FIREXPRESS

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MICRO-DROPS THE FIREXPRESS WAY

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During the last couple of years the use of very small water droplets for fire fighting has become more and more popular. It have scientifically proved that this is a very effective way of combating fires and many fire brigades around the world are using these water mist / micro-drop systems with great success.

Hong Kong Fire Services are using Firexpress equipment for many applications.
Here a Firexpress Motor Bike in action.

This fire was taken out with 25 litres of water

FIRE FIGHTING WITH MICRO-DROPS IN GENERAL

Fighting fires with micro-drops differs a lot from the conventional water on flames scenario.

The accumulated surfaces of these very small drops are extremely large. For example 1 litre (¼ gal) of water will in the micro drop phase have a total surface of 100 m^2 (1000 sq ft)

Applying this large water surface area into a hot fire zone will instantly generate steam, absorbing heat and generating an overpressure around the primary fire, reversing the airflow preventing oxygen from feeding the fire.

PRIMARY EXTINGUISHING FACTORS

- Absorbing heat.
- Suppressing the oxygen flow with steam
- Cooling surrounding surfaces.

The micro drops are so small that they are hanging in the air (long “hang-time”) and transported into the combustion zone by the turbulent air feeding the fire.
Research in Norway has shown that these drops momentarily can be super heated , creating large amount of steam repressing the air giving an extinguishing effect well above the expected values.

This explains the observed effect of micro-drops where only a 1/3 of the calculated water volume was needed to extinguish a fire. (Page 8 – fig. 1)

To illustrate the difference between a micro drop and a small drop from a conventional spray nozzle we can look at the time it takes to evaporate a drop, going from liquid to steam phase. (Page 9 – fig. 2)

This is one of the main factors why only a fraction of the water from a conventional nozzle is actually used in the fire fighting process and why most of it will end up on the floor only causing secondary damage.

CREATING MICRO-DROPS

Creating these small water droplets using conventional methods normally requires a fairly high pressure of 100 – 250 bars (1500-3600 psi). Using the conventional systems this high pressure is unfortunately also needed in order to give the drops sufficient range to have any relevance for fire fighting.

This high pressure will give a high initial drop speed creating a lot of unwanted negative effects.

To mention a few:

- Large amount of entrained air sucked into the spray pattern.
- Violent spreading of burning debris
- Dangerous to use direct on people
- Short range
- Heavy nozzle recoil

This entrained air is actually feeding the fire with oxygen, giving a poor control of hot smoke and gasses. In some cases the entrained air can be of such a magnitude that the fire increases dramatically!!
Also fighting fuel fires is a problem using this high pressure water mists system even if foam is added.
The problem with large amounts of entrained air sucked into the spray pattern generated by conventional high pressure systems has in some cases given the water mist systems a poor reputation among fire fighters.

The Firexpress dual nozzle combines micro-drops with low expansion foam, effectively dealing with a variety of fires from wild fires to difficult fuel fires.

Micro-Drops the Firexpress way is radically different

By using the special aerodynamic effect around a moving water drop, the unique Firexpress nozzle is able to produce micro-drops at a pressure as low as 20 bars and achieving a range of 15 meters.

This is unmatched by any existing system.

The Firexpress nozzle design eliminates all the draw backs experienced in the high pressure system. Especially the low drop speed ensures that virtually no entrained air is present in the spray, avoiding any reduction in the fire fighting effect.

The Firexpress HPU operates at a nozzle pressure (mouthpiece) as low as 23 bar giving the Micro-Drops a range of 15 meters.

BACKGROUND MATHEMATICS

Let us look at some simplified mathematics behind droplet size, speed, pressure, entrained air etc.

The horizontal range of a drop is mainly influenced by its inertia and the friction of the air.

The inertia defined as Mass x Velocity.

To increase the inertia and hereby the range of a drop of a given size, the velocity of the drop has to be increased.
Unfortunately this will also largely increase the friction in relation to the surrounding air due to the fact that friction increases with the square of the velocity, Friction = Velocity^2

For example by doubling the speed the friction will fourfold.

