Improved Chiller Plant Performance Through Air-Dirt Elimination at

Youngstown State University
&
University of Akron

Presentation Overview:

- Common chilled water design and operational challenges
- Traditional Approach to Solve These Issues
- Review separate projects that addressed these issues:
  - *Youngstown State University – Youngstown, OH*
  - *University of Akron – Akron, OH*
- Technical background of High-Efficiency Air and Dirt Elimination

Youngstown State University
Youngstown, OH

Youngstown State University

- Enrollment: 11,500 (2013)
- 4 million GSF total
- 3 million GSF heated & cooled space
- 40,000 lbs/hr Steam Heating Peak Load
- 3,000 TR Cooling Peak Load
- 9MW Power Peak Load
- Chilled Water System Overview
  - (3) 1200TR York Electric Centrifugal Chillers w\primary pumping to campus.

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2006 Campus-Wide Energy Performance Contract project:

- Typical Upgrades:
  - Lighting
  - Steam trap surveys
  - Add VFD's
  - Update controls
- Plus, Chilled water plant updates:
  - New electric centrifugal chillers
  - Converted to Variable-Primary pumping
  - Centrifugal air separator (line-size)

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SCOPE

- (3) 1200 Ton York Chillers
- (3) 250 HP Chilled Water Pumps
  - Max Design Flow = 8,640 GPM
- Variable Frequency Drives
  - Set at 6,500 GPM
  - System Presently Requires Constant Flow
    - (Future Plans For Variable Flow)
- Chiller Output Variable

CENTRIFUGAL AIR SEPARATOR

- Conventional Centrifugal Type with Tangential system connections
- Part of existing system on ChW-R to Pumps
- 16” Line Size
  - Rated for 8,000 Max Flow
  - Peak Efficiency Flow: 1,472 – 2,152 gpm
  - Max Flow = **40% Efficiency**

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(E)CENTRIFUGAL AIR SEPARATOR

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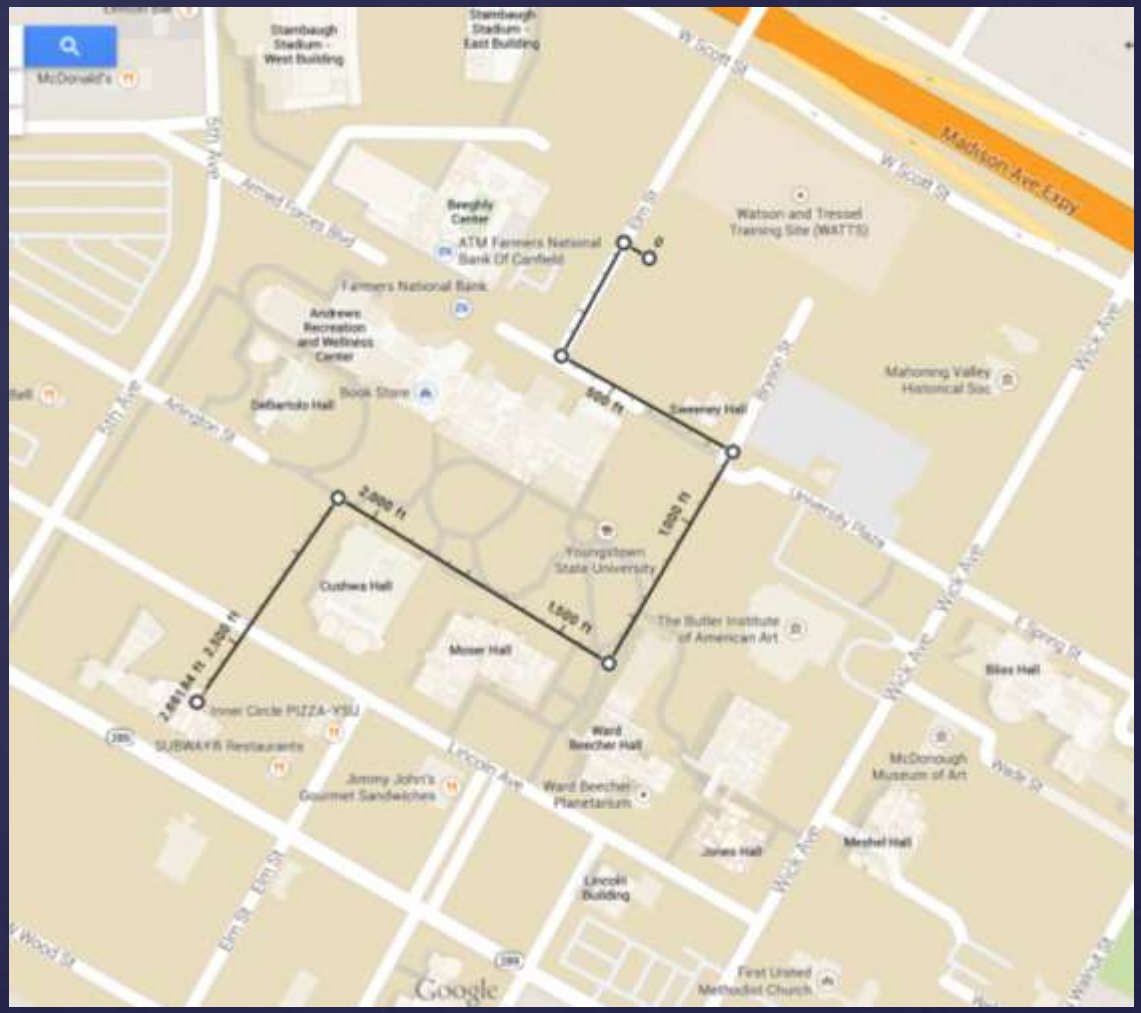
CHARACTERISTICS OF (E)SYSTEM



