SENSITIVITY ANALYSIS OF THE DESIGN OF LARGE SCALE FIRE CALORIMETER FOR FIRE SAFETY ENGINEERING RESEARCH AND EDUCATION

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INTRODUCTION

• Fire disaster is a major concern in urban areas
• If not properly controlled and suppressed, will easily spread
INTRODUCTION

<table>
<thead>
<tr>
<th>Compact Large Scale Fire Calorimeter</th>
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</table>

**Motivation:**  
Various fire phenomena to observe  
Optimization of space utilization

<table>
<thead>
<tr>
<th>Space Utilization:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 7 m Length</td>
</tr>
<tr>
<td>- 14 m Wide</td>
</tr>
<tr>
<td>- 8 m Height</td>
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**Fires Phenomenons:**  
Pool Fires  
Room Fires  
Fire Spread to adjacent object  
Fire spread to vertical direction

Based on ISO 9705, ROOM/CORNER TEST
INTRODUCTION
INTRODUCTION

• Safety & Security Aspect
OBJECTIVE

To analyze the flow capacity of exhaust fan effect on smoke spread, with variation of fire load including:

1. Smoke Distribution
2. Gas Temperature
3. Gas Velocity
PHYSICAL MODEL

- Hood size : 5 x 5 m
- Ducting size : 0.6 x 0.6 m
- Hood height : 3.5 m
- Volume flow of Exhaust Fan :
  3.33 m³/s
  6.66 m³/s
SIMULATION SETUP

• Using Fire Dynamic Simulator of NIST version 6.0.

<table>
<thead>
<tr>
<th>Case</th>
<th>Fire Load (kW)</th>
<th>Volume Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>750</td>
<td>3.33, 6.66</td>
</tr>
<tr>
<td>2</td>
<td>1000</td>
<td>3.33, 6.66</td>
</tr>
<tr>
<td>3</td>
<td>2000</td>
<td>3.33, 6.66</td>
</tr>
<tr>
<td>4</td>
<td>3000</td>
<td>3.33, 6.66</td>
</tr>
<tr>
<td>5</td>
<td>4000</td>
<td>3.33, 6.66</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSIONS

After the simulation has been done, the data analysis can be conducted like the comparison of smoke production, the velocity of smoke movement, and the formed gas temperature. Also, Correlation between the mechanical exhaust rate and plume entrainment rate for keeping the smoke layer interface at a certain height under a steady burning fire will be analyzed.
Smoke Distribution

Smoke distribution of 750 kW for 3.33 m³/s flow

Smoke distribution of 750 kW for 6.66 m³/s flow
Smoke Distribution

Smoke distribution of 1000 kW for 3.33 m³/s flow

Smoke distribution of 1000 kW for 6.66 m³/s flow
Smoke Distribution

Smoke distribution of 2000 kW for 3.33 m³/s flow

Smoke distribution of 2000 kW for 6.66 m³/s flow
Smoke Distribution

Smoke distribution of 3000 kW for 3.33 m$^3$/s flow

Smoke distribution of 3000 kW for 6.66 m$^3$/s flow
Smoke Distribution

Smoke distribution of 4000 kW for 3.33 m$^3$/s flow

Smoke distribution of 4000 kW for 6.66 m$^3$/s flow

3.33 m$^3$/s results are always thicker than 6.66 m$^3$/s
Gas Temperature

Gas temperature of 750 kW for 3.33 m³/s flow

Gas temperature of 750 kW for 6.66 m³/s flow
Gas Temperature

Gas temperature of 1000 kW for 3.33 m³/s flow

Gas temperature of 1000 kW for 6.66 m³/s flow
Gas Temperature

Gas temperature of 2000 kW for 3.33 m³/s flow

Gas temperature of 2000 kW for 6.66 m³/s flow
Gas Temperature

Gas temperature of 3000 kW for 3.33 m³/s flow

Gas temperature of 3000 kW for 6.66 m³/s flow
Gas Temperature

Gas temperature of 4000 kW for 3.33 m$^3$/s flow

Gas temperature of 4000 kW for 6.66 m$^3$/s flow
In volume flow of exhaust fan 3.33 m³/s, the highest gas temperature created is in the 4 MW heat release rate. In the same condition, the highest gas temperature in volume flow 6.66 m³/s also in the 4 MW heat release rate.
Gas Velocity

Gas velocity of 750 kW for 3.33 m³/s flow

Gas velocity of 750 kW for 6.66 m³/s flow
Gas Velocity

Gas velocity of 1000 kW for 3.33 m³/s flow

Gas velocity of 1000 kW for 6.66 m³/s flow
Gas Velocity

Gas velocity of 2000 kW for 3.33 m³/s flow

Gas velocity of 2000 kW for 6.66 m³/s flow
Gas Velocity

Gas velocity of 3000 kW for 3.33 m³/s flow

Gas velocity of 3000 kW for 6.66 m³/s flow
Gas Velocity

Gas velocity of 4000 kW for 3.33 m³/s flow

Gas velocity of 4000 kW for 6.66 m³/s flow

3.33 m³/s results are always slower than 6.66 m³/s
CONCLUSION

- There are many connection between fire load and volume flow of exhaust fan.
- The maximum value of heat release rate that is applied into the hood is about 2 MW.
- Smoke distribution in the hood is safe because it still could be extracted by both 3.33 m³/s and 6.66 m³/s exhaust fan.
- The gas temperature must be concerned because it would affect the work of exhaust fan.
- The smoke stacking phenomenon would influence of the gas flow rate in the hood.
THANK YOU