

The Current and Future Applications of Water Mist Fire Suppression Systems

SFPE Atlanta Symposium

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The Current and Future Application of Water Mist Fire Suppression Technology

- ◆ ***Are water mist systems a myth ?***
- ◆ ***Who buys-sells-designs-installs them ?***
- ◆ ***What kind of engineering issues are involved ?***
- ◆ ***Future directions ?***



Order of presentation

- 1. Introduction & Fundamentals (20 min)***
- 2. Types of Water Mist Systems and Equipment (15 min)***
- 3. Codes, Standards, Test Protocols (15 min)***
- 4. Future directions (10 min)***
- 5. Discussion, questions (10 min)***



Is Water Mist a myth?

- ***Aquamist (Tyco)***
- ***Chemetron (USA)***
- ***Fike (USA)***
- ***Fogtec (Germany, global)***
- ***Marioff (Finland, now UTC)***
- ***Securiplex (Global, USA)***
- ***Semco***
- ***Ultrafog***
- ***Victaulic Co. of America***
- ***Aquasys (Germany)***
- ***Minimax, Germany***
- ***Eusibi (Italy)***
- ***Kidde Italia***
- ***Kidde Fenwal***
- ***Wormald, UK***
- ***Viking Australia***
- ***Others ...***
- ***Apparently not a myth***



Where water mist systems are used

- ***Marine***
 - ***Cruise ships*** – all accommodation, storage and public spaces
 - *Navy - Machinery spaces; total flooding and local application*
 - *Not used on cargo ships (CO₂)*
- ***Petroleum Industry***
 - *Oil production – process modules, turbine enclosures*
- ***Heritage buildings***
 - *Heritage hotels; art galleries, archives, museums historic buildings*
- ***Transportation***
 - *Madrid Metro (Europe)*
 - *Road tunnels (Europe)*



Fundamentals



Water Mist Systems

- ◆ ***are water-based fire extinguishing systems***
- ◆ ***are similar to sprinkler and water spray systems, but ...***
 - *... use less water for equivalent performance*
 - *... may be used to replace gaseous agents*



Extinguishing Mechanisms

- ◆ ***Oxygen displacement by water vapor***
- ◆ ***Flame cooling***
- ◆ ***Blocking of radiant heat***
- ◆ ***Pre-wetting of combustibles***
- ◆ ***Other***



