Reverse Engineering an Oil Pulse Driver

Hallie Stidham & Jessica Manning
Department of Mechanical Engineering
Clemson University
hstidha@g.clemson.edu
jamanni@g.clemson.edu
Dr. Joshua Summers, Professor
Dr. John Wagner, Professor

Fall 2016
Started Fall 2016
Techtronic Industries Power Equipment

Biography
Jessica Manning and Hallie Stidham are graduate students in mechanical engineering. They are both currently working towards their master's degrees. Jessica graduated from North Carolina State University and worked for Fluor for two years before returning to school. Hallie graduated with a degree in Physics and Mathematics from High Point University. Jessica is working with Dr. John Wagner, and Hallie is working with Dr. Joshua Summers as part of the Clemson Engineering Design Applications and Research Group.

Overview:
The goal of this research project is to reverse engineer a RIDGID oil pulse driver to understand the underlying principles behind the oil pulse mechanism. From there a model will be made in Simulink to enable changes of different system parameters to see how they can improve the oil pulse unit.

Motivation
Companies have spent several years reverse engineering existing oil pulse drivers to be able to implement a more efficient oil pulse unit into a driver of their own [1]. This design is similar to an impact driver, however it operates with half of the noise level and double the speed [1]. However, the oil pulse driver has several complications that through this research we hope to reduce. The oil pulse unit has less torque and heats up quickly when used for extended periods of time. By reverse engineering the oil pulse driver down to mathematical equations that model the governing principles, companies will be able to change different parameters to make a more effective design.

State of the Art
Currently there are limited investigations into the underlying principles of an oil pulse driver. Similar reverse engineering projects have been done on other drivers, such as impact drivers. Evidence of reverse engineering on oil pulse wrenches have also been conducted. By comparing previous reverse engineering projects to the oil pulse driver, we will be able to create a first principle model of the oil pulse unit.

Intellectual Merit

There are two main research questions that will be addressed during this study. Currently as the oil pulse driver heats up, the viscosity of the oil changes and thus leads to a decrease in performance. By investigating the viscosity as a function of temperature we will be able to look at alternatives to the oil as the fluid inside of the oil pulse driver. In addition to potentially changing the volume of the oil pulse unit itself to allow for better heat reduction. Next we want to be able to model the torque output and find the limits of said output, allowing an investigation into how to improve the output of the driver through specific manipulation of various parameters.

Broader Impact

By reverse engineering this device, the concepts and underlying principles in the oil pulse unit will then be available to be applied to other devices. Using oil as a medium for electromechanical systems, specifically mechanical transfer of energy through this medium, could lead to the discovery of more effective designs with similar devices. Having a working understanding of the underlying principles allows for manipulation of one parameter to study the affect the parameter has on the entire system.

Research Approach

There are four different tasks with accompanying milestones that have been outlined for this project. The first milestone is to dissect a RIDGID oil pulse driver and experiment with the current system setup. During experimentation different individual parameters will be held constant to gather data on influences. Data will be taken on temperature, heat flux, viscosity, density, torque, amperage, and vibrations. The second stage is comprised of a first principles analytical model created based on the previously mentioned parameters. This model will be representative of the experimental data taken, and also give insight into what additional tests and analysis are needed. The third stage will be to complete a meta-model of the parameters. Here the sensitivity and upper and lower bounds will be identified for given parameters.

Findings to Date

Thus far we have been able to fully disassemble a RIDGID oil pulse driver. We have also been able to fit one end of the oil pulse unit with a Plexiglas cover to allow us to look at how the oil pulse unit itself operates. A model of an electromechanical system has also begun to allow for the manipulation of variables within the RIGID oil pulse driver.

Conclusions

The major anticipated results of this project include mechanical analysis and experimentation (dissection) reports, a first principles model of the system, a Meta-Model of the parametrically defined solution space, and alternative concepts and solutions proposed and documented.

References

[1] Summers, J., Wagner, J., 2016, "TTi 2016: Oil Pulse Driver Modeling and Analysis"