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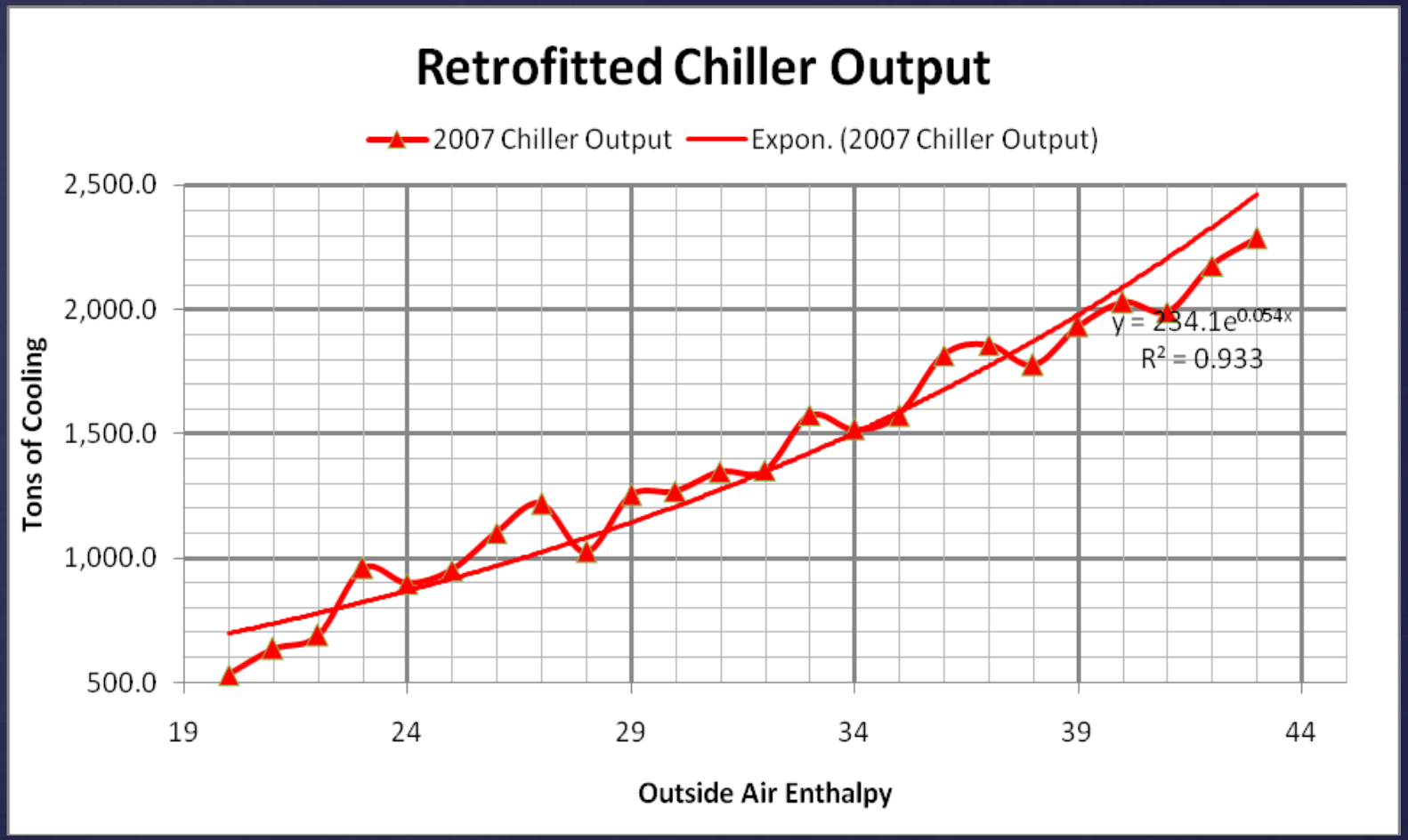
CHARACTERISTICS OF (E)SYSTEM