Reduce droplet size to improve efficiency

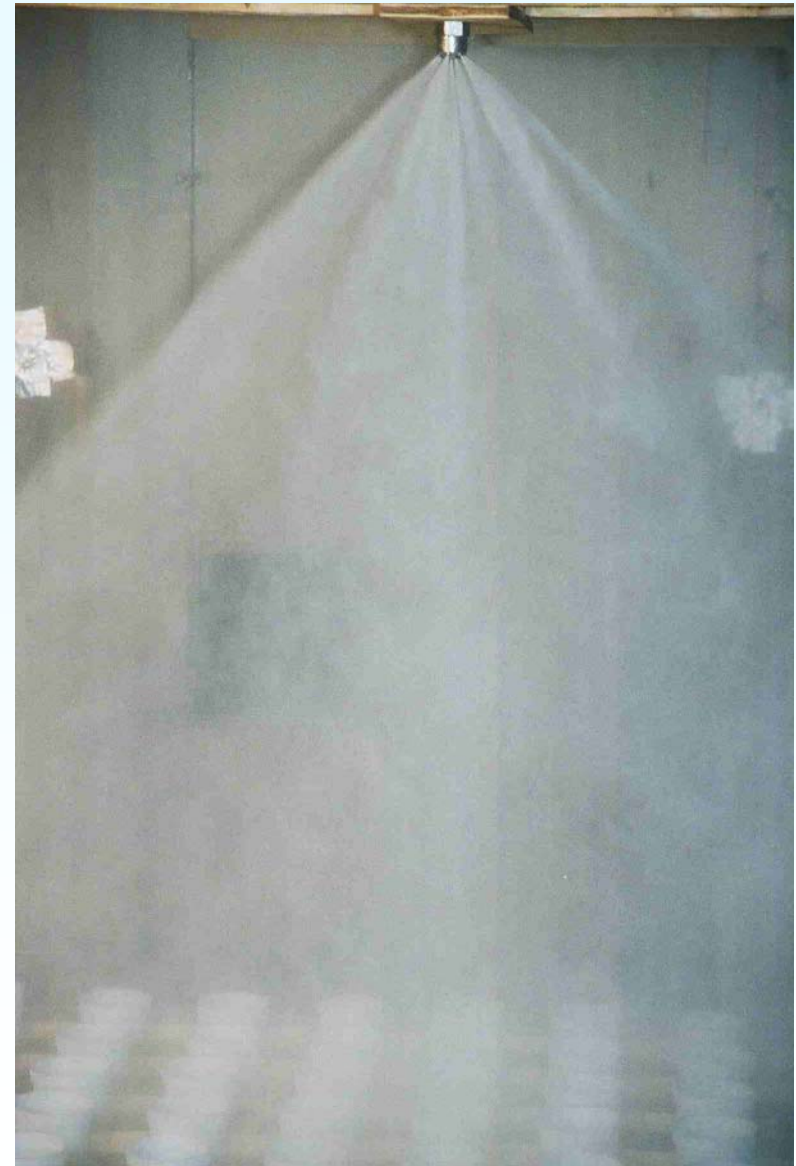
- ◆ ***Smaller drops evaporate faster than larger drops***
- ◆ ***More mass of water evaporates***
- ◆ ***More heat is extracted from the fire energy***
- ◆ ***More water vapor is formed displacing more oxygen***
 - *... than sprinkler sprays*
 - *... per gallon (liter) of water discharged.*



