Gas v water

Gas versus high-pressure water mist in data-centre fire suppression – what are the realities? Barry Ellion, Lewis Oxley and Christophe Balayre explain.

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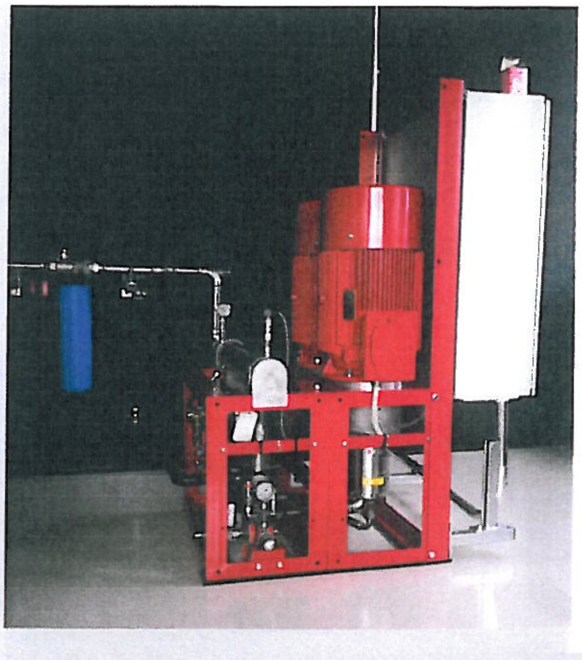
The fighting of electrical fires with water is counterintuitive and yet water-based systems are increasingly being used in European data centres – how can that be? First, we need to consider the problem: the possibility of component failure causing an electrical fire in a manned data centre operation where the consideration of staff safety is closely followed by the need to bounce back quickly from a fire-induced outage.

The current range of options for data centre fire suppression takes in four approaches. First is permanently reducing the oxygen content of the room to below 14% by injecting nitrogen (known as the hypoxic method). Second, when a fire starts, injecting an inert gas into the room to reduce the oxygen level to below 14%. Third, injecting a halogenated gas into the room when a fire starts, which both reduces the oxygen content and interferes with the combustion process. And lastly, spraying a fine high-pressure water mist onto the burning area, which both cools and reduces the oxygen level locally.

As effective as gas release undoubtedly is, however, it has several consequences. Since all the gas is released from every incident (even for a small localised fire), it is a highly committed solution whose reset costs are considerable both in time and money. In addition, the data-centre structure has to be either purpose-built with gas-based suppression in mind, or it has to be retrofitted to provide the semi-pressurised environment required to make gas-based suppression an effective solution.



The compact Sem-Safe high-pressure water-mist pump unit. Top: a Sem-Safe high-pressure water-mist nozzle in action.

By contrast, a high-pressure water mist system requires a network of stainless steel piping and nozzles which only release at the point of the incident, leaving the remainder of the data centre operations and equipment unaffected, requiring no pressure seals or evacuation of personnel, and involving minimal reset times without the associated high cost. Furthermore, compared to conventional gas suppression, a room protected by water mist does not require pressure-proofing to the same level, eg by the addition of overpressure plates penetrating the external walls.

While gas-based systems require that the ventilation system to the room be shut down to contain the gas and to prevent oxygen feeding the fire, such control is not necessary to the same extent for a water mist fire suppression system. Indeed the ventilation can remain running and assist in smoke removal.

One salient misunderstanding regarding water mist relates to water-filled piping systems in computer rooms leaking and dripping onto equipment. This, however, is impossible because the pipes remain empty up to the point of a fire-alarm condition; only then is water released into the overhead piping system. This, known as a 'pre-action' system, also helps to reduce false alarms and unnecessary discharge of the suppressant. This is because two separate events must happen to initiate nozzle discharge. First, the detection system must identify a developing fire and then open the pre-action valve. This allows water to flow into system piping, which effectively creates a wet pipe system. Second, the glass bulbs on the nozzles must have burst as a result of high temperature, which means that only the areas affected by the fire are actively sprayed with water.

It is also worth bearing in mind that gas comes with a certain amount of political and regulatory baggage, especially in Europe.

The 1989 Montreal protocol banned the family of gases, known as chlorofluorocarbons (CFCs) and their brominated cousins are known as halons. As of 1 January 1994, the US has banned the production and import of halons under the Clean Air Act. The EU ban on the use of halons in fire extinguishers came into force in October 2000 and was implemented in the UK in 2003 (although some 'critical' applications are still allowed).

The market splits into two regarding gas systems that are approved for fire suppression.

Inert gas systems, which work by reducing the oxygen content of the room to around 14%, are regarded as a green solution because they effectively reuse existing elements from the atmosphere. However, they require large volumes of gas and, as mentioned, the room needs to be sealed and able to deal with the large pressure event that a gas release will initiate.

