

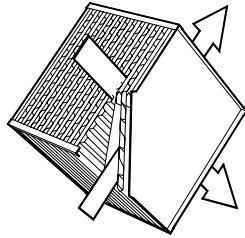
XeteX, Inc.

Residential Energy Recovery Unit

Senior Design Clinic

ENGR 481

Spring 2003



Adam Haag
Andrew Senn
Brian Swanson
J.P. West
Nick Whitehead

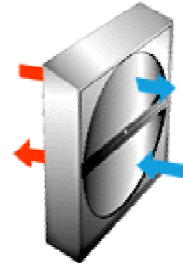


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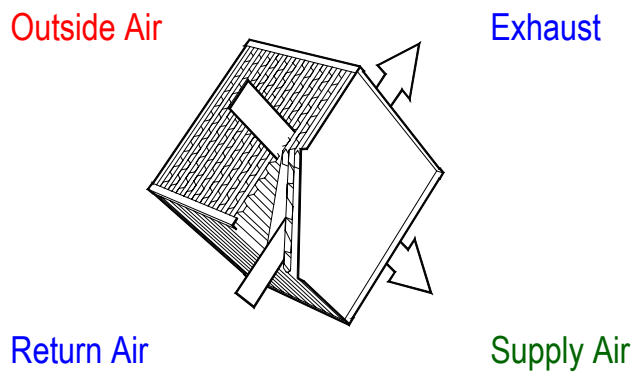
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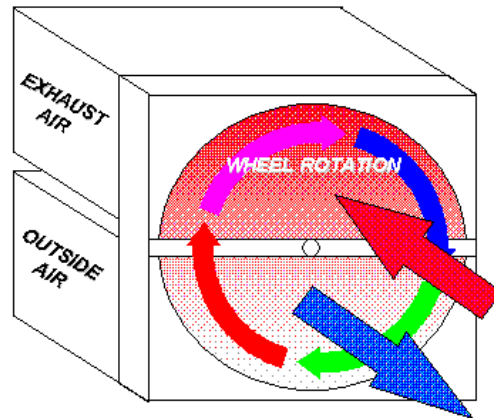
Team Member Assignments

- ✿ J.P. West
 - Product Development, Leader
- ✿ Brian Swanson
 - Product Development, Time Management
- ✿ Nick Whitehead
 - Product Development, Numerical Analysis
- ✿ Adam Haag
 - Product Development, Design of Experiments
- ✿ Andy Senn
 - Product Development, Instrumentation

Flat-Plate Exchanger



Rotary-Wheel Exchanger



Rotary Heat Wheel

Introduction and Background

- ✦ XeteX: Small Minneapolis-Based Company
- ✦ Focus: Air-to-Air Heat Exchangers
 - Flat-Plate Exchangers
 - Rotary-Wheel Exchangers
- ✦ Performance Data and ASHRAE Standards
- ✦ Developed Test Facilities with Universities and the National Science Foundation (NSF)

Problem Statement

- ✂ Design and Fabricate a Test Facility
- ✂ Analyze Performance of Heat Wheel
- ✂ Gain Accurate Efficiency Results

