

THREE DECADES OF WATER MIST SYSTEMS: PROGRESS AND POTENTIAL

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Background

Water mist technology has been part of the fire protection landscape for over 30 years, evolving from an emerging innovation to a well-established solution. My own journey with water mist began in the early 2000s during my time in Finnish academia, where I came across its development as a by-product of research into water hydraulics. At the time, Finnish and Danish companies were exploring water-based hydraulic systems as a safer and more sustainable alternative to oil-based solutions, which led to advancements in high-pressure water mist components.

After completing my post-graduate degree, I transitioned from academia into the water mist industry, where I have remained actively involved for the past two decades. Through my work with the International Water Mist Association (IWMA), industry collaborations, standardisation committees, and research initiatives, I have gained broad experience with this technology. While my current work extends into wider fire safety engineering, my enthusiasm for water mist remains strong. Its ability to suppress even complex fires using only water, without harmful additives, makes it both effective and environmentally

responsible qualities that are more important than ever in today's world.

This article will explore the advancements in water mist technology over the past 30 years, highlighting its progress and continued role in modern fire protection.

What are physical fundamentals of water mist technology?

Modern water mist firefighting systems are founded on several key principles that collectively enhance their efficiency and effectiveness in extinguishing fires. These principles include the cooling effect, oxygen displacement, and radiant heat attenuation. Understanding these principles is essential to appreciating how water mist technology operates and why it is an increasingly popular choice for fire protection.

Cooling effect

One of the most significant advantages of water mist systems is their ability to maximise the cooling effect of water. Traditional sprinkler systems produce larger droplets, which are particularly effective on fuel surfaces but not as efficient in heat absorption or

blocking radiant heat as the finer droplets produced by water mist systems. The smaller droplets created by water mist systems work in a more three-dimensional manner, filling the protected volume and dramatically increasing the surface area of the water exposed to the fire.

This increase in surface area allows the water to absorb heat more efficiently and rapidly, reducing the temperature of the surrounding air and cooling the flames. This rapid cooling effect helps to lower the overall temperature of the fire, slowing down the combustion process and aiding in extinguishing the flames more quickly and effectively. The small droplets can penetrate even complex fire geometries and are suitable for flammable liquid or grease fires.

Oxygen Displacement

In addition to their cooling effect, water mist systems also leverage the principle of oxygen displacement to combat fires. When the fine droplets of water are introduced into the fire zone, they evaporate rapidly due to the heat. This rapid evaporation process expands the volume 1680 times, which displaces the oxygen in the immediate vicinity of the fire.

Oxygen is a critical component of the fire triangle, along with heat and fuel. By displacing oxygen, water mist systems effectively starve the fire of one of its essential elements, thereby inhibiting the combustion process. This dual-action approach of cooling the fire and displacing oxygen makes water mist systems highly effective in controlling and extinguishing fires.

Blocking radiant heat

Radiant heat is a significant factor in the spread of fires, as it can preheat surrounding materials, making them more susceptible to ignition. Water mist systems provide effective protection from radiant heat through the blocking properties of the fine water droplets. When water mist droplets are dispersed into a fire, they create a mist curtain that absorbs and scatters the radiant heat energy. This mist curtain acts as a barrier, reducing the intensity of the radiant heat that can reach other areas. By blocking (limiting) radiant heat, water mist systems help to prevent the fire from spreading to adjacent areas and materials, thereby containing the fire and protecting the surrounding environment.

What is modern water mist technology?

Modern water mist technology is a sophisticated evolution of the systems developed three decades ago. While the fundamental principles have remained consistent, advancements have significantly broadened the scope of applications, approvals, and validation processes. Here is a closer look at what

defines modern water mist systems in my opinion:

Enhanced application range: Modern water mist systems have expanded far beyond their initial applications. They are now employed in a wide variety of environments, including commercial and residential buildings, industrial facilities, marine, and transportation infrastructure. The technology's versatility allows it to address a diverse array of fire risks, including new and emerging hazards. Many of the applications are traditionally protected with sprinkler or gaseous systems, further demonstrating how adaptable mist technology is in working alongside these established methods.

Increased validation and approvals: Over the years, water mist systems have undergone extensive validation through experimental fire tests. This rigorous testing has established their effectiveness across various scenarios and led to the development of comprehensive standards and approvals.