Characteristics of fine water sprays

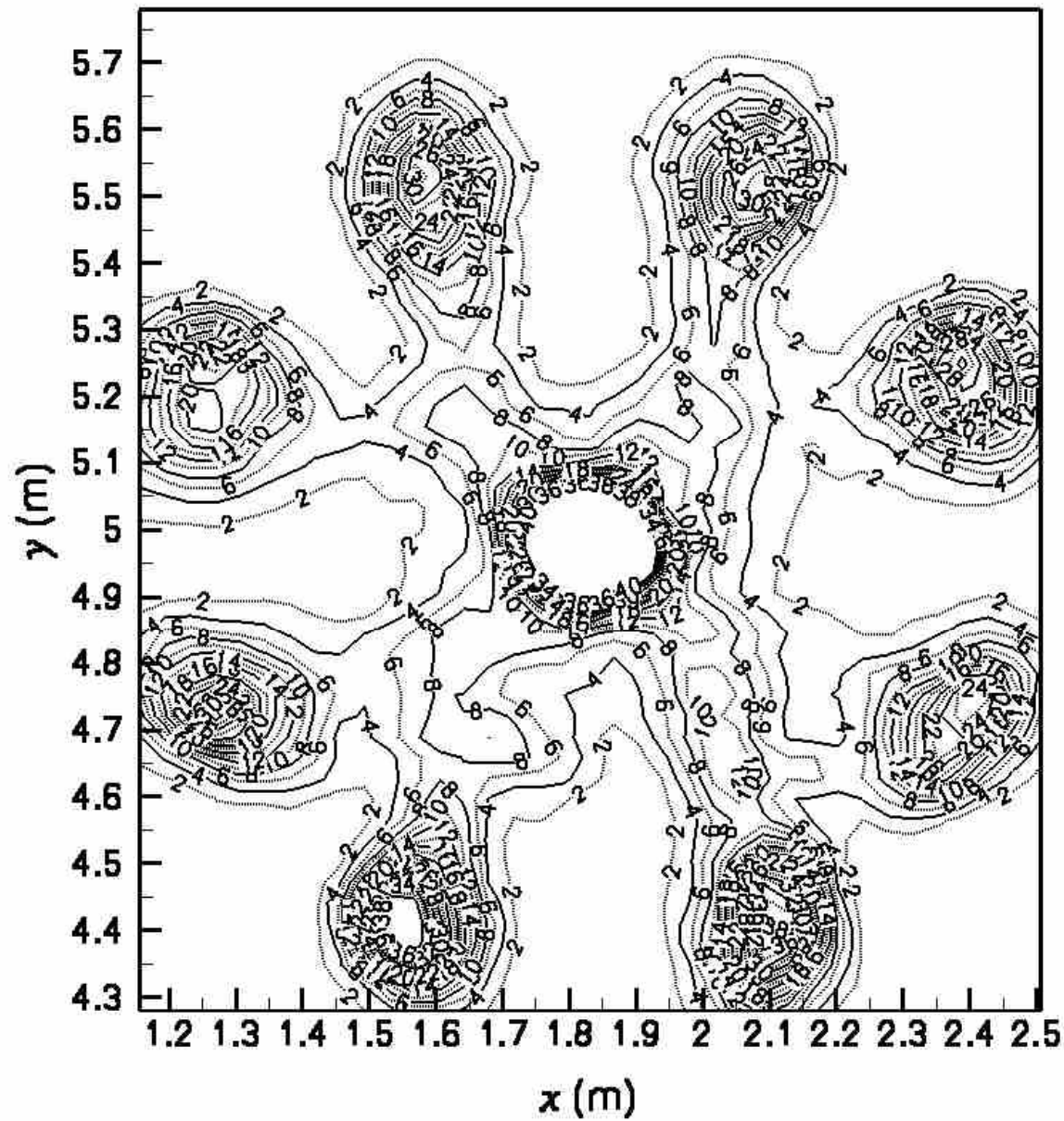
- ◆ ***Drop size distribution***
- ◆ ***Spray velocity and spray momentum***
- ◆ ***Discharge rate***
- ◆ ***Spray momentum (mass x velocity)***
- ◆ ***Directional aspects (cone angle, orientation)***





