Chinese Science Bulletin 2003 Vol. 48 No.8 718—725

Progress in research and application of water mist fire suppression technology

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Abstract **Water mist technology in fire suppression has been a subject of many investigations over the last decade. This paper introduces the concept of water mist technology and discusses its extinguishment mechanisms in comparison with other fire suppression systems briefly. A survey is made on the recent applications of water mist for (1) Class B spray and pool fires in machinery spaces, gas turbine enclosures, combat vehicles, and flammable liquid storage rooms; (2) Class A fires in residential occupancies, marine accommodations and public spaces, heritage buildings and libraries; (3) Class C fires in electronic equipment and computer rooms; and (4) the fires in aircraft onboard cabin and cargo compartments. The paper proceeds to review some new applications of water mist for the Class K fires in commercial cook rooms. Use of water mist for total-ship protection as well as the fire protection of heavy goods vehicle shuttle trains is also investigated. At last, the up-to-date development of corresponding test to evaluate the capabilities and limitaions of water mist is discussed.**

Keywords: water mist, fire suppression technology, application.

DOI: 10.1360/02ww0180

Because of the adverse effects of halogen-based fire suppressing agents on the atmospheric ozone layer, there has been substantial interest in the substitutes such as water sprinkler, CO_2, inert gas and foam. But despite much effort the objective remains to be achieved. During the past several years, water mist technology has been developed and regarded as a promising substitute since it can extinguish the fire quickly with little water and at the same time without damage to environment and protect objects. Generally water mist is defined as fine water droplets for which the droplet diameter at the thickest part on the surface 1 meter away from the nozzle, $D_{V0.99}$, is less than 1000 μm at the minimum design pressure. Water mist can be produced by different means such as impinge, pneumatics, high pressure and ultrasonic[1]. Water mist can be used to suppress electrical fire, and it can also find wide applications in the protection of special fires at high-tech and industrial locations such as computer room and aircraft cabin[2].

In this paper, we introduce the concept of water mist technology and discuss its extinguishment mechanisms. Recent advances in the research and application of water mist are reviewed.

1 Different mechanisms between water mist and other fire suppression systems

The predominant extinguishment modes for water-based fire suppression systems vary with the droplet volumetric mean diameter, D_V. Sprinkler spray contains a significant fraction of droplets large enough to penetrate the fire plume and cool the fuel surface directly. Compared with sprinkler spray, fine water mist is involved by one or several of the following fire suppression mechanisms, depending on the nozzle design (determining the operating pressure and flow)[3]:

(1) gas phase cooling, or heat extraction from the fire;

(2) oxygen level reduction near the fire;

(3) radiant heat attenuation and;

(4) flame stretch through the momentum transfer from the mist.

Generally, water flow demand for water mist system is nearly an order of magnitude less than the conventional sprinkler system. This advantage helps decrease the damage due to water and also helps lower the fire protection cost for locations short of water supply. This advantage also motivated the study of the water mist technology for the locations such as ships and aircrafts where the space to contain water is limited. For some flammable liquid fires which cannot be readily controlled by conventional sprinkler sprays due to splashing and spillage of the fuel, fine water mist may be a reasonable substitute due to its low momentum. In addition, the rapid cooling due to high water fluxes and large droplet diameters of conventional sprinkler spray may damage high temperature equipment surfaces. This disadvantage may be avoided by using fine water mist.

Compared with gas extinguishment, water is nontoxic with low cost. Water mist may be more effective for the suppression of deep-seated fires due to its high cooling capacity and penetration ability. Additionally, water mist may find its applications in the suppression of the fires in machinery rooms and turbine enclosures, where surface fire plays an essential role. The fine water mist can prevent the surfaces from re-ignition by cooling effect.

2 Water mist on flammable liquid hazards

Water mist may be applied in liquid fire suppression at locations such as machinery spaces in ships or industrial settings, gas turbine enclosures, flammable liquid storage rooms, and combat vehicles.

