

Mass Flow Sensor Integration

Group 5: Beau Rodgers, Luis Mendez, Keenan Cheeks, Brian Roberts

Sponsor: Danfoss Turbocor

Advisor: Dr. Chiang Shi

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:

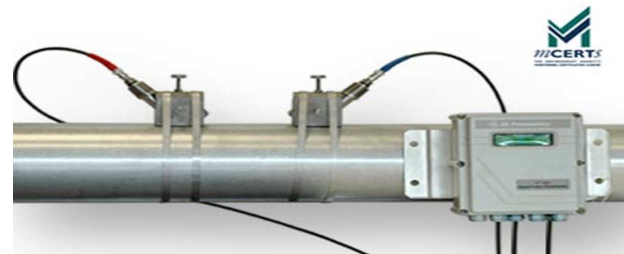
The team seeks to develop and integrate a non-intrusive mass flow sensor coupled with temperature sensors in existing ports to gather the data necessary to calculate efficiency in real time. This system will be compatible for all Turbocor compressor systems.

Project Constraints:

- \$1000 Budget
- System Calibration
- Mounting bracket design

Mass Flow Sensor Selection:

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



Thermodynamic Correlations:

$$COP = \frac{P_{in,comp}}{\dot{m}_w * c_p * (T_{w,in} - T_{w,out})}$$

$$\eta_{comp} = \frac{\dot{m}_{evap} * (\Delta h_{isotropic})}{P_{in,comp}}$$

$$\dot{W}_{out,comp} = (P_{in,R} - P_{out,R}) \dot{V}_R$$

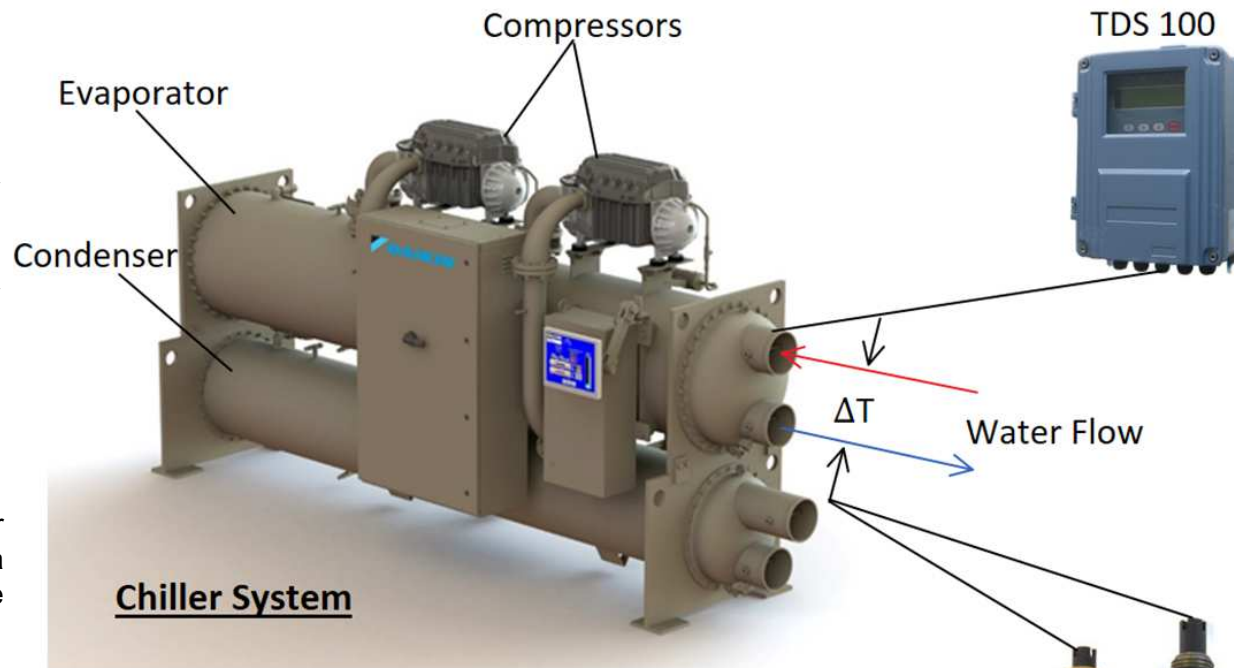
$$\dot{Q}_R = \dot{m}_{evap} * \Delta h_{isotropic}$$

Available Parameters

- $T_{in,compressor}$
- $T_{out,compressor}$
- $P_{in,compressor}$
- $P_{out,compressor}$
- $T_{water,in}$
- $T_{water,out}$
- $h_{R,in,chiller}$

Required Parameters

- $T_{in,Evaporator}$
- \dot{m}_{water}



Installed & Mounted Sensor Module

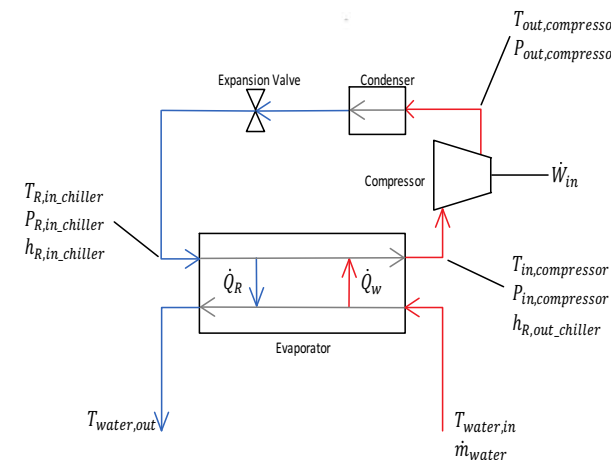
Design:

In order to protect compressor and sensor electronics, a simple protection circuit needed to be constructed. The team also decided to design a mounting system for the acquired sensor module. This added the benefit of keeping the wiring for the sensor package in a condensed area.



Sensor Mounting Bracket Assembly

TI 112CP3-4



Results:

After extensive testing and development, the sensor package and thermodynamic relations were successful in determining real time efficiency. However, the accuracy of the mass flow was not as expected. A 5% error was found in the mass flow rate when compared to inline sensors used by Tubocor. The TDS-100 requires fine tuning in order to ensure more accurate measurements. It is extremely important to know the correct pipe dimensions and input them accurately into the sensor.

Conclusion:

The goal of this design project was to design and integrate a non-intrusive method to determine compressor real time efficiency as stepping stone to the future goal of failure modes prediction. The development of the sensor package was successful albeit with a slight inaccuracy. This inaccuracy is of little consequence however, because it is constant and thus the data can still be used to show a trend. Although our design is complete and functioning, time constraints and availability of our Turbocor advisors, ultimately kept the system from being fully integrated to begin further testing.

