Thermosyphon Cooler Hybrid System Providing Water Resiliency in a Typical Chemical Plant

Presentation to the:

Texas Industries of the Future

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The Challenge:
1. How can the efficiency and capacity advantages of Evaporative Heat Rejection be delivered with far less water consumption?
2. How can we financially evaluate the alternatives?

Objective: Determine relative first cost, summer performance, winter performance, and plan area for commonly encountered wet and hybrid AHRD systems.
Thermosyphon Cooler Hybrid System (TCHS)

Process Loop

“Wet” when it’s Hot, “Dry” when it’s Not
Thermosyphon Cooler (TSC)
Ongoing EPRI – Johnson Controls Thermosyphon Cooler Hybrid System Feasibility Study
Prototype Testing at Plant Bowen
Faced With Potential Water Constraints, Can TCHS Technology Help Make Chemical Plants and Refineries More Water Resilient?
Simplified Business Unit Model Inputs

Process

Material
$0.65/Unit

Energy
$0.05/Unit

Labor
$0/Unit

Capital
$3.75M/Year

Additional Inputs
$28M/Year

Alternative Technology

CT

Fan & Pump

Energy

Chemicals

Make-up

Water

Revenue
$1.10/Unit

Production Requirements
500 M Units/Yr
57,078 Units/Hr

Revenue
$0.65/Unit

Revenue
$0.05/Unit

Revenue
$3.75M/Year

Revenue
$28M/Year

Revenue
$0.103M/Year

Revenue
$0.05/kWh

Revenue
$3.00/k-gal

Revenue
$3.08/k-gal

Revenue
$2.50/k-gal

CWT Impact on:
- Production Capacity = -0.22% per °F Change in CWT
- Waste Heat Generated = +1.00% per °F Change in CWT
- Unit Material = 0% per °F Change in CWT
- Unit Energy = 0% per °F Change in CWT

Houston, TX

Blowdown

Min CWT = 67F
Max = 120F
1,270 BTU’s/Unit
CT Design 118/89/82F

Using The TCHS Saves Water & Saves Operating Costs

Heat Rejection System Utility Cost / Hr

Current System  CT Only

$21.11  $0.00  
$29.42  $21.11  
$13.23  $11.66  
$9.88  $9.88  
$50.00  $30.00  
$20.00  $10.00  
$0.00  $0.00

Water  Electricity  Savings
Contour Plot of the Cooling Tower Make-up Water Requirements

Cooling Tower Make-up Requirement
Houston, TX - Cooling Tower Only

Cooling Tower Make-up Requirement
Houston, TX - TCHS WECER Control (1.0 Modules)

Annual Water Requirement =  64,618,887 Gallons

Annual Water Requirement =  30,963,537 Gallons (52.1% Reduction)
Impact of Water Constraint on Plant Profitability & IRR

**Plant Profitability Vs. % Annual Water Constraint**

- **Base Cooling Tower System**
- TCHS (1.0 Module)
- TCHS (0.5 Module)
- TCHS (0.14 Module)

**TCHS IRR (15 Year) Vs. % Annual Water Constraint**

- TCHS (1.0 Module)
- TCHS (0.5 Module)
- TCHS (0.14 Module)
TCHS Commercialization Status:

1. Robust performance and system models have been developed
2. Performance models have been validated through factory and field testing
3. A detailed conceptual design has been developed for larger capacity systems
4. We are ready to work with you to perform an application specific analysis and provide an application specific equipment solution
General Conclusions:

1. Water constraints will have a significant impact on the ability to meet planned production requirements, profitability, and investment returns.

2. The TCHS provides a cost effective and reliable way to provide operational resiliency and maintain plant production and profitability in the face of coming water constraints.

3. Degree of water resiliency and IRR can easily be adjusted by adjusting the size of the TCHS.

4. Additional TCHS benefits include:
   - Ease of retrofit into existing cooling tower systems
   - Operational flexibility
   - Plume reduction
   - Reduction in operating expenses
   - Enhancement of your Environmental Image