Water mist nozzle spray characterization – flux distributions





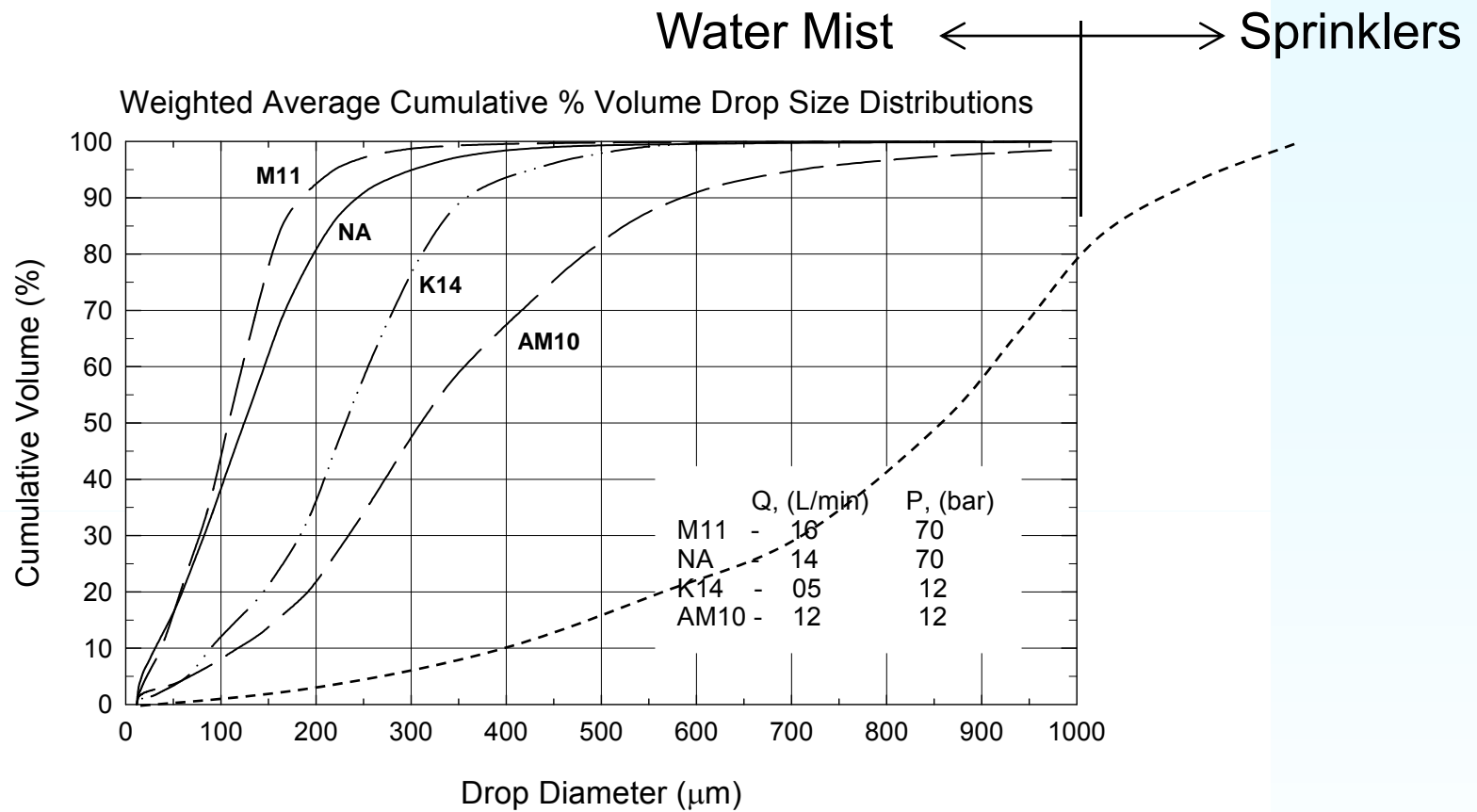
Flux Density Distribution

Contour Plot

$L/\text{min}/\text{m}^2$

(Entrainment between fingers)





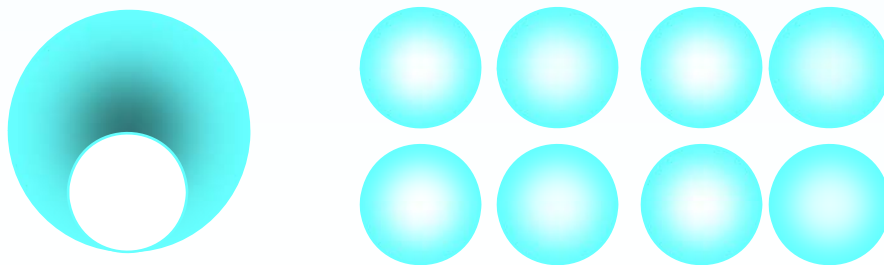
Water mist has drop size distribution with 99 % of volume of the spray contained in drops 1-mm or smaller

