HVAC Design Experiment

The University of Tennessee at Chattanooga
ENCH 4350L

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please put date
Outline

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  - Design Approach
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Introduction

• Problem Statement: The distillation control room of EMCS 120 receives poor ventilation

• Higher temperatures and ventilation problems have been noted

• There is a need for better ventilation and cooler air supply to the laboratory 2nd floor
Experiment Goals

• Design an HVAC system to increase ventilation and lowering control room air temperature
Design Experiment Approach

• Employ fundamental Engineering Design Methodology

1.) Conceptual
2.) Preliminary
3.) Final

Is this word necessary?

Please clarify.

Please make clear the purpose of this image.
HVAC Theory

• Process by which fresh air is introduced, and contaminated air is removed

• Two Design Essentials:
  1.) Provision of cool fresh air to occupants
  2.) Change air in room to remove contaminates
The text reads:

Theory (cont’d)

- Starting point: Standard air ventilation rates

1.) Air change per hour (ACH)
   \[ ACH = \frac{Q}{V_{\text{room}}} \quad \text{(cfm/cf)} \]

2.) Fresh air supply rate per person (ACP)
   \[ ACP = \frac{Q}{\text{person/time}} \quad \text{(cfm/person/min)} \]
Professional HVAC Design Standards

- ASHRAE & IMC: Acceptable indoor air quality

<table>
<thead>
<tr>
<th>Occupancy Category</th>
<th>Air Exchange Rate (Cfm/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IMC</td>
</tr>
<tr>
<td>Educational Classroom</td>
<td>15</td>
</tr>
<tr>
<td>Public Assembly Facility</td>
<td>15</td>
</tr>
<tr>
<td>General Office Space</td>
<td>20</td>
</tr>
<tr>
<td>Hotel, motel, and resort lobbies</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 1: Typical Air Exchange Standards

Please don't change type fonts unless you have some purpose.
Theory – Humidity Considerations

• Relative Humidity: Water-holding capacity of air

\[ H_R = \frac{p_{H_2O}}{p^*_{H_2O}} \times 100 \]

• Temperature Dependence:

\[ \frac{dp^*}{dT} = \frac{\Delta H}{\Delta VT} \]

• HVAC perspective: Humidity = Undesirable
Relative Humidity Sub-Experiment

- Temperature and Humidity Measurements taken in 1st and 5th floor stairwell heights

- Comparison

- Effect of rising less-dense hot vs. dense cooler air distribution
Experiment - Deliverables

• Use bottom 1st floor lower temperatures to supply ventilation to 2nd floor

• Measure control room and design dimensions

• Measure necessary ventilation design variables

• Apply HVAC theory and standards to measured data to develop a preliminary design
Not helpful diagrams but meaningful pictures etc. please use more informative your description is weak.
Experiment - Equipment
## Experiment - Data

### Floor 1 (Inflow): Average T and H%

<table>
<thead>
<tr>
<th>Avg. Temp. (°F)</th>
<th>66.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Relative H (%)</td>
<td>44.2</td>
</tr>
</tbody>
</table>

### Floor 2 (Outflow): Average T and H%

<table>
<thead>
<tr>
<th>Avg. Temp. (°F)</th>
<th>71.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Relative H (%)</td>
<td>38.37</td>
</tr>
</tbody>
</table>

\[ \Delta T = 5.3 \, ^\circ F \]

- Control Room Volume: \[ V_{\text{room}} = L \times W \times H = 4252 \, \text{Ft}^3 \]
Experiment – Data Representation

• (Temperature and RH plot against time)

What will be the purpose of this for your design assignment?
HVAC Design Analysis

- Determination of design flow rate
  \[ Q = ACH \cdot V_{room} \]
  \[ = (10/\text{hr})(4252\text{Ft}^3)/60\text{min} \]
  \[ = 1063 \text{Ft}^3/\text{min} \]

- Required air velocity
  \[ V = V \cdot A \]
Analysis (cont’d)
HVAC Design Results

• Design requirements
  - Input power
  - Fan Selection: centrifugal / squirrel cage

• Design Architecture
  - Dimensions, Physical layout

• Embodiment
  - Ductwork
  - Acoustic analysis
Further Needed Experiments
Applications in Chemical Engineering
Conclusions
Questions/Comments