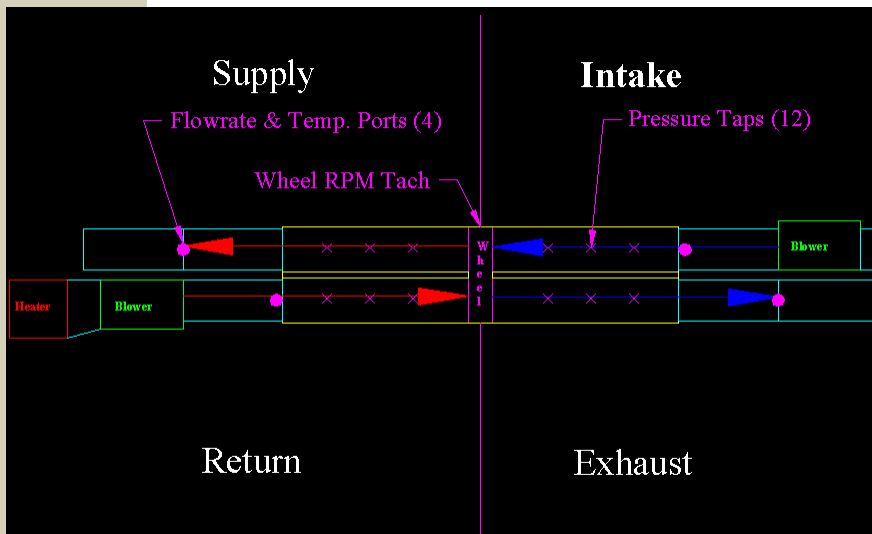
Requirements

- ✂ Modular Design for Multiple Energy Recovery Units
- ✂ Limited Leakage
 - Air, Water Vapor, Heat
- ✂ Environmental Condition Controls
- ✂ Accurate Instrumentation
 - Flowrate, Temperature, Pressure, Humidity, Wheel RPM
- ✂ Design to Fit in Provided Facility
- ✂ Make Valuable Conclusions from Results
 - Heat Efficiency, Moisture Efficiency, Pressure Drop
- ✂ Permanent Test Facility

Instrumentation

- 🔧 **Flowrate** – Hot Wire Anemometer, Pitot Tube
 - Velocity Traverse
 - Screens for Mixed Flow
- 🔧 **Temperature** – Type E Thermocouples, Agilent Multimeter
 - Traverse for Bulk Temperature
- 🔧 **Pressure** – High Performance Pressure Transducer
 - In Plenum and Pitot Tube
- 🔧 **Humidity** – Wet/Dry Bulb
 - Most Accurate
- 🔧 **Wheel RPM** – Bicycle Tachometer

Instrumentation Location



Concept Generation/Selection

✿ Test Stand

- Elevated 8 ft. Above Floor
- Sturdy and Safe

✿ Plenum

- Styrofoam vs. Metal
- Alterable

✿ Duct Work

- Axisymmetric Round Ducts vs. Rectangular Ducts

✿ Blowers

- Backwards Inclined Blowers
- Provided Flow and Pressure Drop Needed

Concept Generation/Selection

✿ Heater

- 5000W Resistance Coil Heater vs. 1500W Round Heaters

✿ Wheel Motor

- DC Motor with POT vs. Variable Frequency Motor

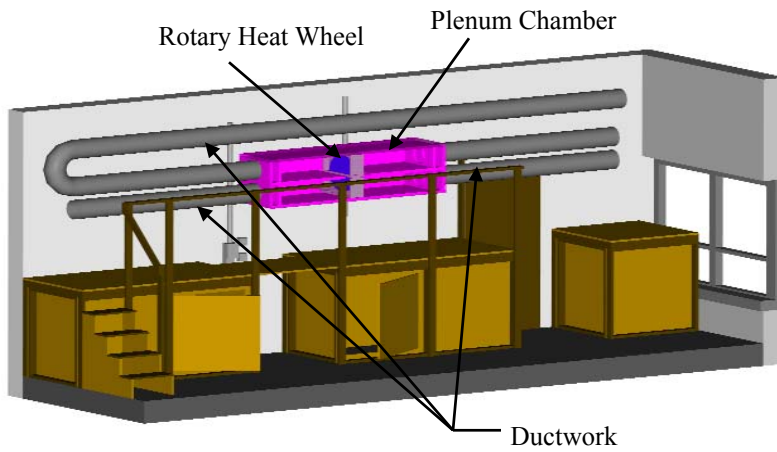
✿ Humidifier

- 220 Volt Power Source
- On/Off Capabilities

✿ Controls

- Automated Control of Flowrate, Wheel RPM, Temperature

AutoCad 3D Layout



Calibration of Facility

✿ Mass Balance

- Initial Testing Indicated 30% Mass Deficit
- Improved Sealing, Smoke Machine
- Anemometer vs. Pitot Tube
- Finer Traverse for Numerical Integration
- Mass Balance of +/- 5%