- Known issues with low delta T at Central Plant- adequate CHWS temps, low CHWR temps.
- Known issues with high Supply Air Temperatures (SAT) at extremities.
- Existing centrifugal air separator installed.
- Constant flow (GPM) to campus based on pressure / flow requirements of campus.
- Decoupled Thermal Energy Storage (TES) system
- Good JCI Metasys controls, oversight, and trending of system

(E)DATA



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NEW AIR / DIRT SEPARATOR SELECTED AND INSTALLED

- Custom Coalescing Air-Dirt Separator
  - Customized to Meet Height Constraints
- 20” Line Size (Required to Handle Max Design Flow)
  - Rated for 9,400 GPM Max Flow
  - At Max Flow
    - 100% Free Air Eliminated
    - 100% Entrained Air Eliminated
    - Up to 99.6% Dissolved Air Eliminated
  - Installed June 2008

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NEW AIR / DIRT SEPARATOR

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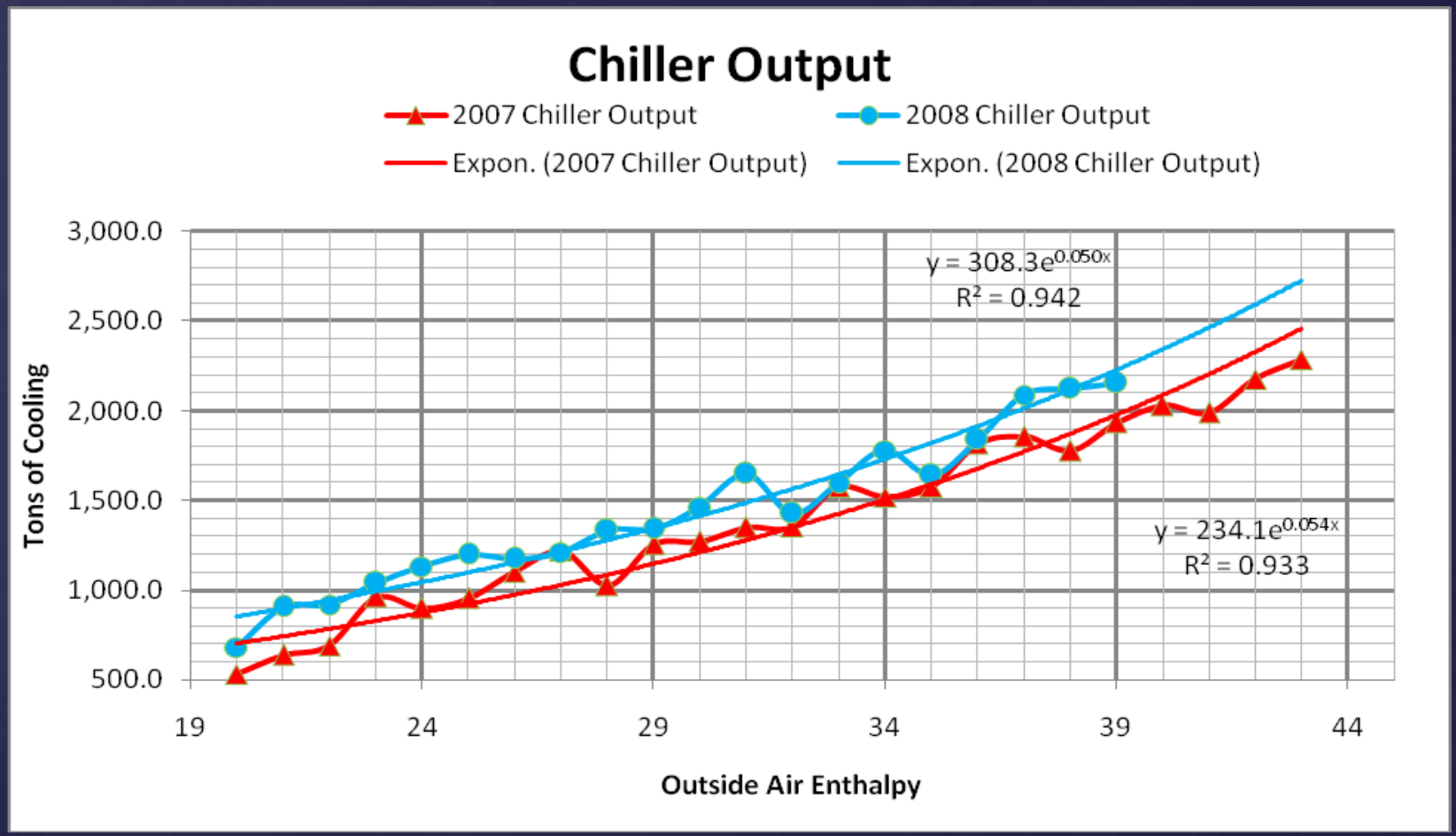
NEW DATA



