and foam systems, continue to have disadvantages in terms of resulting water damages, environmental compatibility, toxicity, or refill costs.

Often, the consequential damages caused by the extinguishing agent are greater than the potential loss by the fire. Therefore most buildings containing valuable goods are only protected by fire detection systems.

The benefits of fire-fighting with water in the form of smallest droplets have been known since the 1930-ies, but only have been identified for archive and library protection during the last decade. For many applications, high pressure water mist technology is a true alternative, reducing or avoiding the disadvantages occurring with other fire fighting agents.

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 into large water run off. 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 with water mist technology, a substantially larger surface area is available to absorb energy and consequently fighting the fire. The fine droplets convert into steam at in the vicinity of the fire. Due to the vaporisation, 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. fabrics, wood, paper etc. and prevent re-growth or re-ignition of the fire.

Additionally to the cooling effect, the fast vaporisation results into a local inerting effect by volume increase of water, resulting into oxygen depletion in the direct vicinity of the fire. Different to other inerting agents this effect is a local effect

Photos from the course of fire

at the fire source, not reducing the oxygen concentration in the entire space.

Fire Tests

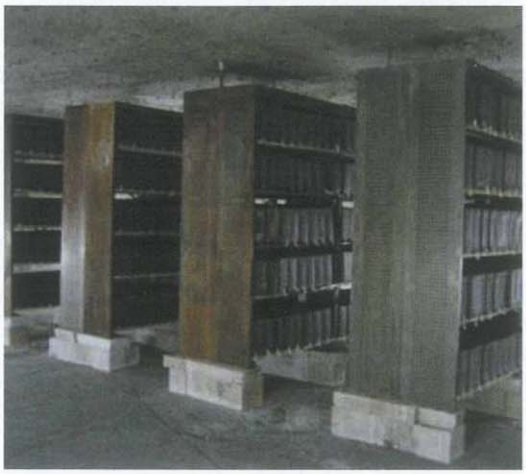
Water mist is not a gaseous agent and therefore can not be designed and approved like a gaseous agent. Likewise water mist cannot be directly compared with conventional sprinkler systems where design is based on two dimensional water calculations.

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.

The International Maritime Organisation (IMO) has established guidelines for the approval and design of water mist systems in accommodation areas on board of ships. Similar to these test guidelines, protocols for light and ordinary hazard risk applications on land have been established by Factory Mutual (FM 5560 standard) and CEN (CEN/TS 14972 standard).

These standards and guidelines are today 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. The type of fire load and risk to be found within archives and libraries are normally not covered by these standard scenarios. Individual fire test protocols and scenarios have to be developed with fire experts to test the technology and to generate layout parameters.

An extensive test series for the above mentioned risks has been carried out by the French Fire Research Laboratory CSTB. Three different fire scenarios were evaluated, since these are typical for storage facilities for documents and other goods in archive and library environment.



Scenario with fixed shelves

The first test scenario included fixed shelves being filled with 900 archive folders. The second test scenario was created for areas with moving compact shelves. The dimensions and the fire load of the shelves were the same as in the test with fixed shelves, but each two shelves were arranged closed to each other with only a small gap. The third fire scenario was elaborated for storage areas containing plastic goods in shelved, e.g. video and data tapes.

The aim of the fire tests in all three scenarios was to control and suppress the fire, thus after automatic system activation each fire test was conducted for 30 minutes. After this test period the fire brigade entered the space and extinguished the fire using a high-pressure water mist fire fighting gun.

All fire tests have shown a rapid control and suppression of the fire as soon as the system has been activated. No fire spread occurred to 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 pipework 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 and libraries are normally protected by pump systems. The main design features of high pressure pump units are similar to a conventional sprinkler pump, whereby positive displacement pumps are used due to the higher pressure levels required. A difference to conventional sprinklers is the water storage requirements. Due to the substantially lower water consumptions, water storage tanks are only 10% of the size of conventional sprinkler systems. In many cases the high pressure pump units are directly supplied by the public water main via a small intermediate tank. Maintenance requirements are

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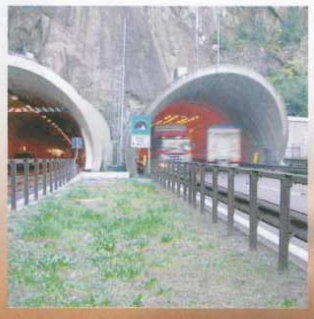

