Water Mist

Fire

What is the problem

A fire is a flaming combustion process and has been widely used for centuries by man for every sort of application. When an unexpected fire occurs the consequences can be dramatic and not only loss and damage of property but sometimes life is lost. The recent nightclub fire in Brazil was an example of horrendous loss of life by fire and smoke which could have been avoided. The financial loss for most countries tops the billions of USD. It is important to prevent fires, but if fire occurs it is vital to tackle it in an early stage of development to mitigate the losses.

Types of fire

To use very broad percentages, it is envisaged that a fire service will attend fires that are open in around 80% of the calls. Open fires include vehicles, houses and storage facilities that either have no windows or are single glazed, bush/wildland, rubbish, deep seated peat style fires, hay/straw. There are also false alarms or fires that are out on arrival. Possibly the other 20% (which could be less) are what are called compartment fires or contained fires. These are fires that develop but because of the building design and construction struggle to find enough oxygen to survive (until something fails or someone creates an opening). In some circumstances the fire will actually extinguish itself. The risk here is a door being opened, a window failing and providing the fire with oxygen and the risk of backdraught or flashover.

WATER

The control of fire over the centuries has been undertaken by humans using water. It is usually readably available, cheap, easy to use and has a high heat absorption quality. As fire is an exothermic chemical reaction it releases energy as heat and water can absorb that energy and extinguish the fire. The best absorption of heat is when the water as a liquid changes to a gas, latent heat of vaporization. Let's say that it takes one unit to raise the temperature of water one degree celsius, then it takes 540 units to change the water into steam at 100C. Research shows that from a normal fire service hose reel or nozzle only 20% will change state to vapour while 80% will end up on the floor. unused.

SO WHY USE WATER AND WHY USE A MISTING SYSTEM

NIMBUS can be used on virtually every fire. Sometimes in can extinguish, many times it controls, it always increases fire fighter safety.

Water provides the fire fighter with five crucial elements to extinguish fire.

1. Heat Extraction - taking the energy from the fire and absorbing it by raising the temperature of the applied water.
2. Oxygen depletion - The greatest extinguishing capacity of water is heat extraction. However, there is more: combustion being a redox chemical reaction, it requires, besides fuel and enough energy to sustain combustion, an oxidizer. The most common one is simply oxygen. From the fact that oxygen is a part of the gases in the composition of air at a level of 21 percent, we can assume that lowering its part below a certain point will end the chain reaction generated by combustion, and thereby extinguish the fire. Typically, we consider that below 12 percent no more combustion can be sustained. The role of water in this process is involving another of its physical properties when it is present in a gaseous phase: the volume change while temperature increases. This is a phenomenon explained by the so called “Perfect Gas Law”. At 100C 1kg of water produces 1,700L of steam, at 500C it produces 3,980L of steam.
3. “Cooling effect” means the direct action of water on the fuel. Since combustion is a gaseous reaction, the energy released by fire causes a gasification process of the fuel when heated. Damping the fuel will then cool it and stop this phenomenon also called pyrolysis. The fire has no more fuel, and is extinguished. This action requires an effective covering of surfaces, which again induces the way of spreading water.
4. Radiation attenuation. Very rarely mentioned or taken into account in fire extinguishing, radiation attenuation, or even shielding, can also be done by water, depending on its repartition, droplet size and quenching. Radiation is responsible for pyrolysis, and it is also radiation which is responsible for fire evolution from a localized to a generalized fire (flashover) due to re-radiation from smoke and flame mattress on the ceiling, subjecting all the combustible items in the structure to dramatically high energy flows, which will involve them in the fire. Water, if used as a mist, can reduce this, or even block it entirely, depending on the thickness of the shield. To explain it briefly, we could represent radiation as a ray of energy (like a laser ray). Seen in a very small scale mist is a cluster of droplets, and when the ray hits a droplet, it loses energy in heating the drop and is diffracted, until again the ray is entirely absorbed.
5. Blowing effect - Last of the known and significant process involved in fire extinguishing, blowing effect is not due directly to the water, but more to the momentum generated by the nozzle that sends water. Pressure in the pipe is converted into speed when water reaches the nozzle, which also generates an air entrainment. After a certain distance, varying with initial speed, spray pattern, and droplet size, it is the remaining air flow which carry the drops. And this air flow also has an influence; it disturbs the continuity of flame feeding by pyrolysis products, and the flame itself by scavenging. We still have sufficient energy to sustain combustion, but not at the same place where we have fuel… flame gets extinguished.