Sprinkler sprays range: $Dv_{90} = 2,000$ microns +



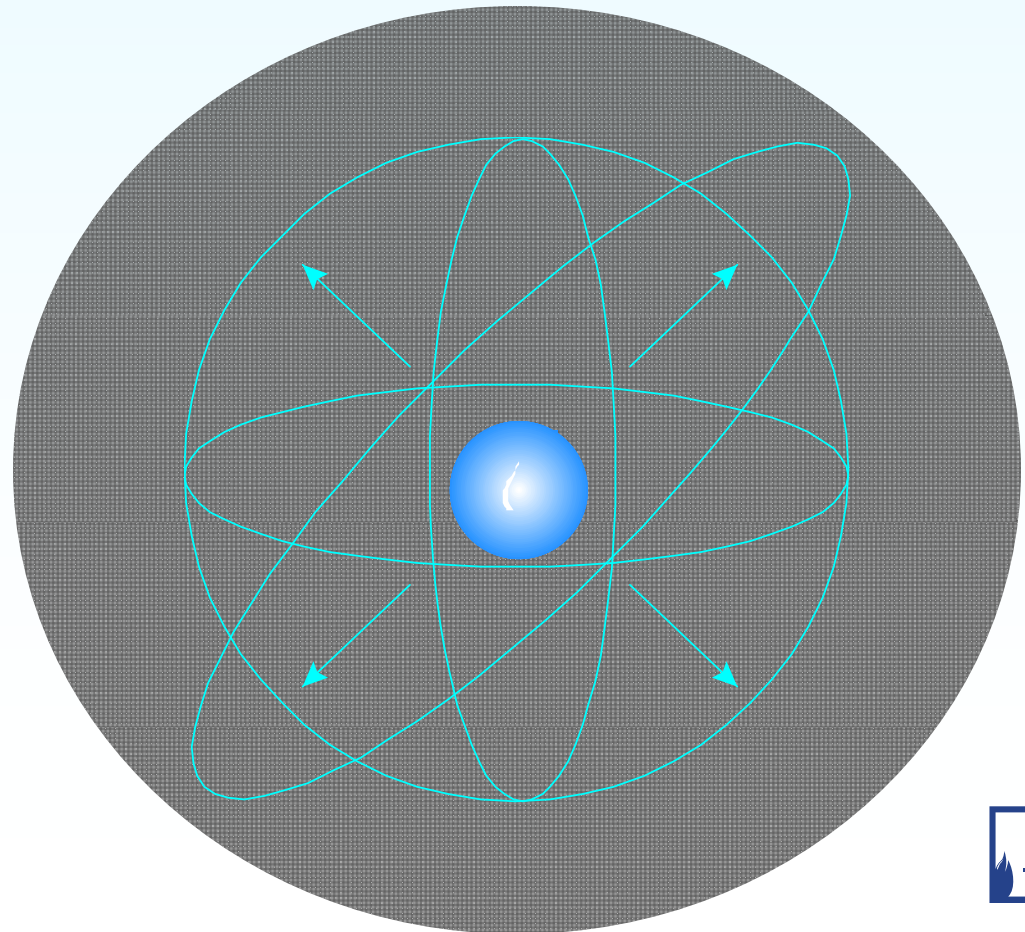
Heat Absorption

- The **rate** of heat absorption is a function of surface area of the droplets
- The **quantity** of heat absorbed is a function of the mass of water that is heated or vaporized
- For a given mass of water:
- $\frac{1}{2}$ the diameter = **twice** the total surface area of the droplets