(i) Water mist for the protection of machinery spaces. Extensive tests have been conducted to evaluate the capabilities and limitations of water mist in machinery space applications. The performance of various water mist systems was evaluated based on IMO's fire test protocol, or under fire conditions that may occur in machinery spaces. The parameters studied in the tests included water mist characteristics (droplet momentum, mist pattern, droplet size distribution, etc.), the types of water mist system (single or twin fluid systems, different flow rates, discharge pressure, nozzle spacing, etc.), fire scenarios (fire type, size, and location), various ventilation conditions and firefighting additives[4—8].

Test results showed that water mist fire suppression systems were able to extinguish a wide variety of exposed and shielded hydrocarbon pool, spray and cascading fires that might occur in a machinery space. Compared to gaseous agents, the extinguishing time using water mist was long. However, water mist quickly controlled fires and cooled the compartment, keeping the combustion products (CO and CO_2) in the compartment at a low level. In the tests conducted by the National Research Council of Canada (NRC)[1)], the compartment temperature was cooled down to 50℃ in less than 15 s after the activation of the water mist system, and the maximum CO and CO_2 concentrations measured in the tests were below 0.08% and 3.5%, respectively, depending on the fire size and pre-burn period. Thermal conditions and gas concentrations in the compartment, after water mist application, were safe enough for firefighters to immediately enter the compartment.

The extinguishing performance of water mist systems in machinery spaces is mainly determined by the fire size, the degree of obstruction, ventilation conditions, compartment geometry, spray characteristics of the water mist systems and their configuration in the compartment. Large fires, relative to the compartment size, are easier to extinguish than small fires, due to the depletion of oxygen consumed by large fires and due to the large amount of steam generated by water mist that is displacing oxygen in the compartment. With increasing degrees of obstruction, the amount of water mist reaching the fire is reduced and the extinguishment of the obstructed fire is more difficult.

An increase in the engine-rooms volumes and ceiling heights reduces the effectiveness of water mist in fire suppression, because it is difficult to deliver a sufficient concentration of fine mist to the fire location. The water mist effectiveness is further affected by an opening in the compartment, due to a leak of steam and hot gases and flow-in of fresh air. However, water mist demonstrates better effectiveness in extinguishing ventilated fires than gaseous agents such as halon, CO_2, and gaseous halon replacements. Studies on low pressure water mist systems[5,6] showed that the ventilated fires were extinguished but that the extinguishing times increased by 30% to 70%. By increasing the number of doorway nozzles from 2 to 4, the water mist effectiveness against ventilated fires was increased, due to the increase in the density of water mist around the opening. The impact of ventilation on water mist performance is a1so determined by the fire size in the compartment. The full-scale tests carried out by the U.S. Navy showed that when three doors in the compartment were kept open, the extinguishing time had a slight increase for small fires, but there was no change for large fires.

Water mist effectiveness is also dependent on nozzle configuration in the compartment such as the nozzle spacing, the distance of the nozzles below the ceiling, and the number of nozzle levels in the compartment. Compared to low pressure single-fluid and twin-fluid systems, high pressure single-fluid water mist systems exhibited better fire extinguishing capabilities against most fire challenges, because a large amount of small and high momentum droplets were produced. However, the low pressure water mist systems with higher water flow rates and larger droplet sizes demonstrated good performance in extinguishing unshielded pool fires and wood crib fires[6]. The selection of a water mist system is strongly dependent on matching the mist characteristics to the fire hazard, as well as considering the cost-effectiveness, simplicity, and reliability of the system. Most test results showed that the performance of low pressure water mist systems (7×10^5 Pa, the same below) in marine applications was acceptable.

When firefighting additives are introduced, the effectiveness of water mist is significantly improved. Tests carried out by the U.S. Navy[7] showed that the use of the additive Quad-Ex, ranging from l2% to 25%, increased a twin-fluid water mist system to extinguish fires. The additives especially improved the performance of low pressure water mist systems. The reductions in extinguishing times ranged from 85% to 99% and water usage for fire suppression was greatly reduced, compared to the use of sea water only. Further studies on the impact of these firefighting additives on water mist effectiveness in full-scale tests are continuing[8].