You may have understood it at the first instant; water is a very efficient extinguishing agent. It is actually about twice as efficient per unit weight as halon 1301, and almost as efficient as dry powder of high quality. Water is an astonishing extinguishing agent not due to the flow rate, but from repartition, and from its displacement capacity.

Many fire service nozzles produce a water droplet the size of 1mm so splitting $1cm^3$ into 1mm gives 1910 droplets offering a total contact area of $60cm^2$. For years and still, fire services and extinguisher manufacturers have added a foam compound (AFFF) in around 1% concentration to increase the efficiency of the large water droplet formed by standard nozzles.

However, water mist, where the droplets are 0.1mm (as NIMBUS produces) then $1cm^3$ will produce 1.9 million droplets offering a total contact surface of $6,000cm^2$.

Finally, a water droplet of 1mm (normal fire service nozzle) will remain airborne for 0.5seconds, giving it little time to do its work whereas a 0.1mm NIMBUS droplet will remain airborne for at least 5.5 seconds.

It is said that the NIMBUS droplets are so light they behave like a gas and resemble a total flooding extinguisher system.

HIGH PRESSURE WATER MIST

For open fires

Water mist has been used for years for fire fighting. Early water extinguisher training recommended the operator putting their thumb over part of the nozzle to disperse the jet (form a mist spray). More recently pump outputs and nozzle design have improved the way water is delivered to the fire, but still there is much waste of a precious resource.

Then came fogging units delivering between 150 and 180 bar, these did provide the ideal water droplet size but lacked the speed in many circumstances to make a credible entry into a fire compartment or even the passenger cell of a motor vehicle. This was especially evident when it came to fighting wildland/bush fires where the mist would not penetrate the material (undergrowth, etc.) but basically stopped at the fire edge, they did have an effect and will extinguish a fire but need more water and in many cases a longer delivery nozzle or lance.

NIMBUS uses 300bar at the pump providing not only the ideal droplet size but also the speed to penetrate the over pressure of a fire compartment or penetrate dense bush/wildland areas including some 2.5m penetration into peat or other fibrous ground material. On an open fire such as vehicle fire that is fully developed, 300bar high pressure water used can extinguish the vehicle with under 30L and in some cases as little as 1L. NIMBUS uses all 5 methods of extinguishing including the blowing effect effectively.

During fires a pressure is produced (over pressure), this is evident by smoke, heat and flames exiting the fire situation, this over pressure needs to be overcome and often lower pressure systems have little effect but at 300bar the water droplets will be driven into the compartment. The other way of getting water into the compartment is to increase the flow and droplet size but as mentioned earlier only 20% of the water will be used effectively, the rest will pool or run off.

The benefit of NIMBUS at 300bar is that it can also be used for cold cutting. This means that a fire in an almost sealed situation can be attacked without making an increase in oxygen supply by opening a door or window. Basically this removes the risk of backdraught all together making a fire fighters role safer. Again with a flash over risk, the use of water mist at 300bar into the upper area of the space will provide a total suppression system that will interrupt the products of combustion, reduce temperature and deplete oxygen and remove the flash over risk. It makes the working environment for fire fighters safer and more comfortable.

The normal air flow through buildings during a fire will carry the water mist and every drop will be used to counter the fire situation. This includes fire drop down in service ducts, ventilation ducts and can provide protection in escape corridors.

NIMBUS uses

Vehicle fires
Bush/Wildland fires
Freight container fires
Hydrocarbon fires
Tunnel and duct fires
Rubbish fires
Aircraft incidents
High rise fires - blow torch
Straw/Hay fires
Deep seated ground fires
Silo fires
Protecting buildings from adjacent fire
Protecting storage tanks and transformers
Compartment fires
Roof void cooling/protection
Thatch/straw/makuti roof fires
...no limits!

NIMBUS

HYDRO-CARBON

Can be used really effectively with dual attack - water mist + dry powder (preferably MONNEX)

WILD-LAND

Penetration into material and a mist that just makes it rain.

COMPARTMENT

Even with enhanced security, NIMBUS can start attacking and controlling a fire whilst an entry is being forced. Rapid Intervention stops fires in their tracks.

Our thanks for the assistance of the following in providing technical information and live fire situations:

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