Restated Project Scope
Super Seal: Adding a 2nd Stage Sealing Device To Recapture Oil From Seal Leaks

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Abstract

The goal of the Cummins Inc. sponsored project is to design a device that will capture oil that leaks out of a crankshaft seal. The collected oil is to be transferred to a holding reservoir enabling future reinsertion into the crankcase. This objective will be obtained through the application of various engineering design methods, coupled with collaboration between the college and industry appointed sponsors. The overall effectiveness of this device will be assessed through a 24-hour simulation across various operating regimes proposed by Cummins, and carried out through a custom test rig for which the group must also design and fabricate. Team 1 has done preliminary research into the problem to better understand the gap between the current and ideal situation, as well as the concept of the product needed to achieve success with the objective.

Acknowledgements

The group would like to make a point to thank Dr. Shih for his hard work in gathering the available projects for the entire semester. In addition, an acknowledgement must be made for the course instructor, Dr. Gupta, seeing as how he has been (and will continue to be) the main source of information pertinent to the course. Furthermore, a note of gratitude would like to be made for the sponsor engineer, Terry Shaw, for his time and effort spent with the team thus far.

Project Scope

The scope of this project has not been modified since the last semester but there are still many aspects of the project that need to be completed. Team 1 will receive the faulty seal from Cummins early on in the spring as well as finish ordering parts for the test rig. The bulk of the time left in the semester will be spent assembling the test rig and fabricating the secondary seal. There are a few weeks towards the end of the semester which will be set aside for the testing and adjusting of the test rig and secondary seal.

Problem Statement

A current industry setback is that engine oil commonly leaks past the rear crankshaft seal. This particular failure is becoming more paramount in the eyes of the customer. This failure is leading to premature engine overhaul.

Goal Statement

“Design a device to capture leaking oil from a rotating test crankshaft and deposit it in a reservoir so that it can later be reintroduced to the crankcase. Additionally, a test rig for the device must also be fabricated in order to assess the functionality of the design.”

Constraints

- Design a capturing device to collect oil that has leaked from a rear crankshaft seal.
- Design a rig that can be used to test the recapture device in order to determine its overall effectiveness.
- Determine feasibility of each design with technical proof (calculations, drawings, etc.).
- Order, obtain, or manufacture components for each design.
- Construct the oil recapture device.
- Construct the test rig; ensuring it can adhere to the operating regimes given by Cummins.
- Perform the 24-hour trial, and assess overall project success.
    - Rig must be able to operate continuously at variable speeds between 500 and 2000 RPM.
    - Rig must rotate the appropriate size “crankshaft” across the provided operating regimes.

Objectives

- Design a capturing device to collect oil that has leaked from a rear crankshaft seal.
- Design a rig that can be used to test the recapture device in order to determine its overall effectiveness.
- Determine feasibility of each design with technical proof (calculations, drawings, etc.).
- Order, obtain, or manufacture components for each design.
- Construct the oil recapture device.
- Construct the test rig, ensuring it can adhere to the operating regimes given by Cummins.
- Perform the 24-hour trial, and assess overall project succes

Methodology

Team 1 will complete the project primarily by dividing the remaining tasks into sections to maintain good lead time on fabrication and assembly of parts. The bill of materials (BOM) has been finalized and the remaining parts left to be ordered will be signed off on over the next couple of days. There are a few components of the test rig that will need to be machined and custom fabricated such as the tapered test shaft and the hybrid labyrinth seal. The tapered shaft is custom made in order to accurately represent the size and shape of the crankshaft without need of a full size, 4 ft. long shaft. The “Super Seal” also needs to be fabricated because the standard hybrid labyrinth seals do not match the tight tolerances and constraints allowed by the crankshaft. Team 1 is still working on the overall design for the hybrid labyrinth seal but have completed the design of the test rig and will work on assembling it while the secondary sealing system is finalized. After all of the sealing systems and testing systems have been fabricated and assembled the testing phase will begin. The data collected over the 24-hour testing period will determine if the secondary sealing system and test rig were a success. The determination for success of the project is based on the proportions of the oil captured by the 2 containers. If the amount of oil captured by the super seal container exceeds the amount of oil that escaped from the super seal enclosure then the project will be deemed successful.

