Intelligent Pumping Controls & Energy Optimizations

Distributed Pumping System
Presented by
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Conventional Chilled Water Pumping System

Common challenges in Conventional Chilled Water Systems
- Balancing and Low ΔT issues
- Commissioning issues
- Variance from design
What kind of Air-conditioning System we want?

Otherwise?
- Minimum commissioning
- Self balancing System

• No need to know what is Differential Pressure (DP)
• Where to install DP sensors?
• What DP setpoint value to input to DDC?
• No need water balancing

Plug & Play
Distributed Pumping System

"...Distributed pumping is a very simple pumping arrangement as well as the most efficient pumping system for (1) large, multiple-zone buildings and (2) multiple-building systems with central energy plants.

It eliminates all overpressure caused by differences in pump head requirements between zones and buildings..."
Distributed Pumping System

ASHRAE Handbook Distributed Pumping

Example:

Figure 15.12 Typical three-building distributed pumping system.

a. Typical distributed pumping, three building system.

b. Pressure gradient diagram for typical, three building system.
Distributed Pumping System

Unlike conventional pumping system, no pressure setpoint is required for the P-CS Pumping System.

The control program will adjust the variable primary pump speed based on whether the supply water flow is meeting the demand.

If the supply is too much it will reduce the pump speed, and if the supply is low it will increase the pump speed.
Distributed pumping is a paradigm shift towards decentralized pumps instead of central pumps in distribution networks. By using coil pumps, the system is “relieved” from all the pressure consuming components and equipped with units that generate pressure only when and where is needed.
Distributed Pumping System – Case Study

Collaborators

Air-conditioned Area: 3460 m²
Factory Floor Area (partially cooled): 8300 m²
6 units of AHU
2 units of PAHU
2 units of Chillers (1 standby)
- Carrier 30XW552P [572 kW (163 RT)]
2 units of 5 kW Primary Pump
Figures 7.1 and 7.2 show the original and modified schematic diagrams for the above AHUs and PAHUs, and for all of them the works were the same and shown as follows:

(i) Removal of balancing valve (Figure 7.3)
(ii) Installation of coil pump (Figure 7.4)
(iii) Fixing of new off-coil temperature sensors in air ducts (Figure 7.5)
(iv) Changing the primary pump to smaller size (Figure 7.6)
Distributed Pumping System – Case Study

Primary–Only Pumping System

Primary–Coil Secondary (P-CS) Pumping System

Computer Simulation

- Simulate Pressure & Flow at all locations in the piping network
- Simulate Power Consumption of Pumps
- Simulate Part load conditions
# Distributed Pumping System – Case Study

<table>
<thead>
<tr>
<th>Year</th>
<th>2016</th>
<th>2017</th>
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<tbody>
<tr>
<td></td>
<td>Nov</td>
<td>Dec</td>
</tr>
<tr>
<td>Baseline Data Collection</td>
<td></td>
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<tr>
<td>Retrofitting &amp; commissioning</td>
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<td>Post-retrofit Data Collection</td>
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<tr>
<td>Data Analysis</td>
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- **Removal of Balancing Valve**

- **Installation of Coil Pumps**

- **Reduced Primary Pump Size**
  - Original: 5 kW
  - Reduced: 3 kW
Distributed Pumping System – Case Study

- Less Pumping Power
Distributed Pumping System – Case Study

Results

Outdoor Weather (Air-con operation periods)

Average Temperature - Post-retrofit period (no significant difference)

Average Relative Humidity – Post-retrofit period (higher)

Other Influencing Factors
- No change of AHU supply air setpoints
- No change of room temperature setpoints
- No change of office and factory operations
Distributed Pumping System – Case Study

CHW Pumping Energy Consumption (4 weeks)

Annual CHW Pumping Energy Savings
= (1727-773) x 52/4
= 12,402 kWh
Distributed Pumping System – Case Study

Larger Temperature Difference ($\Delta T$)

- Total Chilled Water Produced/Pumped - Reduced by 30.7%

<table>
<thead>
<tr>
<th>CHW Pumping EER</th>
<th>Original</th>
<th>Post-Retrofit</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>P-Only</td>
<td>P-CS</td>
</tr>
<tr>
<td>(4 weeks)</td>
<td>(kW/RT)</td>
<td>(kW/RT)</td>
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<tr>
<td>Pumping EER</td>
<td>0.059</td>
<td>0.032</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Primary Only (Kwh)</th>
<th>Primary + CS (Kwh)</th>
<th>% Savings</th>
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<tbody>
<tr>
<td>CHW Pumping Energy Consumption</td>
<td>1,727</td>
<td>773</td>
<td>55.2%</td>
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SAVE PUMP & CHILLER ENERGY

- 32% pump savings (kW/RT)
- ΔT raised by 1,5°C to 6,8°C (design value is 7°C)

- Singapore
  - Temperature : 28°C
  - Humidity (RH) : 75 %
- Office Building from 2014
- BCA Green Mark Platinum
- Constant Load profile
- BMS system
- ~ 6000 m² cooling area
- 15 Coil Pumps used
Distributed Pumping System – Few references

Tamara Hotel and Convention Centre, Trivandrum
HVAC Consultants – M/s Alex Cyriac, Cochin

Air-conditioned Area: 1,12,285 Sq.Ft

18 units of AHU
3 units of HRW
2 units of Chillers - Bluestar – 220 TR
2 units of 11 kW Variable Primary Pump
2 units of 7.5 kw Condenser Water Pump
48 units of Coil Pumps
Distributed Pumping System – Few references

<table>
<thead>
<tr>
<th>CHW Pumping Energy Consumption</th>
<th>Primary Only (Kwh)</th>
<th>Primary + CS (Kwh)</th>
<th>% Savings</th>
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<tbody>
<tr>
<td>97,052</td>
<td>63,430</td>
<td>34.64%</td>
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Distributed Pumping System – Few references
Distributed Pumping System – Few references

Kostal Project, Ranipet
HVAC Consultants – M/s Enersave Solutions
Chennai

Air-conditioned Area: 47,218 Sq.Ft

5 units of AHU
1 Chillers - 200 TR
Climaveneta FX/CA/3902
2 units of 7.5 kW Variable Primary Pump
5 units of Coil Pumps
Distributed Pumping System – Few more references

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<thead>
<tr>
<th>CHW Pumping Energy Consumption</th>
<th>Primary Only (Kwh)</th>
<th>Primary + CS (Kwh)</th>
<th>% Savings</th>
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<tr>
<td></td>
<td>56,368</td>
<td>45,749</td>
<td>19.22%</td>
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Distributed Pumping System

**ADVANTAGES**

- **Hydraulically Self-Balanced**
  - No balancing valves required

- **No modulating valves required**
  - Less flow resistance in the piping network
  - **Savings in Pumping Energy**

- **No DP sensors and DP setpoint required**
  - Control strategy for variable Primary Pump speed based on chilled water supply meeting exactly with Load required

- **Comparable capital cost**
  - Primary-Only System:
    - Balancing valves + Modulating valves + Larger primary pumps
  - Primary-Coil Secondary (P-CS) System:
    - Coil pumps + check valves + smaller primary pumps

- **Simpler commissioning process**
  - Shorter commissioning period
  - Man power savings in commissioning

- **Energy savings in Chillers & Plant**
  - No excessive amount of chilled water to be cooled

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**Diagram**

- **Decoupler**
- **Primary Pump**
- **Chiller**
- **Coil Pump**

**Primary-Coil Secondary (P-CS)**
Thank you for your valuable time