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RESULTS

- Chiller Output
  - From 2300 Tons to 2700 Tons (+15.9%)
- Δ T At Chiller
  - Increased From 8.5°F to 10°F (+1.5°F)
  - 10°F Peak Performance per York
- DAT At Furthest Point On Campus
  - Improved From 65°F to 58.5°F

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IMPROVED CHARACTERISTICS OF (E)SYSTEM

- Known issues with low delta T at Central Plant- adequate CHWS temps, low CHWR temps. CORRECTED
- Known issues with high Supply Air Temperatures (SAT) at extremities. CORRECTED
- Existing centrifugal air separator replaced with coalescing air separator. DONE
- Constant flow (GPM) to campus based on pressure / flow requirements of campus.
- Decoupled Thermal Energy Storage (TES) system
- Good JCI Metasys controls, oversight, and trending of system

EASE OF RETROFIT

Youngstown STATE UNIVERSITY

University of Akron
Akron, OH

University of Akron

- Enrollment: 21,900 (2013)
- 8.6 million GSF
- 6.3 million GSF heated & cooled space
- 90,000 lbs / hr Heating Peak Load
- 6,000 TR Cooling Peak Load
- 20MW Power Peak Load
- Chilled Water System Overview
  - (5) chillers @ 8500 TR installed

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2014 Campus-Wide Energy Performance Contract project:

- Typical Upgrades:
  - Lighting
  - Add VFD's
  - Update controls
  - Lab upgrades
- Plus, Chilled water plant updates:
  - No new chillers
  - Air separator added (coalescing style)
  - CPO 30 (Hartman Loop)

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CHARACTERISTICS OF (E)SYSTEM

- Known issues with low delta T at Central Plant- adequate CHWS temps, low CHWR temps.
- Known issues with high Supply Air Temperatures (SAT) at extremities.
- No vortex air separator installed.
- Primary / Secondary / Tertiary pumping to campus
- Coupled Thermal Energy Storage (TES) system
- Good JCI Metasys controls, oversight, and trending of system

REQUIREMENTS FROM THE AIR-DIRT SEPARATOR

- Proven Track Record of High-Efficiency Air and Dirt Elimination in Large Systems
- Air Absorption Capabilities
- Capability to Reduce System Oxygen Level to 0.08%
- Capability to remove system particulate down to 5 microns