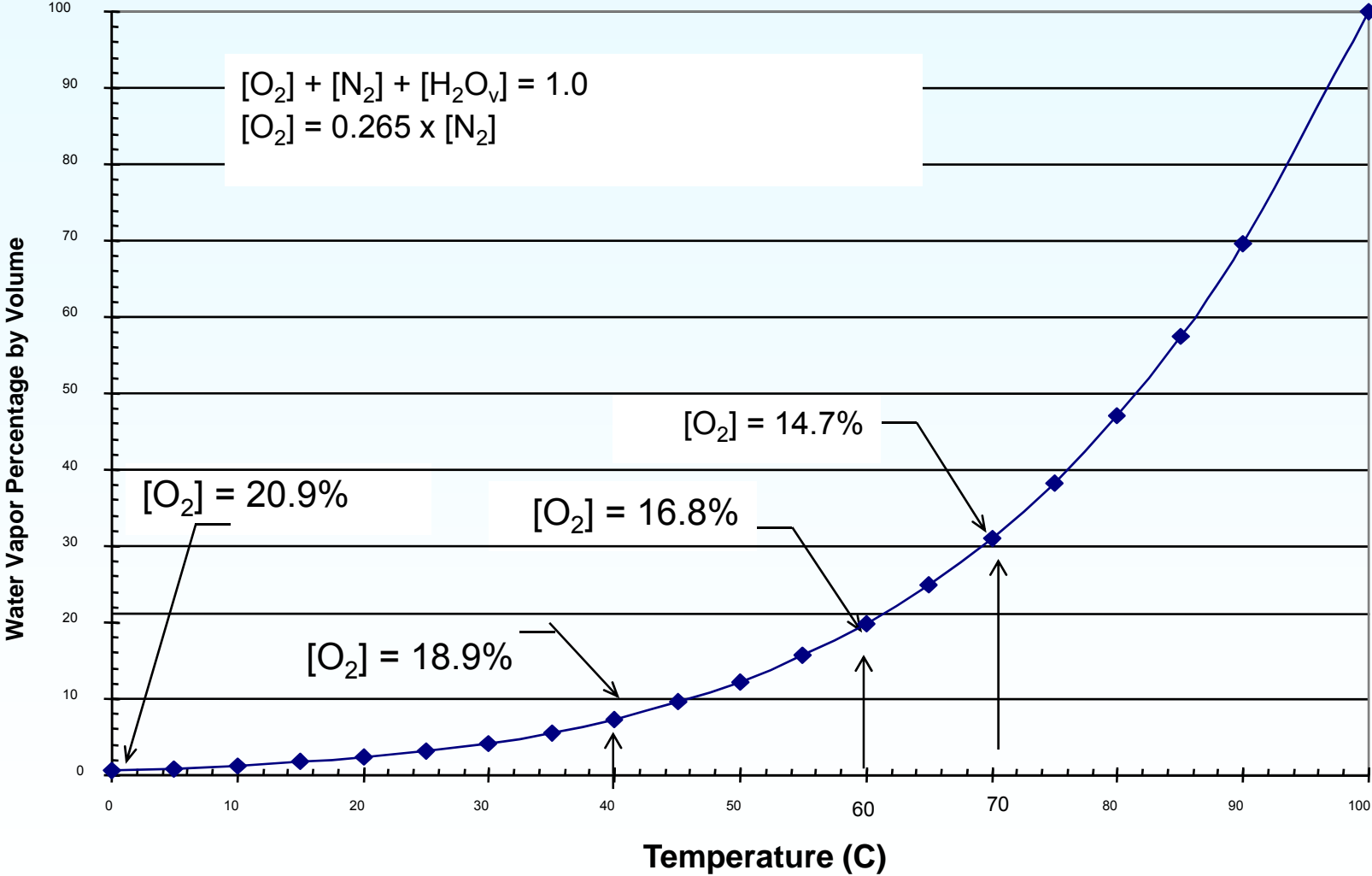


Vapor generation

- *When water vaporizes, it displaces air equivalent to over 1,600 times its original volume*