Current applications have demonstrated the capabilities of water mist for the protection of machinery spaces and their potential to replace halon or CO_2 systems. A number of water mist systems have been approved by various authorities and used on shipboard and in industrial applications.

(ii) Water mist for the protection of turbine enclosures. Over the last decade, extensive studies on the use of water mist to replace existing halon or CO_2 systems in the turbine enclosure have been carried out. These studies included the evaluation of the effectiveness of water mist for fire protection in the turbine enclosure, probable damage of turbine components due to rapid cooling by water mists, and methods for improving water mist performance in the turbine enclosure[9—11].

For more challenging fires in a compartment involv-

1) Kim, A. K., Liu, Z., Su, J. Z., National Research Council of Canada, Private Communication, 1997.

ing a jet engine and gas turbine compressor, the water mist systems using both the total flooding and local application methods extinguished lubricating oil and aviation jet spray fires, and pool fires located beneath the engine or the turbine. The local application method was less effective than the total flooding method, and the extinguishing times increased when a local application method was used for both high and low pressure water mist systems. The increase in the number of nozzles in the compartment by using either the total flooding or local application method had no significant impact on the effectiveness of water mist. The test results, however, showed that the method that combined both total flooding and local application improved the extinguishing performance of water mist systems.

In order to evaluate probable damage of turbine components due to rapid cooling by water mist, the impact of both continuous water mist discharge and repeated short water mist discharges on turbine components were examined[9,10,12]. Test results showed that only the surface temperature of the metal was substantially changed by the cooling of the water mist, while the changes in the temperature in the deeper part of the metal were very slow. The temperature change generated by the cooling of the water mist would not create thermal shock damage to the metal.

In addition, studies carried out by NRC[10,11] demonstrated that the use of cycling discharge was capable of improving the extinguishing performance of a twin-fluid/ low pressure water mist system, in comparison to continuous discharge. Cycling water mist discharge means that, during fire suppression, the discharge of water mist is turned "on" for a short period of time, followed by a short period during which the water discharge is turned "off", and this cycle is continuously repeated. When fire challenges were such that water mist could easily extinguish the fires (e.g. large spray or pool fires, compared to the size of the compartment), the reduction in the extinguishing times using the cycling discharge was not significant. However, even for these conditions, the amount of water required to extinguish the fire was reduced. For more challenging fire conditions, such as small fires, shielded fires or ventilated fires, the use of cycling discharge was able to significantly reduce the extinguishing times and the water requirements, or achieved extinguishment of fires that could not be extinguished by continuous discharge. In some cases, the use of cycling discharge reduced the extinguishing time by one-half and reduced the water requirement by two-thirds, compared to continuous discharge. More efforts, however, are needed to study the optimum cycling frequency.

Based on the demonstrated capabilities of water mist fire suppression systems in turbine enclosures, Norwegian petroleum industry platform operators and regulators have accepted water mist as an alternative to halon in turbine enclosures[9]. The Securiplex water mist fire suppression system has been approved for turbine compartments up to 80 m^3 in size by FMRC[12] and the Marioff Oy Hi-Fog system has been approved for compartments up to 260 m^3.

(iii) Water mist for the protection of other flammable liquid hazards. Water mist is also considered to be a Halon l30l alternative in military ground combat vehicles. The research conducted by Bolt et al.[13] showed that water mist was effective in providing protection against fires in combat vehicles. However, the use of water mist in combat vehicles will increase the agent volume greatly compared to the use of Halon 1301. This will result in the requirement for new hardware in combat vehicles. Bolt et al. also indicated that freezing and electrical conducted issues associated with the use of water mist in the combat vehicles have to be considered.

