Mass Flow Sensor Integration

Deliverable: Project Plan and Project Specifications

Team Number: 5

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Submitted To: Dr. Gupta

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Need Statement:

The design team sponsor, Turbocor, has proposed a project outline. Current variations of Turbocor compressors do not have a real time method for measuring efficiency. Additionally, there aren't any current sensors on board internally or externally that can measure mass flow rate specifically. This hinders the company from achieving its long term goals of providing increased asset value for their line of compressors. Since customer satisfaction is a priority, Turbocor would eventually like to offer a separate package that will be able to integrate with the technology and systems that are already present on the compressors. The need for this project is to develop a mechanically integrated, operating mass flow sensor for the Turbocor "VTT" model compressor.

Goal Statement:

Design an integrated compact mass flow rate sensor with the ability to measure efficiency of the "VTT" model compressor.

Objectives:

- Mechanically integrate a mass flow sensor
- Keep the sensor compact lightweight and nonintrusive
- Must be durable preferably with minimum moving parts if any
- Must provide added value to the customer featuring equipment health and reliability
- Must be simple to obtain and understand without extensive prior knowledge required

Introduction

Danfoss Turbocor uses mass flow meters in their testing to determine the efficiency of their compressor systems. The current hardware systems being used are variations of the Endress+Hauser Promass Mass flow sensors. These sensors use the Coriolis Principle which uses the apparent deflection of moving a moving pipe, when it is described relative to a rotating frame to determine mass flow rate. These style sensors are also capable of determining the density of the fluid that runs through them. The disadvantage of this type of system is mainly in its size and cost. The units currently in use at Turbocor are near 3ft in length and approximately 20in tall. These mass flow sensors are useful in testing situations at the Turbocor facility, however they are impractical for use in field applications. The design team's goal is to design a compact package to measure mass flow on the inlet side of the company's "VTT" compressor system so that it may be used in field applications to monitor efficiency in real time.

Desired Outcome:

Turbocor desires a small mass flow sensor that could be installed in the field on customer units, to deliver real time mass flow data to monitor efficiency. This sensor could also replace the current mass flow sensors on the test platforms currently in use at Turbocor. Turbocor doesn't currently offer the

option/Accessory of the mass flow sensor to their customer, so this will be added value. The team expects to complete this challenge by researching all mass flow sensors currently available and integrating current technology into a more compact arrangement to meet the goal. This may be possible with a design like the current flange to flange component or more desirably a probe/bung assembly.

Product Specifications:

Constraints specified by Turbocor are few with the main emphasis on footprint. The design must satisfy the following:

- Be able to measure the flow rate within ±1%
- Ideally half the size (33''x19''x10'')
- Must be non-invasive or not impede flow
- Must monitor mass flow rate on the suction side of the VTT model
- The inlet and outlet pipe diameter must be 6''
- Must be durable and cost effective
- Must be modular to be able to added to existing compressors

The Turbocor group is open to any design that satisfies these basic constraints. The mass flow measuring method is not bounded by any specific requirements, giving the team multiple possibilities of design.

Research:

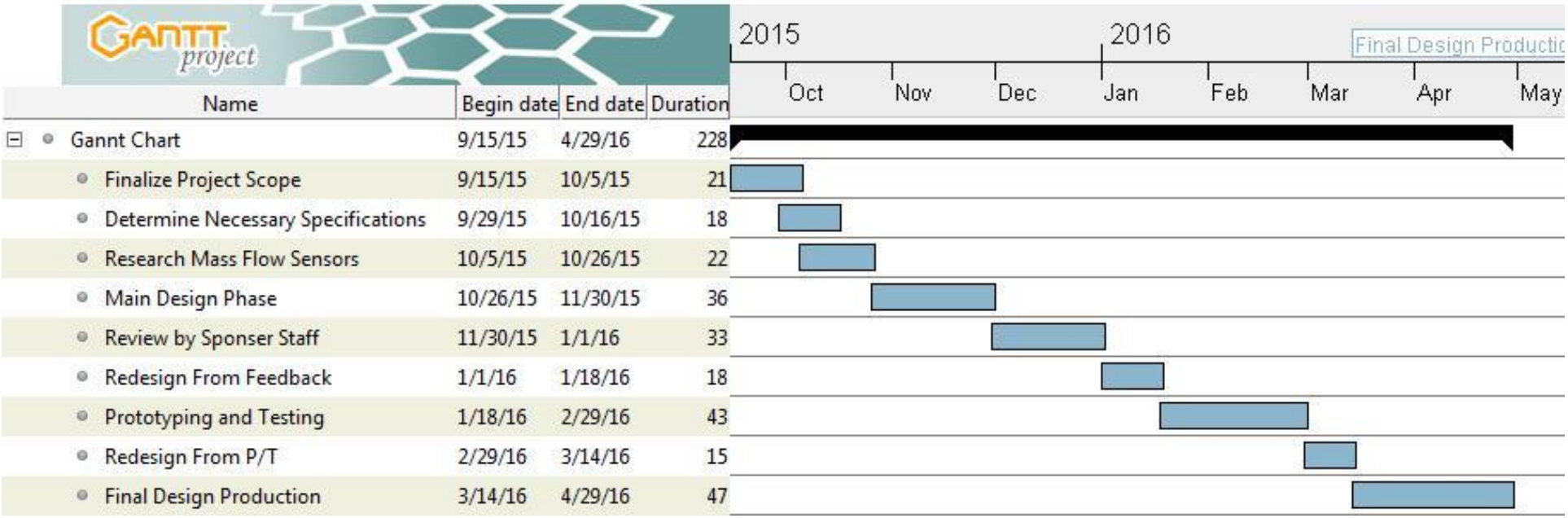
Current mass flow meters installed on the test platforms at Turbocor are the Endress-Hauser model. This Flow meter uses the Coriolis measuring principle developed by French physicist Gustave de Coriolis. The basics of how this particular unit work are thus explained: A tube in the housing is caused to oscillate constantly by an "exciter" on the inside housing wall. Sensors on the inside of the housing but close to the inlet and outlet measure this oscillation precisely. When fluid is caused to flow through the flow meter, additional twisting of the tube is caused by the fluids inertia. Due to the Coriolis effect, the section of the tube at the inlet and exit side oscillate in different directions simultaneously. The sensors detect the position of the tube in terms of time and space, also known as phase shift, and is a direct measure of how much fluid is flowing through the pipe. Higher velocity corresponds to a greater deflection of the tube. This device is also capable of measuring the fluids density by how many times the tube oscillates in one second. In a practical example, it is obvious that a tube filled with gas oscillates more frequently than a tube filled with honey. Therefore less oscillations correspond to a pre-determined oscillation rate and a fluid density.

The team is currently searching for alternative flow meter possibilities that are currently on the market. At this time research is in the infant stage as the project definition was recently defined. The team plans to research and evaluate all current models of flow meters and narrow down the technologies based on our specific project constraints. The team will then use this as a basis to move forward with a design.

Budget:

The team has not been given a specified budget to date. Turbocor has been contacted regarding the finances for this project and we are waiting on a reply. Progressing with the design project at this stage involves mainly research and planning for future events. Because of this, the budget is not essential at this point. However, it will be essential information in the near future.

Gantt chart:



Name	Begin date	End date	Duration
Gannt Chart	9/15/15	4/29/16	228
Finalize Project Scope	9/15/15	10/5/15	21
Determine Necessary Specifications	9/29/15	10/16/15	18
Research Mass Flow Sensors	10/5/15	10/26/15	22
Main Design Phase	10/26/15	11/30/15	36
Review by Sponser Staff	11/30/15	1/1/16	33
Redesign From Feedback	1/1/16	1/18/16	18
Prototyping and Testing	1/18/16	2/29/16	43
Redesign From P/T	2/29/16	3/14/16	15
Final Design Production	3/14/16	4/29/16	47