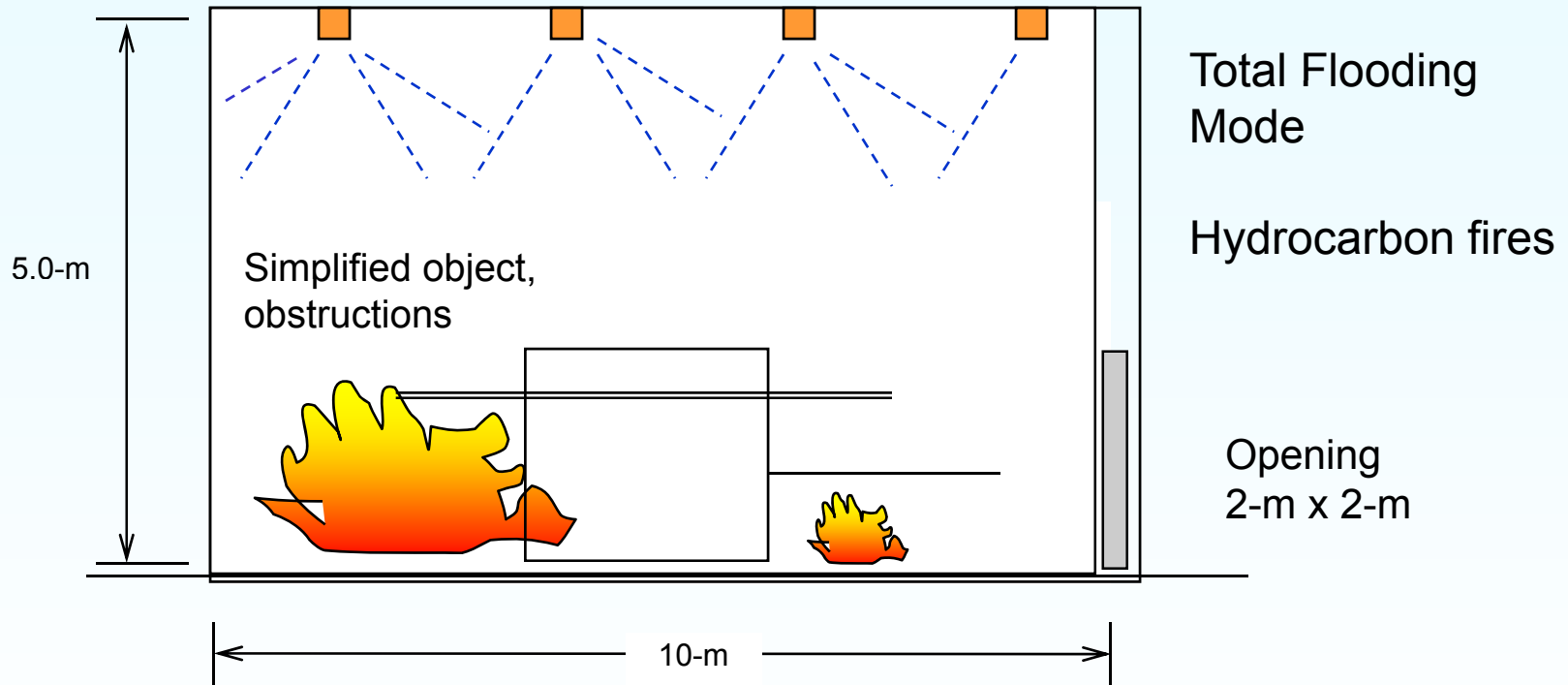
Oxygen displacement by water vapor



Psychrometric chart: vapor concentrations at saturation



Confine heat and water vapor in compartment



IMO: Extinguishment by Oxygen Depletion in 15 minutes or less

$$[O_2] \downarrow = 1.00 - [CO_2] \uparrow - ([N_2a]) \uparrow - [H_2Ov] \uparrow$$



Applications of Water Mist Nozzles

- ***Class B - Flammable Liquids***

- ***Oxygen Displacement to less than 15 %***
- ***Cooling fuel below flash point***
- ***Radiation attenuation, block thermal feedback***
- ***Gaseous agent replacement***

- ***Class A - Sprinkler Equivalent***

- ***Surface Wetting***
- ***Oxygen depletion < 10 %***
- ***Cooling gases***
- ***Attenuation of radiation to unburned fuel surfaces***
- ***Same as sprinklers, but with less water***



Methods of Generating Water Mist

Flame cooling



Types of Water Mist Nozzles

- **Impingement Type**

- A jet of water (e.g. 3-mm diameter) strikes against a deflector surface and breaks up into small particles