Recently, the U. S. Army Research Laboratory conducted a series of tests to improve fire extinguishing capabilities of water at cold temperature. Test results[14] demonstrated that water mists with some freeze point suppressants, such as 60% potassium lactate and 40 wt.% potassium acetate (KAce), showed improved fire suppression performance and permitted low temperature storage and operation. As a mist, water/additive solutions may not have a significant conductivity problem. However, water mist, together with the additive, could condense on exposed electrical equipment and shorting might occur. Cleanup problems caused by the water/additive also need to be addressed. Research in this area is still continuing.

In order to replace existing halon or CO_2 systems for fire protection in flammable liquid storerooms, the feasibility of using a total flooding water mist system in flammable liquid storerooms has been evaluated[15]. It was demonstrated that 90% of the test fire scenarios in the test program were extinguished by the water mist systems evaluated. The firefighting capabilities of the water mist systems were less than Halon l30l but greater than conventional sprinklers. Out of question, water mist technologies were capable of providing adequate protection to flammable liquid storerooms with relatively small space and somewhat simple geometry. The U. S. Navy study on the use of water mist for the protection of larger flammable liquid storerooms will continue.

3 Water mist on Class A combustibles

The effectiveness of water mist systems against Class A fires has been confirmed in a wide range of applications. Such applications can be found in ship cabins and corridors, public spaces, residential occupancies, heritage buildings, and libraries.

(i) Water mist on passenger ships. A series of tests was conducted to evaluate the use of water mist in marine cabin and public spaces by the Swedish National Testing and Research Institute, Marioff Oy of Finland and the Norwegian Fire Research Laboratory. Fire scenarios in these tests included simulated arson fires, flashover fires and wood crib fires with open or closed doors. The effects of different types of nozzles, flux density and nozzle location on the efficiency of water mist fire suppression systems in marine accommodation spaces were investigated[16,17].

Test results showed that the temperatures in cabin spaces were reduced rapidly to low levels and the fire was either controlled or extinguished as the water mist system was activated. Compared to conventional sprinklers, water mist systems extinguished shielded fires more effectively and provided an equivalent or a better fire protection for the small cabin. The performance of water mist systems was strongly dependent on the fire position, location of nozzles and water distribution patterns. When the fire was far away from the nozzles or shielded by the upper bunk bed, high pressure water mist systems performed better in reducing heat release rate, total heat output and ceiling gas temperatures. When the fire was closer to the nozzles and unshielded, however, low pressure mist systems performed comparably or slightly better than high pressure mist systems.

Test results involving public space tests with sofa fires and wood crib fires in various configurations showed that water mist was able to control the fires but the effectiveness of water mist in controlling and suppressing fires decreased with the increase in compartment size and ceiling height. Water mist systems must be selected or designed based on the fire scenario and compartment geometry.

(ii) Water mist on residential buildings. A series of tests to study the feasibility of using water mist fire suppression technology for the protection of residential occupancies was conducted[18,19]. Some important factors using water mist in residential occupancies, such as the performance limits, reliability, cost and corresponding design factors of water mist systems, were investigated in the tests. Various types of the water mist system were evaluated including commercial single-fluid/low pressure systems, single-fluid/high pressure systems, and dual fluid/low pressure systems. Test results showed that water mist systems were capable of providing fire protection at lower total flow rates than that of typical residential sprinklers. Primary factors affecting the fire control or extinguishment by water mist in the residential occupancies were drop size distribution, mist distribution in the enclosure, and mist penetration to the fuel location.

The small water requirements of water mist for fire suppression have made water mist systems suitable for the application in residential occupancies that have limited water supplies. However, more efforts are needed in reducing the cost for producing fine water mist, or increasing extinguishing performance of water mist under low discharge pressure.

(iii) Water mist library settings. The potential to use water mist in heritage buildings and library settings has also been investigated[20—22]. During fire suppression in library settings, librarians want not only the fire to be effectively controlled, but also water damage to books to be minimized. Milke and Gerschefski have reported their water mist research for library applications. With the activation of water mist systems, the fire damage to the documents was controlled, and room temperatures quickly decreased. Post-fire observations found that folded newsprint of two shelves above the fire had only suffered a minor amount of discoloration along the edge nearest the flue, and the newsprint above this shelf showed no signs of damage.

