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The WILLIAM STATES LEE COLLEGE of ENGINEERING
Industrial Solutions Laboratory

UNC Charlotte – Lee College of Engineering Senior Design Program
Company Information

Company Name	*CIRCOR*	**Date Submitted**	*4/28/2021*
Project Title	*Zenith Gear Pump Leakage Model* **(CIR_ZENITH)**	**Planned Starting Semester**	Fall 2021

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	4	Electrical	
Computer		Systems	
Other ( )			

Company and Project Overview:

CIRCOR is a market-leading, global provider of integrated flow control solutions, specializing in the manufacture of highly engineered valves, instrumentation, pumps, pipeline products and services, and associated products, for critical and sever service applications in the oil and gas, power generation, industrial, process, maritime, aerospace, and defense industries.

The CIRCOR facility in Monroe NC manufactures Twin-Screw, 3-Screw and Gear pumps for a wide range of Industrial applications including chemical processing, mining, lubrication, hydraulics and oil production.

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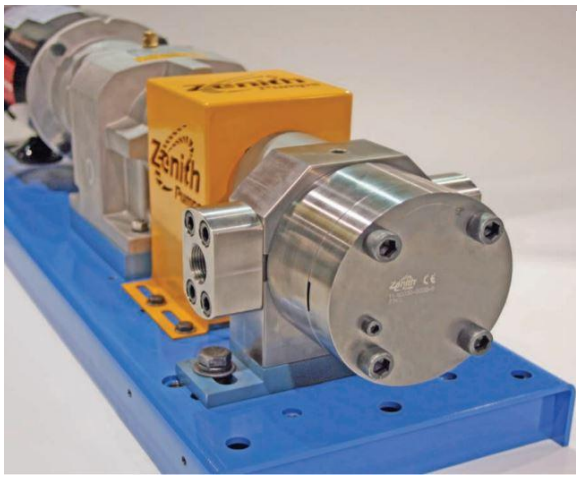

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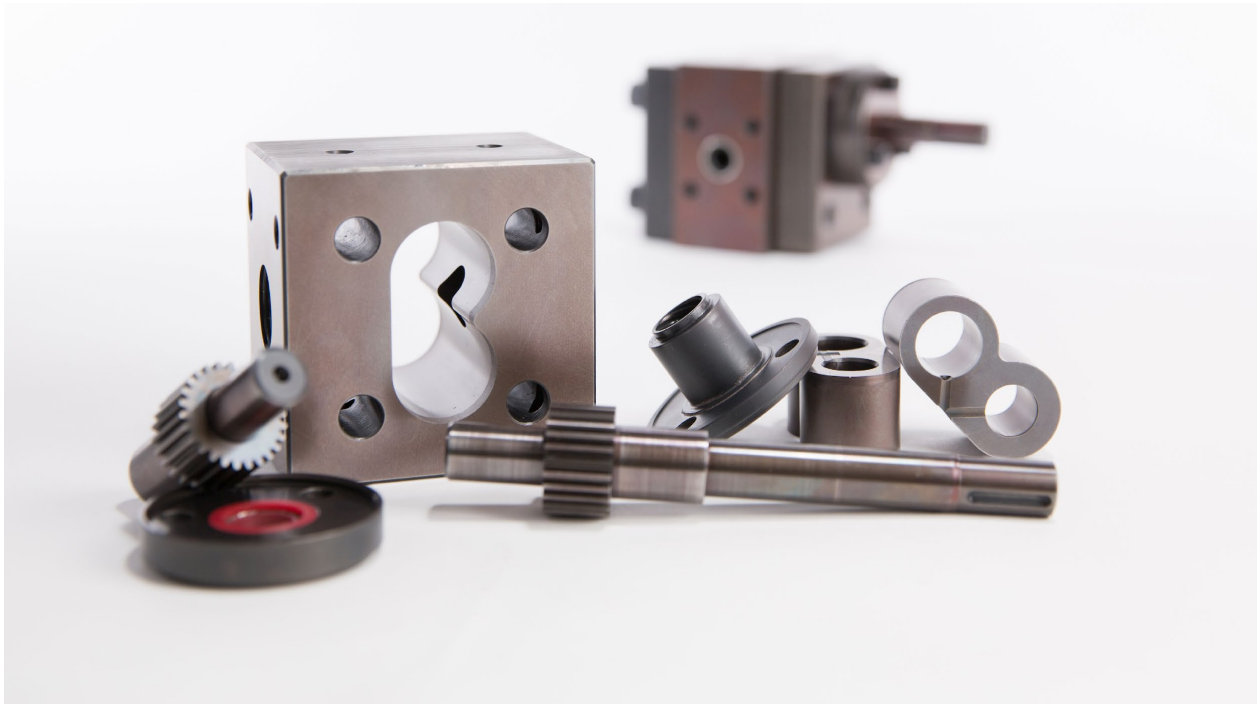
Project Requirements:

CIRCOR manufactures a range of precision metering gear pumps under the Zenith brand name. These are used in a range of pumping applications – where precise control over the amount of fluid delivered is a key characteristic. An example of the pump is shown below. These pumps are examples of precision engineering and manufacture with the critical parts made to tolerances of just 0.0001". The following video demonstrates the method of operation.



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Since these pumps are used in precision metering applications it is important that we have a good understanding and prediction of the actual flow delivered by the pump to a high degree of certainty.

As the fluid viscosity of the pumped fluid decreases, leakage losses within the pump increase. These leakages are unavoidable even when precision parts and very small clearances are utilized. These losses must be accurately accounted for when predicting the resulting flow of the pump.

Our current methods for predicting these leakage losses rely primarily on empirical testing of pumps. This was the only practical technique available at the time these pumps were first developed 50 years ago. Most testing was conducted on higher viscosity fluids. When applying the pump into applications such as low viscosity fluids, the empirically derived predictions start to break down and are of limited utility.

The goal of this project is to apply modern CFD techniques to investigate the fluid leakage paths within the pump. Based on this investigation the team would work to build a leakage model that could be used in the design and development of new or modified pump designs. If desired Circor can supply a Zenith pump for the team to test in a UNCC lab setting to help validate the CFD and leakage model.

Some aspects to be considered for accurately simulating pump conditions are:

- Selection of the appropriate CFD meshing methodology in consideration of the Positive Displacement nature of the gear pump.
- Applying meshing techniques capable of resolving small clearances between moving surfaces
- Applying the appropriate turbulence and near wall treatment methodology
- Applying the appropriate solver methodology

Emphasis should be placed on (in no specific order):

- Building a robust standard work for the CFD simulation process
- Building a robust leakage model from the CFD analysis results
- Ability to consider the effect of manufacturing variability in the model
- Suitability for both turbulent and laminar flow regimes

Expected Deliverables/Results:

- A documentation of the CFD methodologies explored and the effect of each on simulation effectiveness vs. other tradeoffs such as complexity/time/cost etc.
- Design and build of a leakage model (spreadsheet, computer code or Mathcad) that delivers predictions for the individual fluid leakage contributions within the pump. The model will consider fluid properties and manufacturing variability.

- Testing of a Circor supplied Zenith pump on selected low viscosity fluids to validate the leakage model. (Optional if desired by the group)

Disposition of Deliverables at the End of the Project:

Deliverables will be demonstrated at Expo, then handed over to Circor at the completion of Expo

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Knowledge of meshing schemes for fluid volumes in support of CFD simulations especially where the fluid volume changes over time.
- Knowledge of CFD codes and methods - MEGR3242 as a course suggestion.
- Knowledge of fluid dynamics especially as it relates to the flow of fluid through gaps and annular clearances
- Understanding of instrumentation and data logging (if the group elects to test the Zenith pump).
- Understanding of fluid systems in particular pumps and control valves (if the group elects to test the Zenith pump).