3-mm orifice



**Tyco – AM10
Impingement Type**

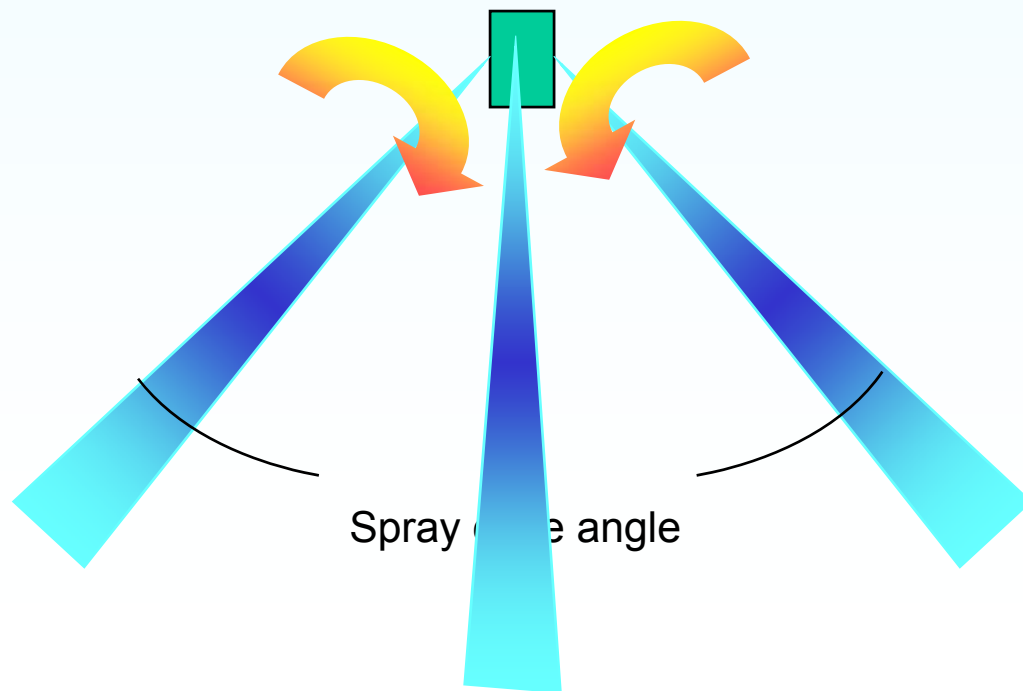


Types of Water Mist Nozzles

- **Pressure Jet Type**

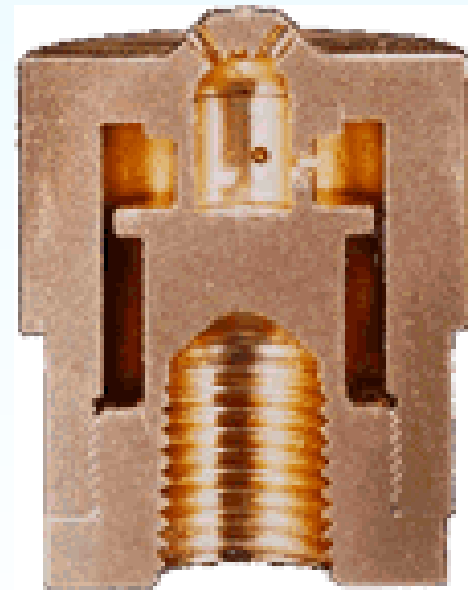
- A group of jets of water at high velocity break up into fine droplets

Entrainment of ceiling gases



Types of Water Mist Nozzles

- ***Twin Fluid Type***
 - *A stream of compressed gas is forced into a stream of water, causing shearing and break up into small drop sizes*
 - *Can use low pressure water*



Examples of Open and Automatic Nozzles



Impingement type (intermediate pressure)



***Pressure jet
2.5 mm fast response***



***Pressure jet
Open***



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