Mawhinney further tested a prototype single-fluid/ high pressure water mist system for fixed library shelves. During the tests, two approaches to the design of water mist system for the protection of libraries were tested: one based on “total compartment application”, in which water mist is discharged from open nozzles into all portions of the compartment, and a second based on a “zoned application”, in which the compartment is divided into several zones and nozzles in each zone are activated on a signal from the detection system that pinpointed the location of the fire. The tests also showed that the majority of the water discharged in a total compartment application was wasted in areas far removed from the fire and caused water damage to the materials. For the zoned application in the tests, the fire spread across aisles was effectively prevented, and the fire and water damage to the materials was minimized.

The zoned application showed that water mist is able to either meet or exceed most of the fire suppression performance objectives for a water-based fire suppression system for archival applications. However, the zoned water mist system that is incorporated with detection/logic elements increases the complexity and cost of the system for the protection of library settings. In order to move from the prototype to a finished design of the zoned water mist system, further work will be required to simplify the system, ensure reliability and reduce installation costs.

4 Water mist on aircraft

The feasibility of using water mist fire suppression systems for aircraft applications has been evaluated. These applications included the protection of onboard cabin and cargo compartments, and the protection of military aircraft engine nacelles and fuel tanks.

(i) Water mist on aircraft cabin. A fine water mist fire control system for aircraft passenger compartments was evaluated and developed in the 1980s by an international consortium involving many aviation administrations and aviation industry agencies. The performance objective of water mist systems in aircraft cabins was to prevent spread of fire into the cabin from an external pool fire and to cool the hot gases in the cabin to extend the available time for passenger evacuation and to have a greater evacuation rate of passengers[23].

During a series of full-scale fire tests, the capabilities of water mist systems, using both total flooding and zoned applications to extend the survivable time for passengers, were evaluated. For the total flooding application, a large number of small nozzles were mounted throughout the ceiling of the cabin discharging fine water mist (mean droplet diameter of about l00 microns) for a period of 3 min. In either a narrow-body test or a wide body test, water mist prevented flashover, cooled the cabin, reduced the production of toxic gases and maintained high oxygen concentration in the cabin. A survivable environment was maintained for the 7 min test duration. Compared to non-discharge of water mist, the increase in survivability was much greater than 2 min.

In order to improve the weight penalty associated with the water mist system, a zoned mist system was designed, tested and optimized in the cabin. In the narrow-body test, the zoned system was effective and increased the available escape time by 53 s. Compared to the total application, visibility in the cabin was also improved by the zoned system. In the wide-body test, the increase in survival time ranged from 86 to 103 s[26].

These studies on the performance of water mist for the protection of aircraft cabins demonstrate that a zoned cabin water mist system is effective, safe and practical. Further development of a cabin water mist system, however, was discontinued after an industry-wide cost benefit study concluded that the cost of outfitting a fleet of aircraft with water mist systems would be too high, compared to the benefits[27].

(ii) Water mist on aircraft cargo. In order to evaluate water mist as a halon alternative in cargo compartments, a series of full-scale tests was conducted by the Federal Aviation Administration[23]. The performance objective of water mist systems in an aircraft cargo compartment is to provide the period of protection that will allow the airplane to be landed safely.

During the tests conducted by Marker et al., the performance of both dual fluid/low pressure and single fluid/high pressure water mist systems were evaluated. Test results showed that the dual fluid system was effective in controlling the cargo fire, but the required water quantity was excessive. The use of a high pressure water mist system exhibited some reduction in the water quantity requirement.

Water mist technology for providing protection in cargo compartments has developed continuously. In Europe, a major R&D program for water mist fire suppression systems in cargo compartments was recently initiated by a consortium of organization. They will conduct a series of tests of water mist fire suppression systems using the fire test methodology and fire threats outlined in the draft minimum performance standard for a cargo compartment[28].

(iii) Water mist on aircraft engine nacelles. Class B flammable liquid fires and high-explosive incendiary explosions are the main threats in an engine nacelle, and fuel tanks. Currently there is no design for an active explosion suppression system on board U.S. Navy aircraft.