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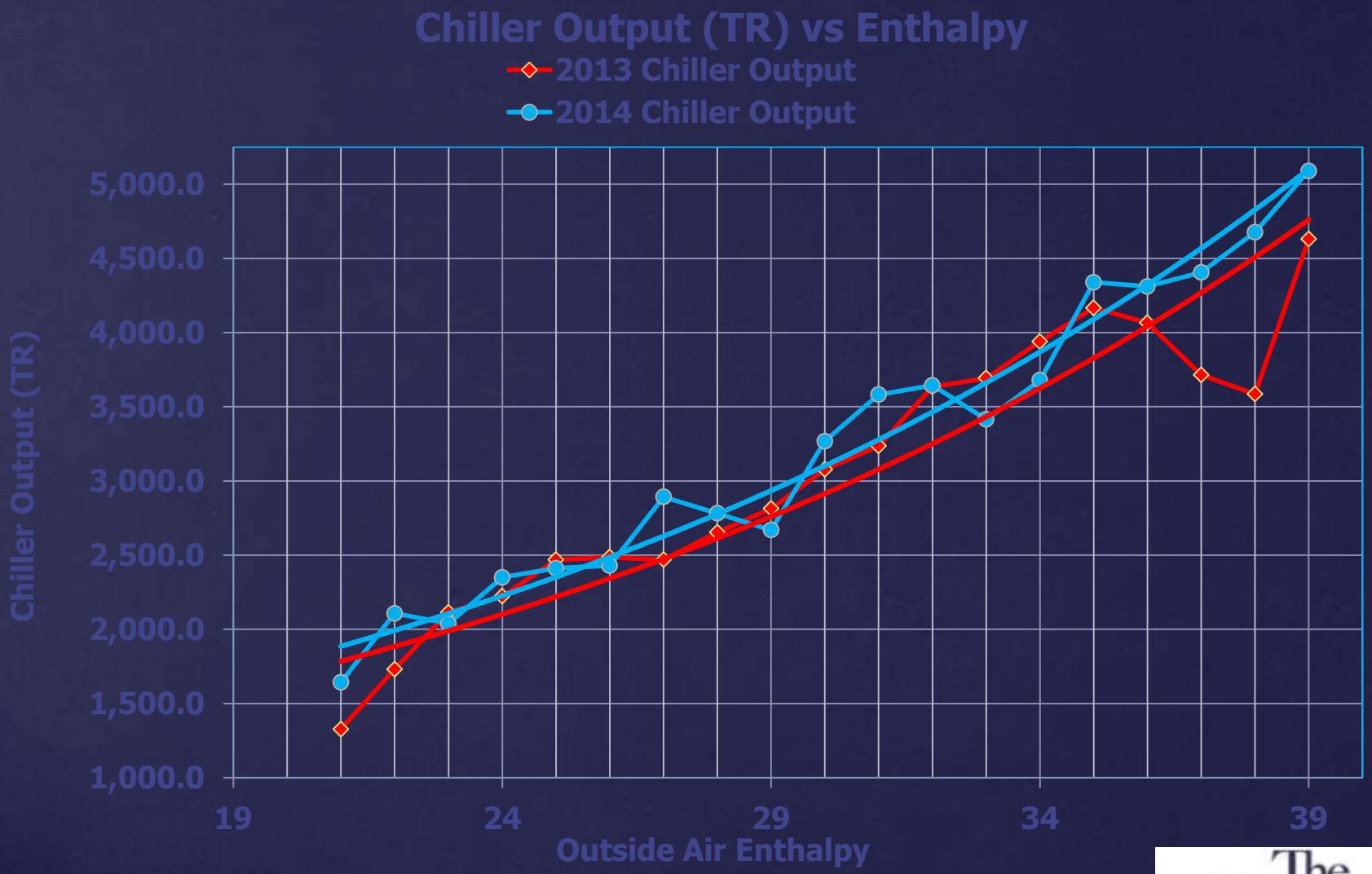
U. of Akron- Installation

The University of Akron

U. of Akron – Preliminary Results



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CHARACTERISTICS OF (E)SYSTEM

- Known issues with low delta T at Central Plant- adequate CHWS temps, low CHWR temps. PENDING
- Known issues with high Supply Air Temperatures (SAT) at extremities. PENDING
- No air separator installed. CORRECTED; Coalescing air separator installed.
- Primary / Secondary / Tertiary pumping to campus
- Coupled Thermal Energy Storage (TES) system
- Good JCI Metasys controls, oversight, and trending of system