Response to new risks: The rapid pace of change in the world has introduced new fire risks and challenges. Modern water mist technology is practised at adapting to these. The industry is accustomed to carrying out fire tests, enabling quick responses to new or evolving risks. Mist systems are well-known in typical applications performed with performance-based fire safety design methods. Recent advancements have addressed fire safety issues related to cross-laminated timber (CLT) structures, tunnel protection, lithium-ion battery applications, power generation, air hangars, data centres, various industrial risks and complex steel and glass structures. Water mist systems have proven to be highly effective in mitigating these new risks, demonstrating their ability to provide innovative solutions.

Continued technological evolution: While the core principles of water mist technology have not changed, ongoing improvements in system design, nozzle technology, and control mechanisms have enhanced their performance and efficiency. These advancements ensure that water mist systems remain at the forefront of fire protection technology.

In summary, modern water mist technology represents a blend of well-established principles and innovations. Although the fundamental concepts have been around for decades, the technology's evolution has been marked by increased application versatility, rigorous validation, and a proactive approach to addressing new fire risks. This dynamic nature of water mist systems allows them to remain a vital and effective tool in modern fire protection.

Why modern water mist is gaining popularity?

The principles of water mist systems have been known for over 100 years, but their popularity has risen gradually, particularly over the past 20 years. This increase in popularity can be attributed to several factors, including physical fundamentals, technical benefits, and environmental considerations. While the physical fundamentals have been covered previously, the following will address the technical benefits and environmental aspects.

Technical benefits

Water mist systems offer technical benefits that increase their popularity in many applications:

Ease and speed of installation: Water mist systems are relatively easy and quick to install compared to traditional fire suppression systems. This is due to the smaller components, such as pipes and tanks, that are required. Nozzle spacing is also typically much larger for mist systems.

Retrofitting: These systems can be easily retrofitted into existing buildings, including those with high architectural significance or heritage status, as the components are typically very small.

No compartmentation required: Unlike many gaseous systems, water mist systems do not require compartmentation. They can be activated immediately, which helps to limit damage in sensitive areas such as data centres.

Distribution and penetration: Due to the small size of the droplets, water mist is well distributed and fills many nooks and crevices within seconds of activation. It can be carried by air flow, allowing it to control or extinguish even concealed fires.

Smoke control: Water mist efficiently cools the smoke layer, preventing the hot gas layer from contributing to further fire spread. It also helps to clean out some of the smoke particles, improving visibility and reducing smoke inhalation risks.

Human safety: Water mist is harmless to humans, making it safe for use in occupied spaces.

Minimal water damage: The disposal of fire water is easy due to the small amount of water used, resulting in less water damage to property.

Environmental aspects

Water mist systems offer significant environmental benefits that contribute to their growing popularity as eco-friendly technology:

Reduced water consumption: Water mist systems use notably less water compared to traditional sprinkler systems. This not only minimizes consequential water damage but also reduces downtime for businesses after a fire event.

No ozone depletion or global warming: Water mist systems do not contribute to ozone depletion or global warming. Unlike some fire suppression systems that use chemical agents, water mist relies solely on water, making it a more environmentally responsible choice.

Non-toxic and simple disposal: Water mist systems do not produce toxic by-products when applied to a fire. Additionally, they do not require complex decommissioning procedures, simplifying the cleanup and disposal process. This ensures that water mist systems are safe for both humans and the environment.

What is hindering modern water mist technology?

Despite the increasing popularity of modern water mist systems and their numerous advantages, several factors have historically hindered their broader adoption and development. Understanding these challenges is important to appreciating both the progress made and the areas where further advancements are needed. Here are some of the key obstacles that I find most relevant:

Knowledge and expertise: The relatively recent and continuously increasing adoption of water mist technology means that there is a limited pool of professionals with extensive experience and knowledge in this area. The specialised nature of the technology requires skilled engineers and technicians who understand the nuances of water mist systems, which can be a limiting factor in some regions. The IWMA has extensively educated and promoted knowledge related to water mist systems, helping to address this challenge.

Historical preference for sprinklers and gas systems: Sprinkler systems and various gas-based fire suppression methods have been industry standards for several decades. Sprinkler systems have been widely used since the early 20th century, while gas-based systems gained prominence from the mid-20th century onwards. They are well-established, with a long history of proven performance and extensive regulatory approval. The entrenched use of these older technologies can lead to resistance against adopting new methods, even when modern alternatives offer significant advantages. Although water mist systems are often considered a new technology, they have been around for nearly 30 years and hold almost 100% market share in many applications.

Costs: The initial cost of water mist systems can be higher compared to traditional fire suppression systems, such as sprinklers. This is due to the advanced technology and components required, such as pumps and specialised nozzles. For some organisations, the upfront investment can be a significant barrier, despite the long-term benefits and savings on water usage and potential damage. Additionally, indirect costs, such as those related to tank and sump sizes, drainage, or disposal, are often not fully considered.