Full-scale tests using water mist systems in engine nacelles and fuel tanks, were conducted by the U.S. Naval Air Warfare Center. These included the evaluation of two types of fine water mist nozzles (dual fluid and single fluid nozzles), the measurement of mist parameters, the use of heated water, and development of design criteria under different fire scenarios and different air temperatures. It was shown that nozzles, which can produce fine water droplets with high velocity, are the most effective in extinguishing spray fires. The fine water mist also provided excellent cooling capability[29—31].

Weight restrictions and the efficiency of water mist systems under cold operating temperatures are two major concerns for the use of water mist systems in aircraft engine nacelles. The tests conducted by DeSipio showed that water mist systems, which were capable of operating at low ambient temperatures with additives in the water, could be designed successfully for applications in aircraft engine nacelles. Studies on the use of water mist in suppressing explosions in engine nacelles and dry bays are continuing.

5 Water mist on electronic equipment

The fire protection community has, for a long time, recommended sprinklers in computer and other electronic rooms with the belief that the water damage is certainly not worse than the damage from an uncontrolled fire. The technology to dry out and recommission electronic equipment has improved dramatically over the past several years. Water mist systems, with less water requirement than sprinklers to extinguish a fire, will have minimal, if any, water damage to the electronic environment.

Recently, extensive full-scale fire tests have been conducted to evaluate the feasibility of using water mist systems for the protection of electrical and electronic equipment[32—34]. Studies showed that fine water mist was effective in extinguishing in-cabinet electronic fires, as well as fires in a computer room, without causing short circuits or other damages to electrical and electronic components. Water mist has also demonstrated some advantages in suppressing fires in electrical and electronic equipment, in comparison to gaseous agents. For example, water mist appears to be the most effective extinguishant for a hot cable fire due to its efficient cooling. In addition, evacuation of the compartment may not be necessary and the electronic equipment can be continuously operated during discharge of the water mist system, especially if a zoned water mist system is used. On the contrary, when halocarbon gaseous agents are used, the compartment has to be evacuated completely due to high concentrations of corrosive gases generated by the agent in fire suppression, which disables the operation of the room.

Grosshandler et al.[32] carried out a series of fire tests to show the extinguishment performance of the water mist systems on electronic equipment that was mainly determined by the mist characteristics of the water mist systems, their configuration in the compartment, the fire size, the degree of obstruction, the ventilation conditions, and compartment geometry.

6 Water mist in other applications

Water mist applications in many areas are still continuing to expand. Recently, Underwriters Laboratories Inc. and Underwriters' Laboratories of Canada have listed one portable water mist fire extinguisher[35] for the use on Class A and C fires. It is shown that a portable water mist extinguishing Class A fires and the discharge of water mist does not cause electrical shock to the user when the extinguisher is used against energized electrical targets. Such a portable water mist extinguisher can be used for fire protection in hospital, telecommunication facilities and health care facilities.

The National Research Council of Canada[36,37], in collaboration with Fountain Fire Protection Inc., has recently carried out a research project using a water mist fire suppression system for the protection of commercial cooking areas. Cooking oil in cooking areas are the most difficult fires to be extinguished, because they burn at a high temperature and re-ignite easily. They cannot be effectively extinguished by foam, powder or carbon dioxide. Recently, cooking oil fires have been classified as a new class fire, Class K. Wet chemical agent is a major agent currently used in cooking areas. It extinguishes the cooking oil fire in 3—5 s but it takes a long time for the wet chemical agent to cool the oil below its auto-ignition temperature, which will increase re-ignition opportunities in the cooking oil. Another concern is the toxic combustion by-products generated by the wet chemical agent during fire suppression that may result in evacuation of the cooking area as well as the whole restaurant immediately, and increase the clean-up time.