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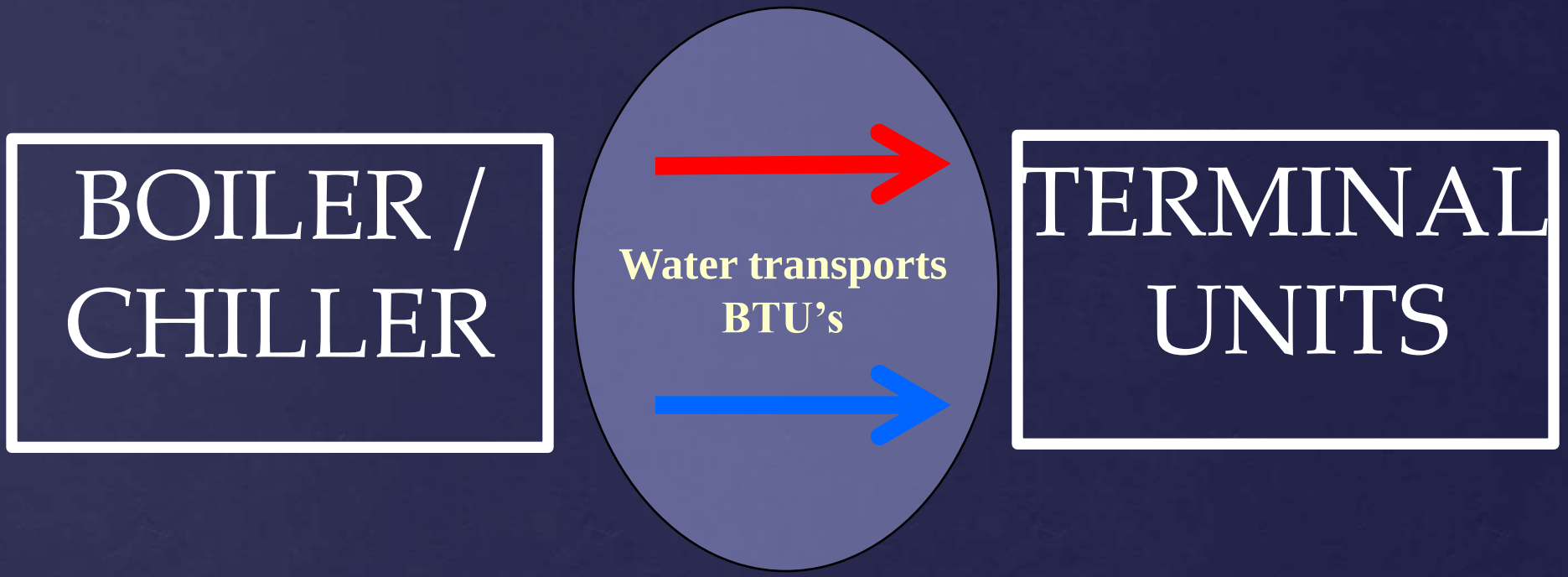
Physics of High-Efficiency Air and Dirt Elimination

SYSTEM SYMPTOMS

- Need For Frequent Bleeding / Purging
- Gurgling Noise In Piping
- Pump Vibration
- Dirt Settling in Coils
- Poor Heat Transfer
- Customer Complaints
- Facilities Personnel Confirm
  - Treated as “Routine” Maintenance in a Wet System

THERMAL DISTRIBUTION EFFICIENCY



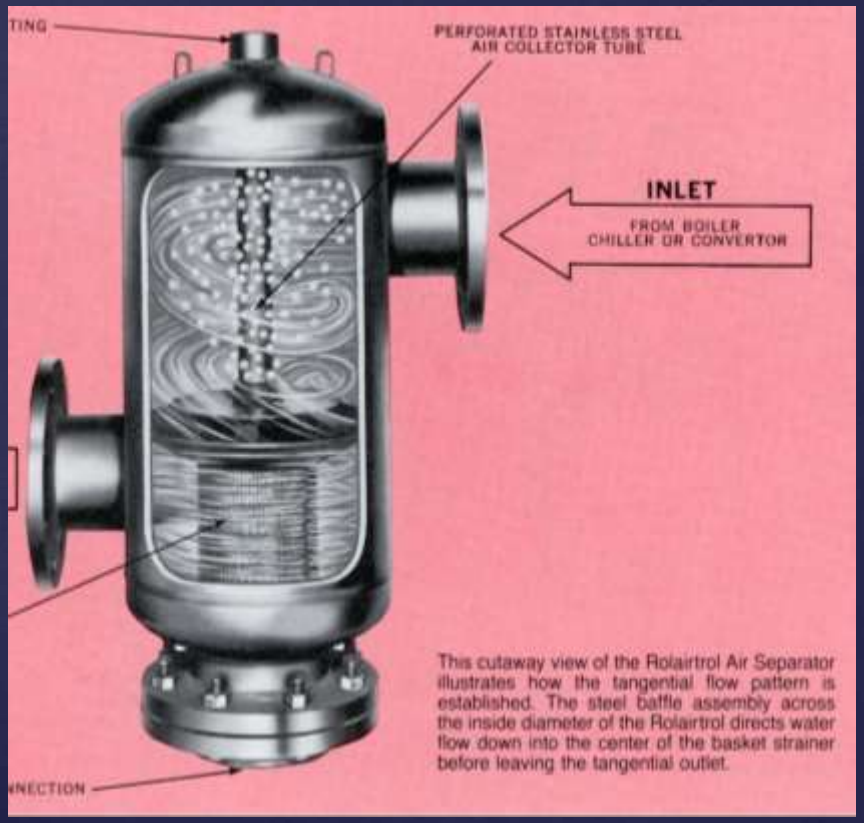
Q. What specific component in the system protects the efficiency of the BTU heat transfer?