Progress Made

Senior design team 1 has finalized a design for the test rig. Initial cad renderings have been created. Team 1 has entered into the procurement stage of the project. The team has constructed a bill of materials with as many off the shelf components as possible. Due to irregular dimensioning several components required machining. The university's machine shop would assist the team with the fabrication of the custom components. Many of the off the shelf components have been ordered. The conceptual design for super sealing system has been completed. At this time team 1 had previously anticipated being through with the ordering phase. Due to the challenges encountered team 1 will keep a sharp focus on making up for lost time.

Schedule

The dynamic of team 1 throughout the first semester resulted in a change in scheduling. Due to unforeseen obstacles team 1 has fallen behind the original tentative schedule. As shown below in figure 1 team 1 has created a new Gantt chart. The team has finalized the bill of materials the week of January 27th. The procurement process has been initiated and will conclude by the end of the month of January. During the month of February team 1 will maintain its focus on fabricating a labyrinth seal and other custom components as well as assembling the test rig. Early March will be dedicated to the testing process. These results will then be analyzed through the 15th of March. The final month of the project will be set aside to make any necessary adjustments for the testing process.

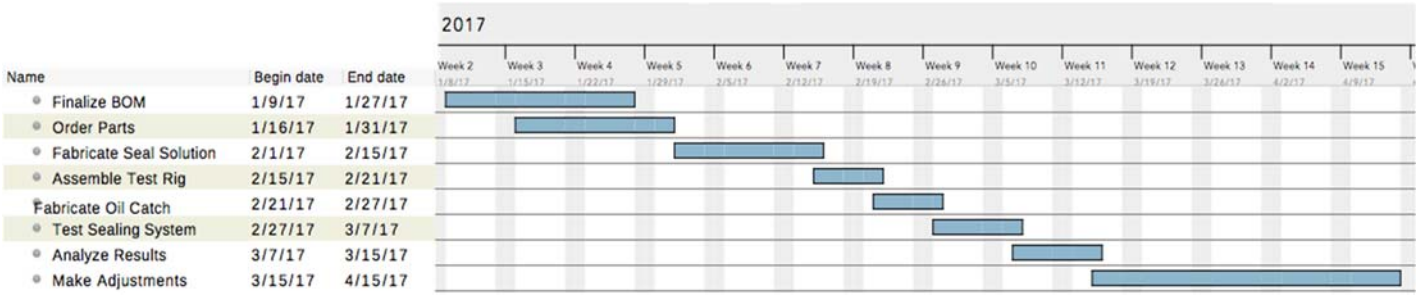

Fig. 1 Displays the Senior Design Team 1 Gantt chart for the spring semester

Summary

At present the rear crankshaft seal on heavy duty Cummins diesel engines have trace amounts of oil escaping early in the life of the engine. This problem is has grown with increasing demands for longer engine life by customers. This failure is perceived by customers when areas surrounding the rear crankshaft seal have oily residue build up. To combat this Senior Design Team 1 will be designing a hardware configuration capable of recapturing the oil that leaks past the rear crankshaft seal. The oil recapture device must drain to a container that will be used to hold the oil until it could be later reinserted into the crankcase. This secondary sealing system will be tested on a student designed test rig. This test rig will have a shaft with machined to mimic the tapered crankshaft on a 15 liter diesel engine. This test rig will adhere to a 24 hour test run at sponsor given parameters. During this test the shaft will spin at 500 and 2000 RPM. The project will be deemed successful if the secondary sealing hardware configuration is able to capture more oil than can escape beyond the secondary sealing system. Currently team 1 is in the ordering phase of the project. Many “off the shelf” components have been selected and purchased. The team will soon begin fabricating the custom components needed for the test rig and secondary sealing system. After all components have been acquired the rig will be assembled. At this time the team will move into the testing phase. After conducting a successful 24 hour test the results will be recorded and analyzed.

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