During the NRC tests, the extinguishing performance of water mist against the cooking oil fires was evaluated in a mock-up cooking area. The tests showed that water mist can effectively extinguish and cool cooking oil fires. In comparison with agents currently used in cooking areas, water mist is able to provide cost-effective protection for commercial cooking areas. The feasibility with water mist fire suppression systems for the protection of heavy goods vehicle (HGV) shuttle trains has been evaluated.

The Eurotunnel[38] is developing an onboard fire system for its HGV shuttle fleet. They have evaluated the performance of one low pressure water mist system ($(2—7)\times10^5$ Pa) and one high pressure water mist system ($(80—100)\times10^5$ Pa) in a HGV wagon. Test results showed that the on- board fire suppression system provided the ability to inhibit the spread of fire to adjacent vehicles, reducing collateral damage. The high pressure water mist system was more effective in fire protection than a low pressure water mist system.

The U. S. Navy has recently initiated a program to use a small self-contained water mist system for the protection of miscellaneous shipboard spaces, including flammable liquid storerooms, paint issue rooms, emergency diesel generators, and fuel pump rooms[39,40]. Another program, recently initiated by the U.S. Navy, is to use water mist as a possible total-ship protection method for flashover suppression in shipboard compartments and boundary cooling[41].

7 Progress of water mist fire suppression in China

Although great progress on research of water mist fire suppression technology has taken place around the world, research on water mist system has been studied lately in our country. Tianjin Fire Protection Science Institute of the Ministry of Public Security developed a high-pressure/ two-phase flow water mist fire suppression system. Some tests were conducted on 320KVA electrical transformer located in the middle of 7 m×7 m×3.5 m combustion test room. During these tests Class B combustibles, such as transformer oil, diesel and gasoline, were used. Test results show that the water mist system was effective in extinguishing transformer fires.

State Key Laboratory of Fire Science (SKLFS) of University of Science and Technology of China (USTC) conducted a basic research on characteristics and extinguishment mechanisms of water mist. At the same time SKLFS is developing high-effective/practical water mist fire suppression systems.

Water mist fire suppression technology has been brought into the State Science and Technology Key Program, the Knowledge Innovation Project of the Chinese Academy of Sciences (CAS) and the Major State Basic Research Development Program of China as an important research. The future of water mist fire suppression technology in China will be promising.

8 Summary

Water mist fire suppression systems have demonstrated their capabilities in extinguishing Class A, B, C, and K fires with effective cooling, non-toxicity, low cost, less water requirement, less water damage, and less clean-up time. As a result, water mist fire suppression systems have been used in many applications, including the protection of machinery spaces, pump rooms, gas turbine enclosures, marine accommodations and public spaces. They are being considered/used for the protection of residential occupancies, heritage buildings, libraries, electronic environments, aircraft, commercial cooking areas, industrial oil cookers and combat vehicles. Studies on the use of water mist in other areas, such as for the protection of small shipboard compartments, and for flashover suppression in shipboard compartments and boundary cooling, are continuing.

The effectiveness of water mist in fire suppression is determined by factors, including spray characteristics of a water mist system, its configuration in the compartment, fire size, the degree of obstruction of the ceiling height and ventilation rate in the compartment. It is important to evaluate the capabilities and limitations of water mist systems in applications, based on corresponding tests and design criteria.

Great progress on improving water mist effectiveness in fire suppression has been made over the last decade. New methods, such as the combination of both total flooding and local applications, cycling water mist discharge mode, hybrid water mist systems, as well as the intelligent water mist that combines zoned water mist application with intelligent detection, are used. In order to further apply these new technologies in fire suppression, however, more research efforts are needed, including studies on optimum cycling frequency in the cycling discharge mode, reliable and cost-effective intelligent water mist systems, as well as the performance of hybrid water mist systems in the practical applications.

Acknowledgements The authors would like to thank Dr. Liu Naian and Ass. Prof. Qin Jun for their useful suggestion, discussion and necessary help. This work was supported by the National Key Basic Research Special Funds of China (Grant No. 2001CB409600) and K. C. Wong Education Foundation, Hong Kong.

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(Received January 17, 2003)