Watermist – State of the Art Technology

IWMA Seminar
19th January 2014
Dubai, UAE

By Alex Palle, VID Fire-Kill, Denmark
Agenda:
1) Introduction to VID Fire-Kill.
2) What is a fire.
3) What is Watermist and how does it fight fires.
4) How to accept Watermist and where can it then be applied.
5) Some Watermist Benefits and Limitations.
1. VID Fire-Kill

- In-house Production and Testing
- Covering most applications found on - and offshore
- World wide Player
- Low Pressure, low flow
- Environmentally friendly solutions
- Smart Designs
- Tested and Approved
2. What is a Fire?

Air: 21% O₂ + 78.8% N₂ + ?
Fuels: Carbon + Hydrogen + ?

Energy to Fuel (heat)

Pyrolysis process
Fuel => Pyrolysis gasses
Example: CH₄

Energy to Pyrolysis gas + Atmosphere => Oxidation process

Fire example:
CH₄ + 2O₂
=> 2H₂O + CO₂ + E

1 kg O₂ => 13,000,000 joule
1. Pyrolysis gasses are created.
2. Oxidation process happens.
3. Energy is released (seen as flames).
As more heat will create more pyrolysis gasses, a fire will grow exponential until there is no more O2 or fuel. This creates the big risk of fat fire spread (flashover).
3. What is Watermist and how does it fight fires?

Watermist consist of small water droplets. Water is:

\[ \text{H}(1) \quad \text{O}(16) \quad \text{Mole} \]

\[ \text{H}(1) \quad 18\text{g} \]

Phase change

1 mole Water + 47000 Joule

=> 1 mole Steam

- Water = Liquid H\(_2\)O
- 1 mole Water Vo=18 ml
- Steam = Gas H\(_2\)O
- 1 mole steam V\(_o\) =0,0224m\(^3\) (0°C, 1 bar) = 22,4l steam
What is watermist?

**NFPA**
By definition, water mist is a water spray for which the 99% of the total volume of liquid (Dv0.99) is in droplets of diameter smaller than 1000 microns at the minimum design operating pressure of the water mist nozzle.

**Europe**
By definition, water mist is a water spray for which the 90% of the total volume of liquid (Dv0.90) is in droplets of diameter smaller than 1000 microns at the minimum design operating pressure of the water mist nozzle.

Watermist can perhaps also be seen as a way to develop new optimized products without having to follow existing product approval standards. E.g. minimum requirements for sprinkler orifices and water density inhibits sprinkler to use less water.
How is watermist created?

The small droplets are created with specially designed nozzles at a certain water pressure. Nozzles exist in many forms:

- Automatic Nozzle (glassbulb type)
- Open Nozzle (deluge type)
- Special Nozzle (pop-up type)

However the Water pressure and droplets size alone does not determine the performance of a watermist system, only fire – and component tests does.
How does watermist fight fires?

Focus on pyrolysis process

Blow away pyrolysis gasses => blow fire out

Cooling fuel => reducing the pyrolysis gas production
Focus on oxidation process

How is does watermist fight fires?

Focus on oxidation process

Cooling oxidation process => slow down process

Reduce oxygen concentration => reduce heat output

Inert gasses from fires

Oxidation processes connects atm.oxygen to hydrogen and carbon from fuel, nitrogen remains in atmosphere => CO2, H2O (combustion) + N₂ + Water Steam (inert gas) = Inert gasses reduces O₂ % in the vicinity of oxidation processes. => making it harder for the oxidation process to run
Watermist on fires

Water mist spray primarily fight fires by cooling chemical processes and inerting ambients of oxidation processes.

=>

1. Water mist is **most** effective in locations with
   1. Large fires => large steam production
   2. High heat => Large steam production & little steam condensation
   3. Enclosures => Reduced oxygen supply => fast oxygen depletion
   4. Little ventilation => increased oxygen depletion effect.

2. Water mist spray **primarily** fights fires by
   1. Cooling pyrolysis processes
   2. Inverting ambients where the oxidation processes occur.

3. Water Mist sprays **may** in some situations be applied to blow fires out.
4. How to accept Watermist and where can it then be applied.

Notifying Body Approval / Official Approval.

Examples

- FM5560: US light Hazard (EU OH1), machinery rooms/tubines,
- UL2167: Residential areas, LH, OH1.
- VDS: Hotels, Offices, car parks, cable tunnels,
- LPS1283: Hotel, offices.
- Etc.

Testing to an application.