TYPES OF AIR

1. Entrained Air
2. Free Air
3. Dissolved Air

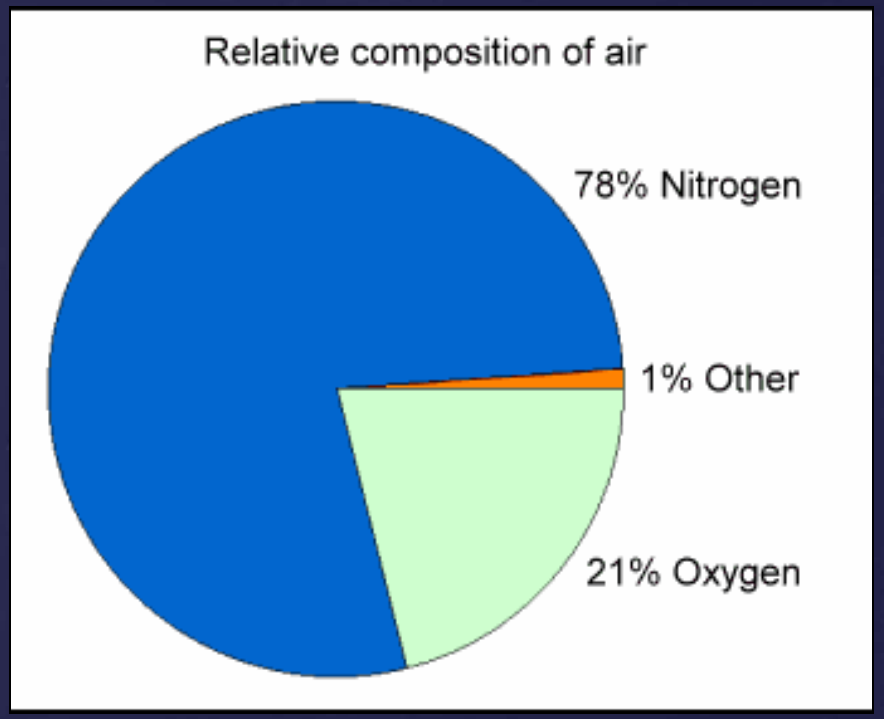
AIR
TRADITIONAL TREATMENT METHODS

Centrifugal Air Separator w/Tangential connections



AIR
TRADITIONAL TREATMENT METHODS

- Chemical Treatment
  - Common goal is to limit corrosion activity
  - Various types, including Oxygen Scavengers (Sodium Nitrites)
  - **Does not remove the air**
  - Nitrogen: Inert



AIR
TODAY'S BEST PRACTICE

- High-Efficiency Coalescing Air-Dirt Separators
  - Reduce Velocity
  - Eliminate Turbulence
  - Repeat Circulations
  - Absorption Process

ENERGY SAVINGS SUMMARY

- *Assuming* Variable Flow & Constant Output
  - Old (Centrifugal) Separator
    - 6500 GPM / 2300 Tons = 2.83 GPM / Ton
  - New (Coalescing) Separator
    - 6500 GPM / 2700 Tons = 2.41 GPM / Ton
  - 2300 Tons x 2.41 GPM = 5543 GPM (85.3%)
  - Head Reduced to 72.7%
  - Pump Power Reduced to 62.1%
  - 37.9% kWh Savings

Questions?