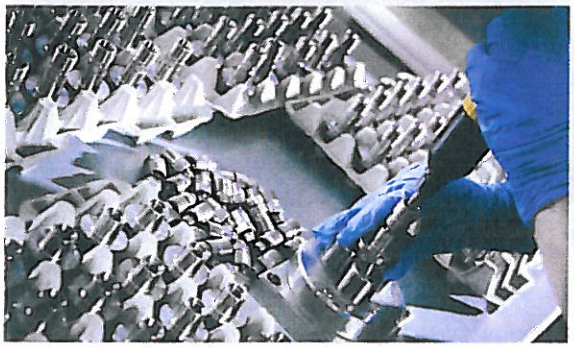
The other method works by a combination of chemical and oxygen-reduction means using either hydrofluorocarbons (HFCs) or fluorinated ketones, as listed in the widely recognised NFPA 2001:2015 *Standard on clean agent fire extinguishing systems*. Although there isn't an exact European equivalent list, there is the 'F-Gas' Directive, which only allows gases with a zero ozone-depletion potential. The F-Gas Directive lists HFCs and PFCs (perfluorocarbons) that are allowed to be used in the EU. Although this includes familiar brand names such as HFC227ea (FM200) there is no list that specifically authorises inert gases or fluorinated ketones.

Unlike sprinkler and gas systems, high-pressure water-mist systems require full-scale fire testing to demonstrate their efficacy. Currently, there is only one internationally recognised standard, FM Global 5560 (2016) Appendix M and N, which reflects the real-life conditions within a data centre by also taking into account forced ventilation.

There is a potential problem with HFCs because the Global Warming Potential of a substance is now coming under increased scrutiny.

Politicians are now considering the GWP potential of substances; this led to the meeting on 14 October in Kigali, Rwanda, of the Ozone Secretariat for the Vienna Convention for the Protection of the Ozone Layer and for the Montreal Protocol on Substances that Deplete the Ozone Layer.

GWP is the ability of a substance to trap the sun's heat within



High-pressure water mist technology has a number of advantages over gas-based fire systems.

the atmosphere and not allow it to radiate back into space - the 'greenhouse effect'. The popular HFC fire suppression gas HFC227ea, for example, has a GWP rating of 3,220, compared to CO2's 1.

The outcome of the Kigali meeting is the intention to reduce HFCs dramatically in the environment. While the main target is the air conditioning industry, the fire suppression industry is expected to be caught up in the slipstream.

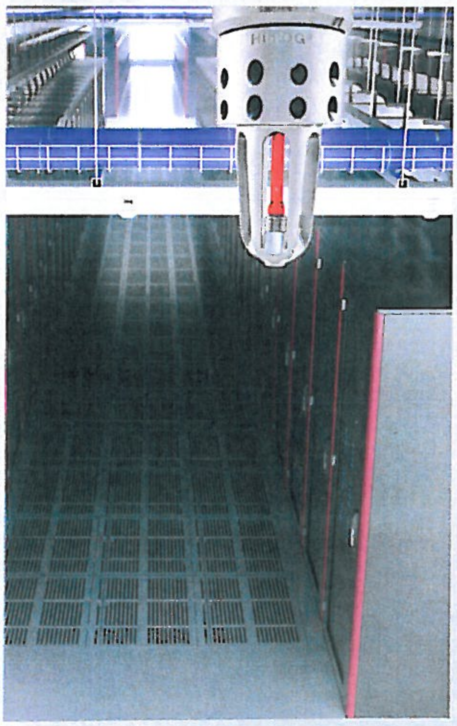
According to reports, richer economies like the European Union, the US and others will start to limit their use of HFCs within a few years and make a cut of at least 10% from 2019.

Some developing countries, including nations in Latin America and island states, will freeze their use of HFCs from 2024. Other developing countries, specifically India, Pakistan, Iran, Iraq and the Gulf states will not freeze their use until 2028. China, the world's largest producer of HFCs, will not actually start to cut its production or use until 2029. India will start even later, making its first 10% cut in use in 2032.

This leaves inert gases, fluoroketones – which have a GWP of 1 just like CO_2 – and water-mist fire suppression.

To sum up the advantages of high-pressure water mist: it's an approved and certified solution with no issues of ODP or GWP; the room does not have to be sealed in the same way that a gas suppression system requires; there is no overpressure impact on a structure; ventilation does not need to be turned off; there is no safety impact upon people in the data centre; and a localised response to a fire can be provided.

HIGH-PRESSURE MIST FOR THE CLOUD



A high-pressure water mist fire protection system has become the first of its kind to receive FM Approvals certification for protecting data halls and subfloors from a fire.

Marioff's Hi-Fog has been verified in full-scale fire tests for use in ventilated conditions as well as in the narrow spaces under the raised floor of a data hall.

The new system is equipped with a pre-action security mechanism which can help prevent accidental water leakages and false discharges in data processing equipment halls. According to its manufacturer, the system also uses much less water than traditional sprinkler systems or low-pressure water mist systems, minimising potential damage to equipment as well as downtime.

The Hi-Fog addresses the requirement to keep data centres operating at all times even in the challenging environment caused by high airflow and the increased power density of servers. The resulting high-pressure water mist efficiently suppresses, controls and cools down fires in ventilated conditions and in the narrow spaces under the raised floor of a data hall.

In 2016, FM Approvals identified the increased fire risks in data centres and upgraded its FM Standard 5560, a detailed document covering water mist systems, with data center-specific test protocols.

New areas covered by the upgraded FM Standard 5560 include protection of data processing equipment above/below a raised floor; combustible loading of cables and cable trays; and challenges of ceiling height, obstructions, and impact of ventilation.

"Marioff is proud of this certificate by FM Approvals. It is a logical add-on to our impressive list of approvals and shows that Hi-Fog is a performance-based solution now formally certified to protect modern data centres as well," said Henri Simula, global account manager, Marioff Corporation. "In addition to Hi-Fog's superior firefighting capabilities, another benefit is there are no expensive refill costs, which are typically found with gas suppression systems."