This being the reason for the extreme amount of entrained air sucked into a flow of high speed drops.

CONSEQUENSES

In Sweden tests have been made of a 200 bar system where wind speed in the spray pattern has been measured.

The result was:

- 4 metres from the nozzle 26,0 metres/sec
- 5 metres from the nozzle 17,8 metres/sec

26 m/s is the same as 94 km/h (58 mph) or the metrological equivalent to 10 on the Beufort scale corresponding to full storm!
This fully explains the violent flare up effect often experience by fire fighters using high pressure systems.

For the Firexpress system the wind speed 4 meters from the nozzle has been estimated to 4 m/s (2 on the Beufort scale = Light breeze)

SAFETY DISTANCE

The Swedish authorities (Räddningsverket) has for the mentioned 200 bar system recommended a safety distance for unprotected skin to 7 metres.
This makes it problematic to use in car fires with trapped persons, or in room fires where persons might be present, but it also creates a safety hazard to the firemen in case of an accidental activation of the nozzle.

The Firexpress basic system can be used directly on unprotected human skin (contact shot)

FIREXPRESS AND COMPARTMENT FIRES / CAR FIRES:

When micro-drops are used in an Direct fire Attach, it is very important that the fire fighter is able to applicant the water mist in a precise and narrow-angled stream into the low-pressure zone of the fire - the area where the fire is breathing fresh air.

The very lightweight micro-drops will be sucked into the primary fire zone by the air stream feeding the fire. Due to the very large surface of the micro-drops, they will evaporate almost instantaneously.

This process creates a very heavy steam pressure around the initial fire. The temperature is drastically reduced and at the same time, the steam pressure prevents the ambient oxygen from reaching the fire
Thus a cooling and a smothering effect are obtained at the same time.

Some of the steam developed around the primary fire will be carried into the unburned gasses above the fire by the up-current from the fire. This has a substantial cooling effect on the gasses, which at the same time are diluted by the steam and thus more difficult to ignite.

As the drop rate of the micro-drops is very low, it is not always necessary to direct the jet directly towards the primary fire. This can of course be made difficult because of e.g. interior fires in which flames are shielded by obstructions, where there is multi-fire sources scattered within the compartment, or where the visibility of the room is very poor and the fire is obscured.
Under these circumstances you will have to adapt a ‘sweeping technique’ that ensures that the whole area around the fire is filled with micro-drops.
As mentioned earlier the small drops (long hang-time) will be carried into the fire by the air stream that feeds the fire and therefore ensure the cooling and smothering needed.

In popular terms, you could describe the technique using micro-drops as "firing around corners".

Hence, you need not always cool the smoke gasses below the ceiling by means of pulsation to avoid a flash over. The steam hat produced by the initial fire will be carried upwards and perform the cooling necessary.

When micro-drops are used, the greatest effect is reached during the period where the temperature in the primary fire is high. As the temperature is lowered - which happens very fast – you must attack the fire more directly in the same way as using a traditional nozzle. The advantage being that you spend only a fragment of the water normally used for this post extinguishing. Secondary damage from water is therefore almost eliminated.

FIREXPRESS AND FUEL FIRES:

Fighting a surface fuel fire with micro-drops alone is very difficult, even with the use of a foam additive.
To make the Firexpress concept a true multipurpose concept the unique dual nozzle besides creating micro-drops also is designed to deliver low expansion foam with a range of 15 metres (50 feet) at a nozzle pressure (mouth pipe) at only 24 bars. Delivering 34 litres (8,8 gal) water/foam per minute. Trough a handle on the lance/pistolgrib the operator can quickly select either micro-drops or foam. The recommended foam for the Firexpress system is high quality AFFF foam – alcohol resistant.

The foam capability is very important for a first strike unit. Difficult fuel fires can be attacked immediately, and prevention action can be taken to safe-guard fuel spill, a problem often faced in traffic accidents or at any handling of flammable liquid.

FIREXPRESS AND WILDFIRES.

