EFFECT OF WATER MIST SYSTEM ON CONTROLLED FIRE

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OBJECTION

• Replicate water mist system in FDS accurately

• Achieve best distribution (uniform) of water vapour in enclosure

• Measure water concentration at representative spot in enclosure

• Investigate effect of water mist on flame (HRR reduction/ extinguishment)
Particle Image Velocimetry (PIV)

- Pattern recognition technique
- Laser illuminates a thin sheet in spray and takes two images within short intervals
- Movement of droplets by comparing pixel intensity of the two frames

Images from:
“Experimental measurements of water mist systems and implications for modeling in CFD” Bjarne Paulsen Husted (2007)
REFERENCES TO PAST WORK (PIV RESULTS - VELOCITY MEASUREMENTS)

(i) "Experimental measurements of water mist systems and implications for modeling in CFD"
Bjarne Paulsen Husted (2007)

(ii) "Comparison of PIV and PDA droplet velocity measurement techniques on two high pressure water mist nozzles"
Bjarne Paulsen Husted, Per Petersson, Ivar Lund, Göran Holmstedt

Distance from nozzle (mm)

<table>
<thead>
<tr>
<th>Distance (mm)</th>
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<tbody>
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<td>25</td>
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W-VELOCITY (VERTICAL)

Investigating past attempt to improve accuracy of water mist simulation (method replicated)

Previously had challenges validating velocity profiles

1. Plain

1. With Air Inlet
   - 80 x 80mm
   - $0.045m^3/s$

2. With Air Inlet & Turbulence Mesh
   - two obstruction layers (1 cm blocks)
   - 80 x 80mm each
W-VELOCITY (VERTICAL)

Momentum lost
TURBULENCE RESOLUTION

Investigating degree of turbulence captured in simulation (LES)

Measure of Turbulence Resolution, MTR

\[
MTR = \frac{k_{subgrid}}{k_{LES} + k_{subgrid}}
\]

- Ideally should be 0
  - Turbulence fully resolved by LES (DNS)
- LES to resolve 80% of total turbulence
SIMULATION

ISO Fire Cell Scale
- Quarter (0.8 x 1.2 x 0.8m)
- Third (0.6 x 0.9 x 0.6m)

Nozzle distance from opening
- 20 cm
- 30 cm
- 40 cm
- 50 cm
- 60 cm
SIMULATION

Regions of acceptable magnitude (threshold value of $5 \times 10^{-5}$)

- Accumulated Mass Per Unit Area (AMPUA)
- 21 device measurements exceed
- Total of 187

Overall: 11%
**SIMULATION**

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<th>Nozzle distance from opening (cm)</th>
<th>ISO Fire cell scale</th>
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<tr>
<td></td>
<td>Quarter</td>
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Max distance limited by:

- Physical setup (hood & extreme nozzle position)  
  ≈ 100 cm
- “Opening width” vs “Spray width”  
  ≈ 60 cm