✿ Energy Balance

- Involved Bulk Temperature Measurements
- Energy Balance of +/- 2%

✿ Most Test Facilities Assume Mass and Energy Balance

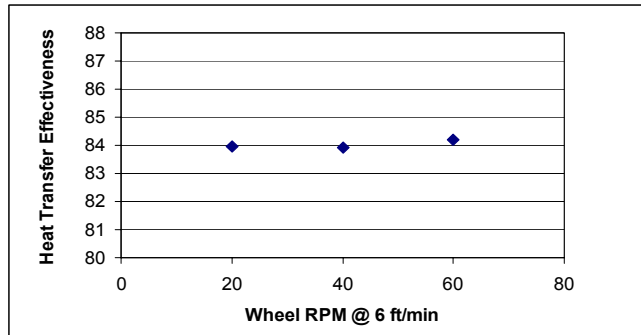
Testing and Results

✿ Developed Design of Experiments Protocol

- Obtain a Predictive Equation
- Identify Inconsequential Parameters

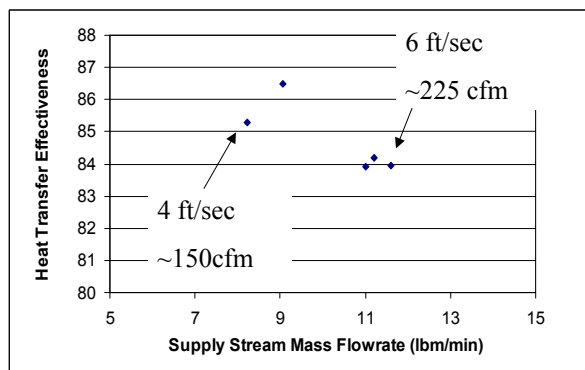
Parameter	Low	High
Blower setting (volts)	3	5
Wheel speed (rpm)	20	60
Plenum Length (ft)	1	4
Temp. Difference (°F)	30	70

Effectiveness vs. Wheel RPM



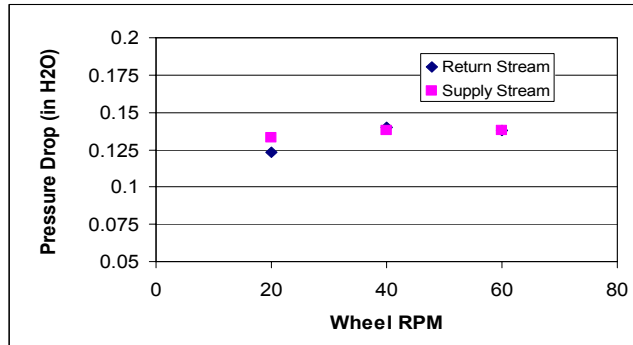
Heat transfer effectiveness with wheel RPM

Heat Transfer Effectiveness vs. Flowrate



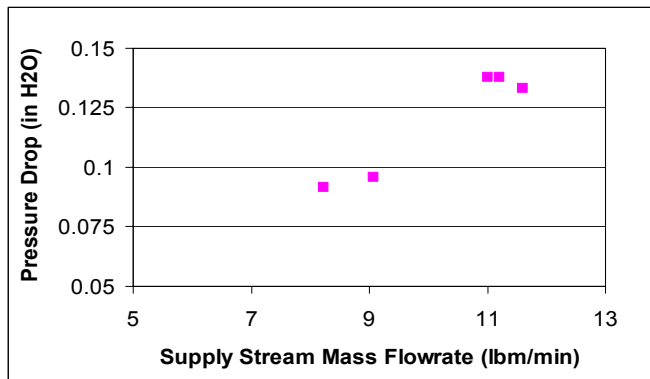
Heat transfer effectiveness with mass flowrate of supply air-stream

