OPTIMIZATION OF
DISTRICT HEATING SYSTEMS
STEAM VS. HOT WATER

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Optimization of District Heat Systems – Steam vs. Hot Water

- District Heat System Brief History and Advantages
- Heating Medium - Steam or Hot Water
- Considerations for Converting from Steam to Hot Water
- Alternative Fuels and Energy Evaluation
- Optimization of a District Hot Water System
US District Heating Systems History

District Heating Systems in US

District Heating Installations (2009)

Majority of Existing District Heating Systems Use Steam
Advantages of District Heating Systems

- Use of Combined Heat and Power (CHP)
  - Efficiency: 80% CHP vs. 45% Combined Cycle
- Use of absorption chillers for cooling
- Reduced costs for users
- Can allow for greater fuels flexibility
- Hot water systems allow great flexibility in utilizing additional heating sources
Heating Medium – Steam or Hot Water

- Advantages: Hot Water vs. Steam
- Heating Loop First Costs
- Operation and Maintenance Costs
# Advantages: Hot Water Vs. Steam

## Steam Systems
- Open System – Does not require condensate to be returned
- Applicable for use with building hot water or steam heating
- Circulating Pumps are not required

## Hot Water Systems
- Lower heating losses (vs. Steam)
- Flexible piping materials
- Lower installation and material costs
- Lower chemical treatment costs (closed loop)
- Allows for hot water storage
- Lower maintenance costs
- Increased CHP efficiency
- Easier energy metering
- Modern buildings utilize hot water for heating
- Allows for inclusion of lower temperature heat from industrial waste or renewable energy
Heating Loop Initial Costs

**HIGHER INITIAL COST ASSOCIATED WITH STEAM SYSTEMS**
- Additional Expansion Loops
- Drip Leg Vaults
- Higher Piping Material and Installation Costs
  - High Temp Insulation
  - Additional Drip Leg Piping
- Heat Exchangers at Building
- Condensate return pumping system

**HIGHER INITIAL COST ASSOCIATED HOT WATER SYSTEMS**
- Supply and return pipes are both full size
- Require Circulating Water Pump
- Conversion of existing building steam systems to hot water
Steam Vault

Expansion Loops

Drip Leg
Steam and Hot Water Pipe Systems

Condensate

Steam Pipe

High Pressure Drip Leg
Operation and Maintenance Costs

Higher O&M Costs Associated with Steam Systems

- Steam Traps and Vaults
- Heat Losses
- Chemical Treatment
- Lower CHP Electrical Output
- Condensate Piping Wear

Higher O&M Costs Associated with Hot Water Systems

- Higher Aux Loads
Considerations for Converting from Steam to Hot Water

Why Convert?

- For Equivalent Pipe Lengths, Operating and Maintenance Costs for Steam Systems are Twice that of Hot Water
- Lower Line Losses, Increased Efficiency, and Better System Control Can Significantly Lower Fuel Usage in Boilers by 25 to 50% or in CHP Plants Potentially Double the Steam Turbine Efficiency
Considerations for Converting from Steam to Hot Water

- Evaluate Existing Steam System
- Evaluate Plant Efficiency Increases
- Evaluate Operational and Maintenance Cost Savings
- Alternative Fuels and Energy Source Evaluation
- Existing Customer Perceptions, Willingness to Convert, and Necessary Incentives
- Potential for New Customers
Effect of Loop Temperature on Steam Turbine Efficiency

![Graph showing the relationship between loop temperature (F) and steam turbine efficiency.]
Alternative Fuels and Energy Evaluation

- Solar
  - River Centre – District Energy
- Heat Pumps
Alternative Fuels and Energy Evaluation

- Waste Incinerator
- Polk County
Alternative Fuels and Energy Evaluation

- Biomass/Biogas
- Andersen Inc.
Alternative Fuels and Energy Evaluation

- Industrial Waste Heat
  - Andersen Inc.
Elements of an Ideal Hot Water System

- District heating system utilizes a CHP system to maximize efficiency and operating cost
- Buildings are capable of heating with 160 degree water (low temp)
- Temperature differential between supply and return is 50 degrees or more
- Summer excess heat from CHP provides heat for absorption chillers
- A hot water storage tank in winter and chilled water storage tank in the summer shifts loads to match thermal to electrical loads
Questions and Answers

Thank you!