Attitude toward innovation: The fire protection industry is known for its conservative approach, often favouring established technologies over exploring new innovations. This cautious attitude can slow the acceptance and implementation of newer technologies, such as water mist systems. Many stakeholders may be hesitant to transition from proven systems to newer alternatives due to this reluctance. Furthermore, the conservatism of the fire protection industry has also limited the influx of young engineers. I have observed that we rarely compete with more attractive industries, like the automotive or aviation sectors, to attract top-level young engineers. Additionally, other industries within the construction sector have demonstrated significantly more innovation compared to fire protection.

What is the future of modern water mist technology? In my opinion, the trend of growth and expansion within the water mist industry is set to continue. The commercial value of this sector is already substantial, and the technology is being increasingly applied across a wide range of applications, thanks to its superior efficiency. Several factors will play a crucial role in this ongoing development:

Even broader application scope: The water mist industry will continue to be a leading innovator in fire protection. Emerging risks related to energy storage systems, data centres, car parks, and the automotive industry have demonstrated the sector's ability to quickly develop sound and reliable solutions. Performance-based design is gaining traction, allowing for the development of application-specific best practices that further support the use of water mist systems. I have personally been involved in projects such as those for the Eurotunnel, a unique rail link, where we developed tailored solutions to address specific challenges.

Environmental and sustainability focus: With an increasing emphasis on environmental sustainability, water mist systems will benefit from their eco-friendly attributes. Innovations in water recycling and conservation within these systems will enhance their environmental credentials. As environmental

regulations tighten, water mist systems are likely to gain further recognition and support. Their reduced water usage and non-toxic nature align well with global sustainability goals, potentially leading to more favourable regulations and incentives for their adoption.

Standardisation: The standardisation of water mist systems is expected to advance, with new standards emerging for broader applications. The IWMA has developed a comprehensive matrix outlining all relevant water mist standards and applications, which is available on their website. This progress in standardisation will help facilitate wider adoption and ensure consistency in system performance.

Increased market penetration: As water mist technology becomes an industry standard in various regions and applications, the resulting commercial momentum is likely to reduce costs. This will make water mist systems more accessible and attractive to a wider range of applications and markets.

Education and training: Expanding education and training programmes for engineers, designers, and installers will help address the expertise gap and promote broader adoption of water mist technology. Enhanced knowledge and skills in this area will contribute to more effective implementation and optimisation of water mist systems.

Ongoing research: Continued investment in research and development is crucial for advancing water mist technology. This includes exploring new materials, testing novel applications, and refining system performance to address emerging fire risks. Ongoing research will drive innovation and ensure that water mist systems remain at the forefront of fire protection solutions.

Conclusions

Over the past 30 years, water mist technology has evolved from an emerging concept into a well-established and commercially viable fire protection solution. Its influence extends beyond market success, driving innovation in fire suppression and challenging traditional approaches to fire safety.

Future growth in the water mist industry looks increasingly promising. Advancements in system design, expanding applications, and an increasing emphasis on sustainability will continue to strengthen water mist's role in modern fire protection. As costs decrease and industry knowledge expands, these systems will be even better equipped to address both longstanding and emerging fire risks. However, continued progress will require technological

innovation, regulatory backing, and strong collaboration within the fire safety community, areas where the IWMA remains a driving force.

Having closely followed the development of water mist technology for over two decades, I have witnessed its transformation first-hand. With its deep roots in Europe, particularly in the Nordic region, the industry has made remarkable progresses. I look forward to seeing how the next 20 years will shape the future of water mist fire protection.



Water mist has proven to be highly effective against emerging risks, such as lithium-ion batteries and battery energy storage systems (BESS). As a highly efficient coolant, it requires only a limited amount of water and does not rely on enclosures to operate, unlike many other technologies. Additionally, water mist is eco-friendly, utilising only water in its operation. (SUVEREN / IFAB)



Notre Dame Cathedral, Paris – Protected by a water mist system and reopened in December 2024 following the devastating fire in 2019. (Anne Stahnke / pixelio.de)

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<https://iwma.net/member-news/detail/a-new-item-on-the-hall-of-fame-list-notre-dame>



The IWMA Annual Conference is an excellent opportunity to learn about the latest developments in water mist systems and connect with key stakeholders in the industry. (Valentyna Rostovikova Photography, IWMA)



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"24th International Water Mist Conference Manchester, UK

24th and 25th September 2025

Conference webpage: www.iwma.net/iwmc

*If history repeats itself, and the unexpected always happens,
how incapable must man be of learning from experience*

-George Bernard Shaw