Displacement Ventilation for an Industrial Production Hall: Saving of Energy, Improvement of Air Quality

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• Overview
• Problem/ Initial situation
• Alternative concepts
• Cost-benefit analyses
• Summary
Building data

- assembly hangar (165m x 90m x 8.6m)
- gearing manufacturer
- designed in 1979
- 280 workers

Ventilation system

- supply and exhaust air
- seven supply units
- five extract units
- several local exhaust systems
Problems

- Too hot in the summertime
  - employees complain about very high room temperatures
  - in the warm season more than 30°C

- Bad air quality
  - smoke
  - aerosol
  - smell
Ventilation data

- air volume rate: 625 000 m³/h
- air change rate: 5 1/h
- running time: 4680 h/a

Supply air

- 50 swirl outlets arranged under the ceiling
- 12 m distance between 2 outlets
- heating units and filters
- no cooling
- 100% external air (also in winter)

Exhaust air

- ducts with inlets under the ceiling
Heat sources
Hear emission generated by
- people 34 kW
- machinery 268 kW
- lighting 208 kW

Internal cooling load
510 kW → 34 W/m²
Controlling of the air flow pattern/ fog
Controlling of the airflow pattern

- horizontal emission of supply air
- temperature of supply air = hangar air temperature
- short circuit

→ More or less fresh air in the working area
Requirements

Improvement of the

• thermal situation
• air quality

in the working area

No restriction of the process flow by the ventilation system

→ little space required for air ducts, inlets and outlets
→ no limitation of the indoor crane
Solution 1: move Supply air outlets

Evaluation:
- fresh air in the working area
- good ventilation
- draft
- no cooling effect
- backflow of air pollutants
Solution 2: Installation of cooling elements

Evaluation:

- decrease of air temperature
- no draft

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- large spaces are necessary (600 elements)
- no ventilation effect
- backflow of air pollutants
Solution 3: Supply air outlets at the ground

Evaluation:

- displacement ventilation
- cooling unit is necessary -> cooling effect
- no draft
- no backflow of air pollutants

- 22 outlets at the ground
- required space
## Comparison and costs

<table>
<thead>
<tr>
<th>Concept</th>
<th>Reduce Air rate</th>
<th>Thermal Situation</th>
<th>Air Quality</th>
<th>Total Costs TEUR</th>
<th>Saving TEUR/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Move supply inlets</td>
<td>-66%</td>
<td>0</td>
<td>+</td>
<td>422</td>
<td>76</td>
</tr>
<tr>
<td>2 Cooling ceiling</td>
<td>0%</td>
<td>++</td>
<td>0</td>
<td>797</td>
<td>0</td>
</tr>
<tr>
<td>3 Displacement Ventilation</td>
<td>-80%</td>
<td>++</td>
<td>+++</td>
<td>745</td>
<td>122</td>
</tr>
</tbody>
</table>
Summary

Using Displacement Ventilation means

• better thermal quality
• better air quality
• large reduction of the air volume rates
• Short pay back time

Implemented in the meantime. Satisfaction is very high!
Thank you!