Pressure Drop Across Heat Wheel



Pressure drop across heat wheel with wheel rpm for high flowrate

Pressure Drop vs. Flowrate

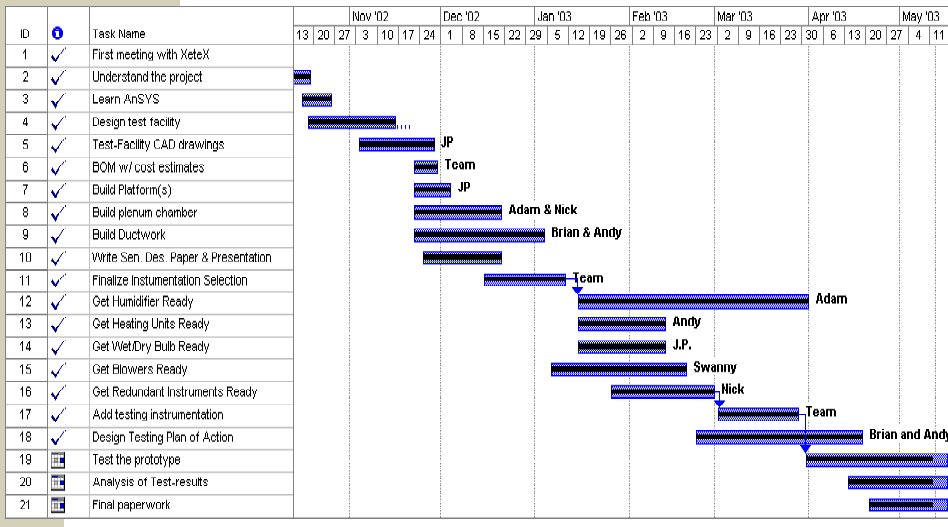


Pressure drop across heat wheel with flowrate

Testing to Do

- ✦ Heat Transfer Effectiveness vs. Temperature
- ✦ Mass Transfer Effectiveness
- ✦ Complete D.O.E.

Project Management





Conclusions

✦ Strengths of Design

- Flexibility of Design, Mixed Flow, Measurement Accuracy
- Permanent Test Facility for Future Use

✦ Weaknesses (Solved)

- Leakage, Mass Imbalance, Controls

✦ Reflections on Process

- Smooth Design Process
- Implementation Delays

✦ Team Performance

- Team members contributed with their strengths

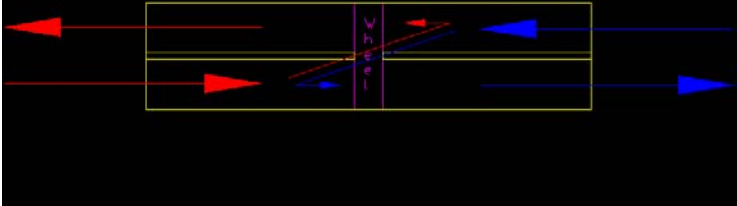


Questions?

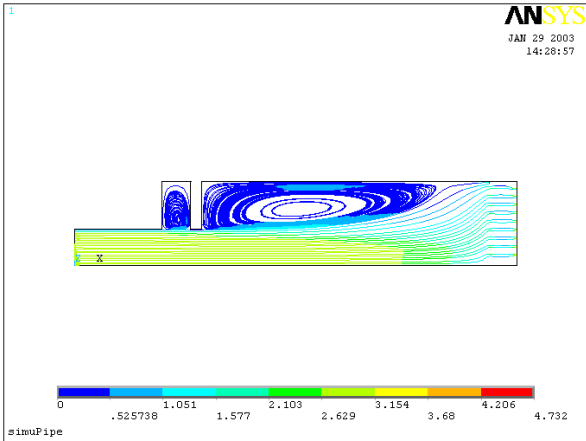
Thank You For Your Attention!

Contamination

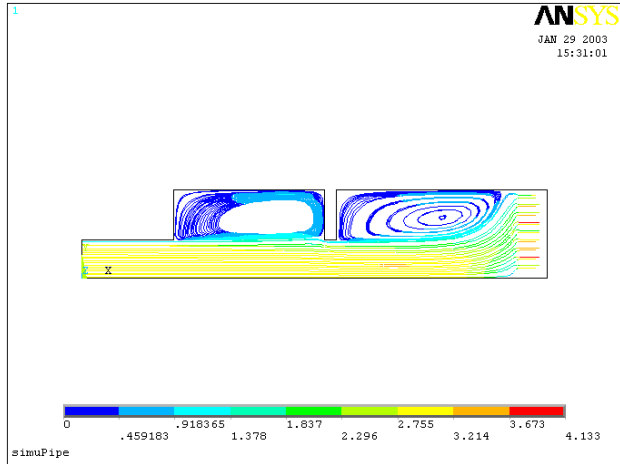
Cross Contamination
BAD!!!



ANSYS



ANSYS



Applications