Examples

- CEN/TS 14972 Appendix B.
- Fire test "demonstrations"
Example - FM5560 "HC1"

Approval process:
- Fire tests
- Component tests
- Design manual approval
- Production facility approval
- Periodically follow-up (4 times per year)

Limitations:
- 5m ceiling height.
- Pendent automatic nozzle
- Sidewall only for small compartments.
- Flat ceilings (less than 8.3%)
Example - FM5560 "HC1"

**Scope (well defined):**

- Apartments
- Atriums
- Churches
- Concealed spaces
- Gymnasiums
- Hospitals and hospital laboratories*
- Hotel rooms
- Institutions
- Kitchens
- Libraries*
- Meeting rooms in convention centers and hotels
- Metalworking shops with nonhydraulic cutting operations
- Mineral processing such as: glass, cement, ore treating, gypsum processing, etc.
- Museums
- Nursing or convalescent homes
- Offices
- Restaurant seating areas
- Schools and universities classrooms
- Unused attics

* = additional limitations.

**Final proof – an approval certificate:**
Example – CEN/TS 14972 annex B

Scope (limited)
The Application / scenario tested.

Verification process:
- Fire tests conducted in ISO17025 acc. test lab
- Production facility shall be ISO9001.
- AHJ often involved from beginning.

Limitations:
The results do only reflect exactly what tested.

Process to develop a fire test standard

1) Operating temperatures
2) Water flow
3) Water distribution
4) Water droplet size
5) Functional tests
6) Strength of nozzle body
7) Strength of release element
8) Leak resistance
9) Heat exposure
10) Thermal shock
11) Stress Corrosion
12) Salt spray corrosion
13) Moist air exposure
14) Water hammer
15) Dynamic heating (RTI, C)
16) Resistance to heat
17) Resistance to
18) Impact Test
19) Lateral discharge test
20) Thirty-day leakage test
21) Vacuum test
Wooden Church, Norway:
-Large and high open space with low fuel loads (sofas, benches) placed at floor. Fire spread risk high due to all wood.
-Heated and unheated areas with natural ventilation.
-Ceiling painting not to be destroyed by installation or water spray
-Authority was fire brigade.
System chosen: SPECIAL WATERMIST SYSTEM tested to the application

Example – CEN/TS 14972 annex B

<table>
<thead>
<tr>
<th>Length (L):</th>
<th>unlimited</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (H):</td>
<td>unlimited</td>
</tr>
<tr>
<td>Width (2xD)</td>
<td></td>
</tr>
<tr>
<td>Type A</td>
<td></td>
</tr>
<tr>
<td>Type B</td>
<td>max. 16m</td>
</tr>
<tr>
<td>Type C</td>
<td>max. 20m</td>
</tr>
<tr>
<td>Type D</td>
<td>max. 26m</td>
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<tr>
<td>Nozzle wall height (B):</td>
<td>3.5m – 7m</td>
</tr>
</tbody>
</table>
Test scenarios from test method designed in accordance to CEN/TS 14972 Annex B.
Example – CEN/TS 14972 annex B

Test 1:
No system

VID

fire-kill
www.fire-kill.com
Example – CEN/TS 14972 annex B

Test 2:
Sprinkler ref. Test
5 l/min/m²
0,6 bar
3.7m spray
Example – CEN/TS 14972 annex B

Test 3:
WM system:
2 l/min/m²
6 bar
10m spray
Example – CEN/TS 14972 annex B

Scope:
Church main hall floor and wooden walls with no large obstructions hanging in the air and with main fuel load being wooden chairs, benches with upholstery.

Design limitations:
- Horizontal installed zoned deluge system activated with electrical detection system not being slower than 2 min from a 0.25MW fire.
- Installation height: 4 -7m
- Minimum zone size: 13m x Ym
- Minimum zones to activate: 3 (4)

Final proof – a test report and perhaps witness letter:
5. Some Watermist Benefits and Limitations.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Optimization of water use which gives many other benefits such as smaller reservoirs, less water damage, smaller system dimensions, etc.</td>
<td>- Can only be used in applications and scenarios where realistic tested and where approved to.</td>
</tr>
<tr>
<td>- Posibility to create &quot;special&quot; products for the industry which otherwise could not be accepted and used.</td>
<td>- More caution is needed when treating the systems as less experience is available.</td>
</tr>
<tr>
<td>- Good fire performance which is proven in actual fire tests.</td>
<td>- Knowledge on test standards, design codes, and system design manuals are needed to work with watermist therefore more time is required to use watermist.</td>
</tr>
<tr>
<td>- Safety factor inbuilt for fires in enclosures – the larger the fire the better the system perform.</td>
<td></td>
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</tbody>
</table>
Thank you for your attention.

The full presentation including videos can be requested on sales@vidaps.dk