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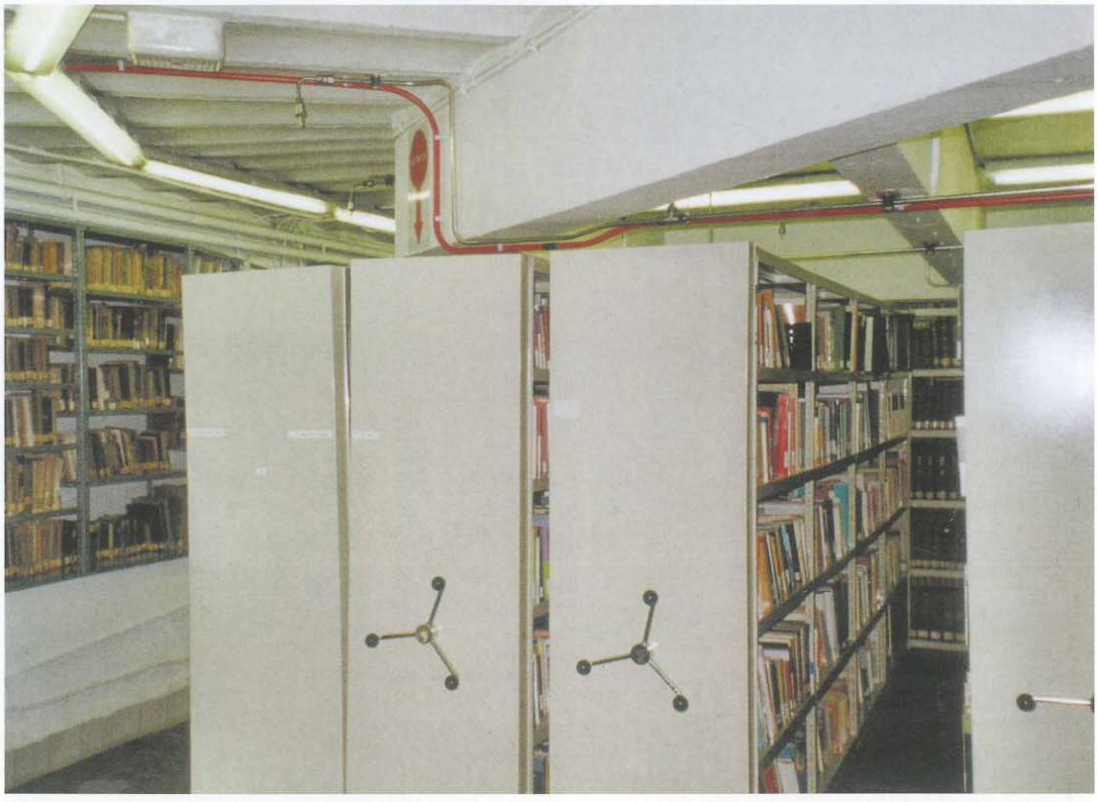
Nozzle arrangement in the library



comparable to 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 with conventional sprinklers, also hydraulic pressure losses of up to 70 bar allow to install the systems with pipe diameters of 10 to 50 mm. These properties permit installations in confined locations and ease retrofits in historical buildings.

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

Case study

Due to substantial benefits of high-pressure water mist technology for archive protection, numerous smaller and larger storage areas for paper documents are today protected by this technology around the world. Among these is the Bizcaia Library in Bilbao, Spain.

Due to valuable documents stored in this library and the building being national heritage, there was a requirement for an automatic fire fighting system with minimum disturbance of the old building structure and reduction of the fire damage and consequential damages by the water discharged.

Since the building has an open ceiling structure with no false ceilings and only minimal space for the pipework installation, only small bore pipes routed along the ceiling and the walls could be used.

Additionally, no fixed fire zones could be defined. Large open areas demanded for an automatic fire fighting system, capable to rapidly control and limit the spread of a potential fire.

The system used to protect the reading hall as well as all book shelving areas of the building was designed based on specific fire tests independently carried out for storage areas of paper documents in shelve structures.

With small bore stainless steel pipes of diameters between 12 and 42 mm an architecturally pleasing installation without disturbance of the old structure of the building could be achieved.

A wet pipe system with glass bulb activated nozzles was used to protect book shelving areas, offices and technical areas. The nozzle spacings used for the water mist system are comparable to those of conventional sprinkler systems, but flow rates are substantially lower.

The entire pump system, including a 1000 liters break tank, has been installed in a room of only 10 m^2 floor area. Although the area is very small, the pump equipment is easily accessible for maintenance and test run purposes.

Conclusion

Even if water mist systems initially were mainly seen as alternative to gas extinguishing systems for machinery and special risk protection, more and more applications in areas that traditionally have been protected by conventional sprinklers are identified for water mist.

Due to partly higher initial investment cost and the lack of general design parameters, water mist systems will today not substitute sprinklers in most traditional applications, but they have found their market place for applications, like archives and libraries, where benefits of water mist technology over conventional sprinklers or gas extinguishing systems are recognized by users and insurers. IFP

Ruediger Kopp completed his studies of Chemical Engineering and Safety Engineering at the University of Dortmund as Diploma-Engineer. Since 14 years he is involved in the development, approval and marketing of high pressure water mist systems. At present he is Sales & Product Manager for these systems at the company FOGTEC Fire Protection based in Cologne.

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