Mass Flow Sensor Integration

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Overview:

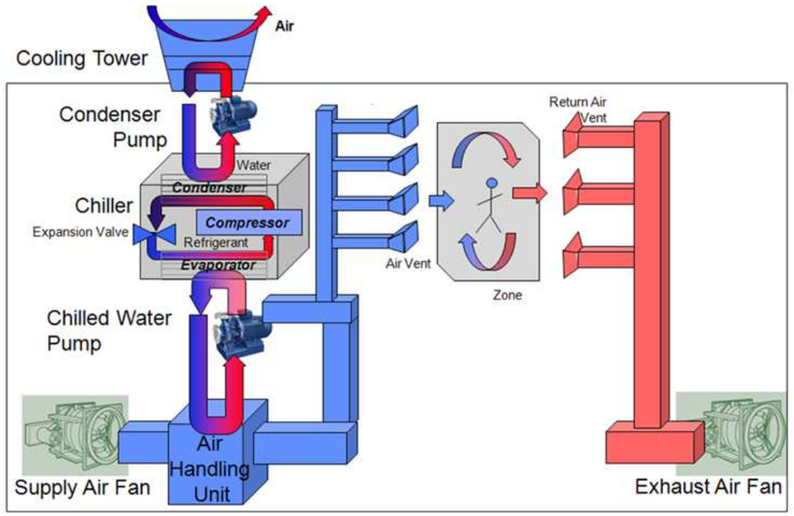
Danfoss Turbocor is a local company that produces an oil-free centrifugal compressor for HVAC and chiller systems. The company currently has no way of measuring real time efficiency of their compressors except in their test facility. Turbocor seeks an integrated non-intrusive system to determine efficiency on new as well as existing customer platforms. This capability will enable the company to collect and analyze data in their quest to determine and predict failure modes. This feature will add value to the Turbocor product in a market where other companies are encroaching on shaft levitation technology.

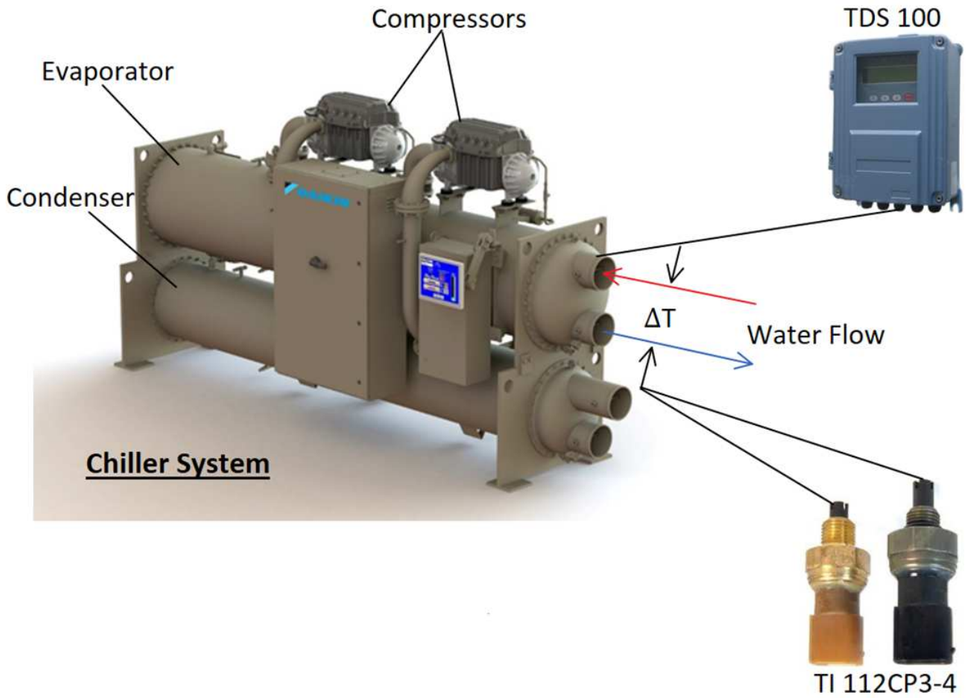
Approach:

The team seeks to develop and integrate a non-intrusive mass flow sensor coupled with temperature sensors in existing ports to gather the data necessary to calculate efficiency in real time. This system will be compatible for all Turbocor compressor systems.

Background:

Typical water cooled HVAC system.

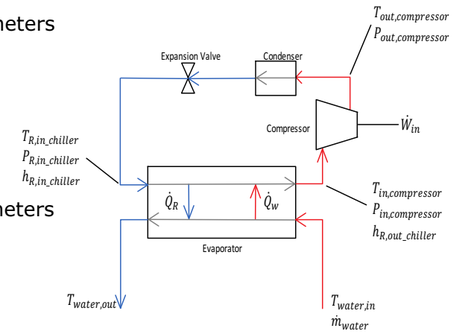




Thermodynamic Correlations:

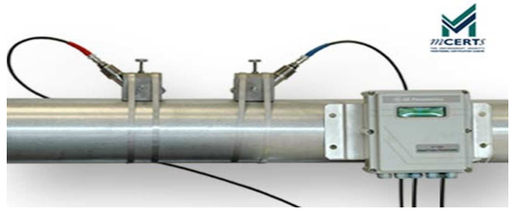
- $\dot{Q}_w = \dot{m}_w c_{p,w}(T_{w,in} - T_{w,out})$
- $\dot{Q}_R = \dot{m}_R(h_{R,in} - h_{R,out})$
- $\dot{W}_{out,comp} = (P_{in,R} - P_{out,R})\dot{V}_R$
- $\eta_{comp} = \frac{\dot{W}_{out,comp}}{\dot{W}_{in,comp}}$
- $Q_{max} = C_{min}(T_{h,in} - T_{c,in})$
- $\varepsilon = \frac{\dot{Q}}{Q_{max}}$

- Available Parameters
  - $T_{in,compressor}$
  - $T_{out,compressor}$
  - $P_{in,compressor}$
  - $P_{out,compressor}$
- Required Parameters
  - $T_{water,in}$
  - $T_{water,out}$
  - $\dot{m}_{water}$
  - $h_{R,in\_chiller}$



Mass Flow Sensor Selection:

- Require external mounted sensor
- Within 1% accuracy
- Output must be compatible with existing system



Temperature Sensor Selection:

- Turbocor currently uses the TI 112CP3-4 sensor
  - Detects pressure and temperature
  - System already calibrated for use
- Operating Ranges:
  - -40 to 120°C
  - 9 to 149 PSI
- Accuracy ±0.6%

Potential Challenges:

- $2000 Budget
- System Calibration
- Mounting bracket design

Future Plans:

- Analyze and Test Data
- Acquire and Calibrate Mass Flow sensor
- Test system at Turbocor's test facility
- Compare efficiency results to actual data
- Design algorithms for control unit
- Integration into existing system