The Firexpress system is used by many fire brigades around the world combating bush fires.
The experience from actual fires and tests show that the system has a very high knock-down effect. In many cases the fire fighter can knock down the fire along the fire line “as fast as he can run”. This will provide him with a fast control of the fire in his section; however blackening out behind him is still needed and essential.
This task can be done with the Firexpress nozzle in the foam position alternately with the flat jet nozzle adapter installed.
This nozzle adapter is also effective for making stop lines in grass, low vegetation or similar.
Various foam types, wetting agents or fire retardants can easily be added to the water increasing the fire fighting effect.

Firexpress used in wild fire Brisbane Australia

REFERENCES:

Fire Brigades in many European, Arabic, Australian and Asian countries are now using the FIREXPRESS systems with very good results.

Firexpress units have been installed in Fire trucks, Rescue vehicles, Duty Fire Officer vehicles and in fast response vehicles enabling fire brigades to launch an effective first strike attack.

FIREXPRESS Motor Bikes are used as rapid invention vehicles in long road tunnels, and in crowded city areas.

FIREXPRESS ATVs patrol cities with narrow streets, areas with rough terrain and tourist beaches with high-risk bush areas.

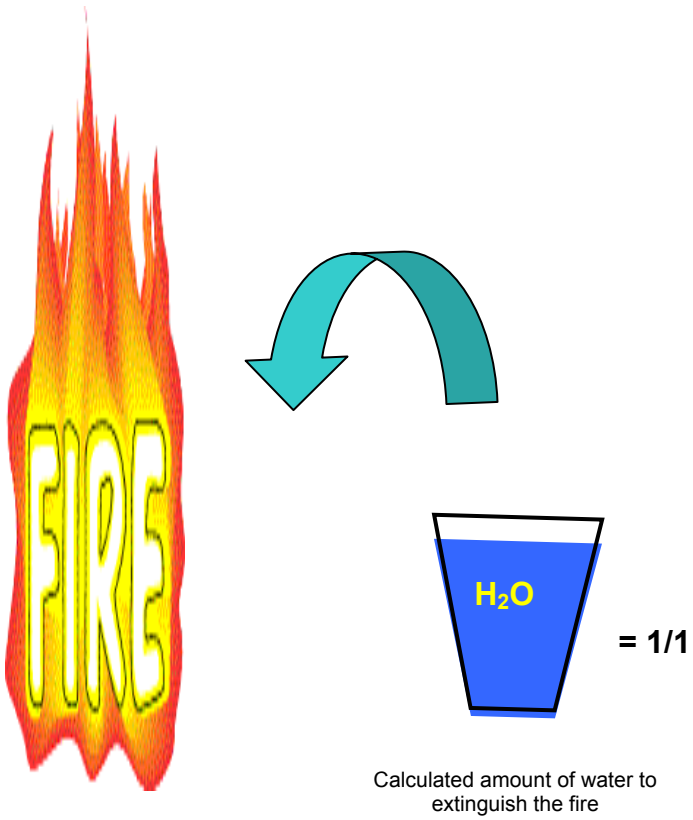
Army, Navy and Air Forces in the Nordic Countries have implemented the system, as have various NATO and UN forces (e.g. KFOR, SFOR, SHIRBRIG). The FIREXPRESS systems are installed in armoured personnel carriers and patrol vehicles and are used as base camp protection. The Air Force uses the system as hangar protection and fire back-up during aircraft engine start.

On the maritime side the Navy uses the FIREXPRESS systems for fast response fire fighting in engine rooms. Also civilian ships now use FIREXPRESS widely and especially car ferries use the system to deal effectively with fires on car deck.

Source material:

SINTEF – Norwegian Fire Research Laboratory
NRC – National Research Council Canada
Räddningsverket – Fire and Rescue authority Sweden

FIG. 1



1 litre (0,26 gal) of water heated to 100^0 C (212 F)	generates 1700 litres (450 gal) water vapour
1 litre (0,26 gal) of water heated to 200^0 C (392 F)	generates 2160 litres (570 gal) water vapour
1 litre (0,26 gal) of water heated to 500^0 C (932 F)	generates 3500 litres (925 gal)water vapour
1 litre (0,26 gal) of water heated to 1000^0 C (1832 F)	generates 5800 litres (1532 gal) water vapour

Source material:

SINTEF *– Norwegian Fire Research Laboratory*

FIG. 2 EVAPORATION water-droplets

Example:
A drop travelling at a velocity of 18 m/s (40 mph) takes 0, 27 sec. to pass through a fire zone of 5 metres (16 feet).

