Mechanical Cooling: A Tale of Two Systems

The two systems for large buildings:
- Compression-Based
- Absorption-Based

And you can’t tell from the building’s exterior.

Compression Cooling: Principle and Parable

Principle #1
- Compress gas – it heats up
- Decompress gas – it cools down

Parable #1
The scuba diver who doesn’t submerge his tank while filling it burns his hands. (The water dissipates the released heat of compression.)
Compression Cooling: Principle and Parable

Principle #2 Change of State
- Liquid to vapor—absorbs heat from environment
- Vapor to liquid—gives off heat to environment

Parable #2
The person who’s hand is placed in steam (at 212°F) is burned. (The steam condenses on the hand releasing 970 btu/lb of water. You can put your hand into a 500°F oven for a short time without burning it.)

4 Components

Refrigerant properties:
- Boils at atmospheric pressure at 0°F
- Condenses at high pressure at 100°F

Hot arid solution: Swamp coolers
…or use a ground source (geo-exchange)

Water-coupled GeoExchange System

Jubilee Campus
University of Nottingham
—Michael Hopkins

Absorption Cooling

Principle:
Change of state

Liquid absorber
Evaporator

...what about equilibrium?
The Basics: Absorber & Evaporator

Add-ons for efficiency
Solar-Powered Absorption Cooling

Cleanwater Times Bldg
Clearwater, FL

<table>
<thead>
<tr>
<th>Compression</th>
<th>Absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>High pressure</td>
<td>Low pressure</td>
</tr>
<tr>
<td>High grade fuel for compressor &amp; pumps</td>
<td>High grade fuel for pumps</td>
</tr>
<tr>
<td>Energy efficient when ground-coupled</td>
<td>Energy efficient when solar-coupled</td>
</tr>
<tr>
<td>Noise, CFC use?</td>
<td>Use of waste heat?</td>
</tr>
</tbody>
</table>
The Big Picture

Cooling System Issues in Design

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooling Towers</strong></td>
<td>Replace with ground-source?</td>
</tr>
<tr>
<td><strong>Heat Transfer Medium</strong></td>
<td>Water vs. Air?</td>
</tr>
<tr>
<td><strong>Centralized System</strong></td>
<td>Isolate mechanical noise?</td>
</tr>
<tr>
<td><strong>Thermal Zoning</strong></td>
<td>Organize by thermal need?</td>
</tr>
</tbody>
</table>

Intelligent Buildings

…require intelligent building
Definition:
“Provides for unique and changing assemblies of recent technology in appropriate physical, environmental, and organizational settings—to enhance occupants’ comfort/productivity/life quality.”

Criteria 1
Accommodates integrated package of new technology that manages:
• Communications
• Maintenance/Diagnosis
• Comfort

Criteria 2
Appropriate physical and environmental setting—includes:
• Structure
• Massing
• Orientation
Criteria 3
Address crucial environmental conditions such as:
  • Spatial quality
  • Physical safety
  • Thermal, acoustic, & visual quality
  • Indoor air quality

Diversity of Approaches

<table>
<thead>
<tr>
<th></th>
<th>Focus on Workstation</th>
</tr>
</thead>
<tbody>
<tr>
<td>American</td>
<td>Focus on workstation</td>
</tr>
<tr>
<td>Japanese</td>
<td>Focus on core</td>
</tr>
<tr>
<td>European</td>
<td>Focus on shell</td>
</tr>
<tr>
<td>British</td>
<td>Focus on materials and details</td>
</tr>
</tbody>
</table>

American Approach: The Workstation

Personal environment by Johnson Controls
Planning for thermal zoning


Farm Credit Bank, Spokane

Thermally elegant building
British Approach: Materials and Details

Lloyds of London
European Approach: The Shell

Commerzbank
City: Frankfurt
Country: Germany
Developer/Owner: Commerzbank
Contact: Karl Stiefelhagen
Project Completion Date: 1997
Project Type: Commercial/Office
Building Type: New Construction
Project Size: 928,495 m²
Location Description: Downtown Frankfurt, Germany

Project Description:
Commerzbank is one of the largest banks in Europe, and its new headquarters in the Frankfurt capital of Germany represents both a new image and a direction towards great development. The building itself comprises 58 floors, with a height of 158 meters, making it the tallest building in Europe at that time. In its design, the bank had some specific criteria to be met, such as natural daylight entry into every room, fire-resistant materials, and specific window treatments. The building is divided into three towers totaling 60 floors, with sub-towers in each tower. The structure includes a glass curtain wall system that enhances the building's visual appeal.

The strategy is to create a new landmark in the city that symbolizes Commerzbank's global presence and its commitment to innovation and excellence. The building represents a significant milestone in the company's history, reflecting its ambition to become a leading player in the European market.
So, Which is best?

- American
- Japanese
- European
- British