- Only a very few drops delivered from a conventional nozzle will evaporate in 0, 27 sec. even with fire temperatures up1000 ^{O}C (yellow markings indicate the evaporation)

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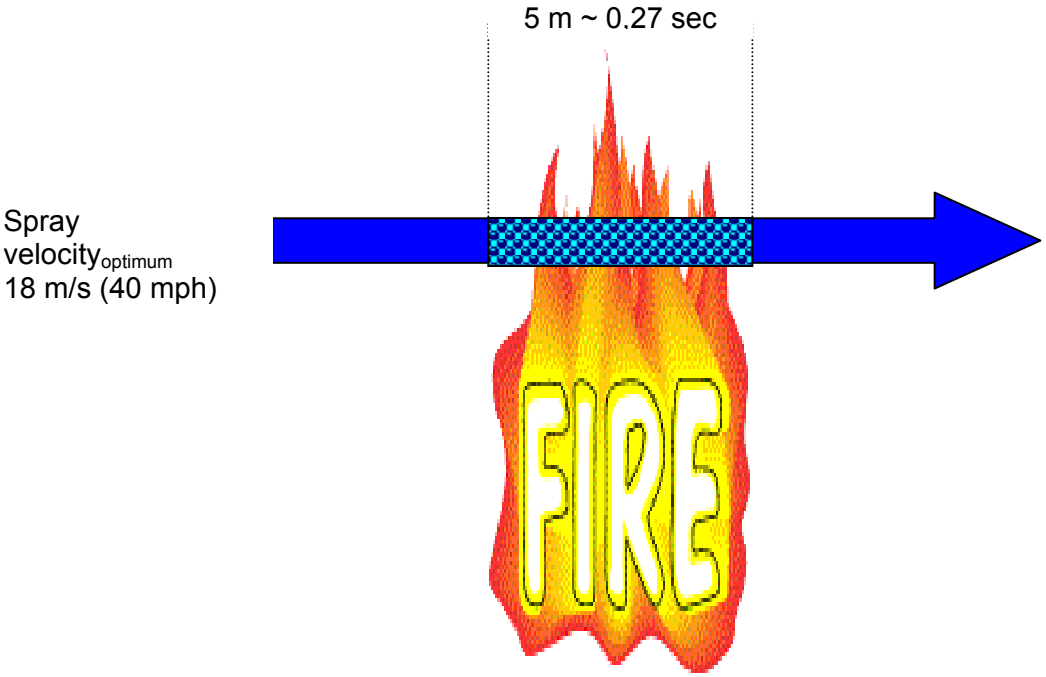
- With the micro-drop nozzle evaporation already starts at 200 ^{O}C. 100% of the drops have evaporate in 0,27 sec. at 600 ^{O}C (yellow markings indicate the evaporation)



Variation of Lifetime of Droplets (T_{live} seconds) With Temperature:

	Conventional water-fog nozzle 1000-100 (µm)	**Firexpress micro-drop nozzle** 100-7 (µm)
ΔT (^{0}C) – (^{0}F)	**T_{Live}**	**T_{Live}**
200 – (392)	8,0 – 0,8 s	0,80 – 0,080 s
300 – (572)	5,3 – 0,53 s	0,53 – 0,053 s
400 – (752)	4,0 – 0,4 s	0,40 – 0,040 s
600 – (1112)	2,6 – 2,6 s	0,26 – 0,026 s
800 – (1472)	2,0 – 0,2 s	0,20 – 0,020 s
1000 – (1832)	1,6 – 0,16 s	0,16 – 0,016 s

Source material: National Research Council Canada, Research report: RR 124 (December 2002)