Determining the Effectiveness of Oleophobic Gaskets

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Purpose

Cummins Inc. has proposed a project to determine the effectiveness of oleophobic gaskets to reduce the measured leak rate at low pressure, large joints on engines compared to the current gaskets used on engines.

Background

- Oleophobic items are items which repel oil by having a lower surface energy than the oil.
- A gasket is an item which is placed between two flanges to form a seal, which is meant to prevent oils from leaking to the opposite side of the flange.
- The theory behind the project is that if the gasket can repel the oil, it is less likely that oil will be capable of leaking past the gasket.
- Low pressure joints on engines include the oil pan, gear housing, and valve covers.
- Common gasket types that are used in this application include paper and rubber coated metal.

Objectives

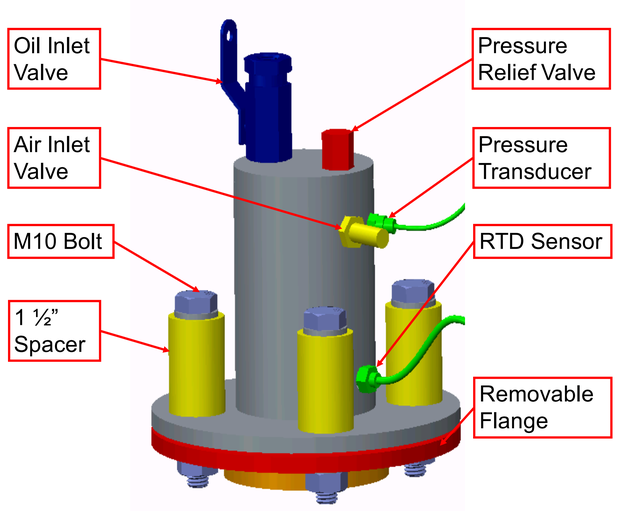
- Research what causes items to become oleophobic.
- Create oleophobic gaskets using on market products.
- Create oleophobic gaskets using non-conventional gasket materials.
- Design and build the test rig to be capable of varying clamping pressure and temperature.
- Test oleophobic gaskets and currently used gaskets for leak rate and compare results.

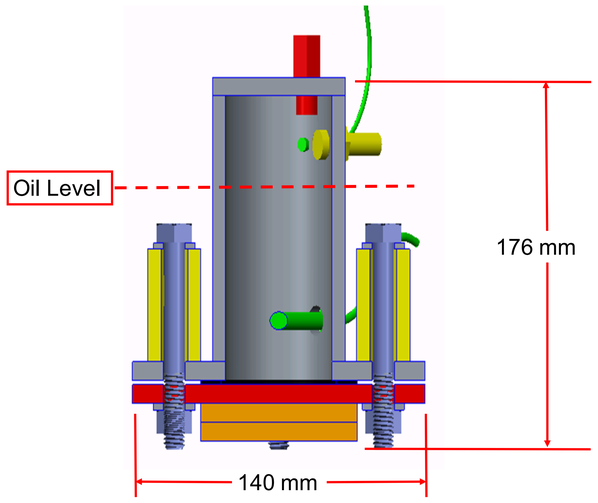
Product Specifications

Design Specifications	Required Value
Test Rig Dimensions	Inner Diameter: ≤ 55 mm
Test Rig Stress Capacity	Minimum bottom flange thickness: 4.94 mm
Flange Dimensions	Inner Diameter: ≤ 55 mm Outer Diameter: > 140 mm
Clamping Pressure	Minimum: 0.5 MPa Maximum: 10 MPa
Flange Surface Roughness	Maximum: 3.2 μm RA

Performance Specifications	Required Range
Oil Temperature	22-120 ° C
Internal Pressure	0-2.5 psi

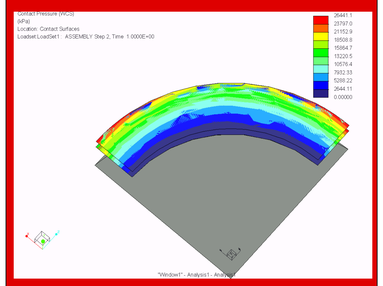
Test Rig Conceptual Design





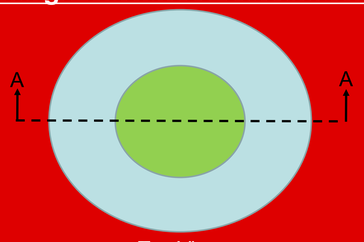
Test Rig Analysis Results

Clamping Pressure FEA

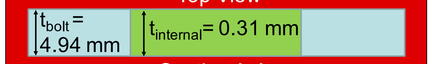


Gasket clamping pressure distribution based on analysis results that ensures no leak paths running radially through the gasket.

Flange Thickness Calculation



Top View



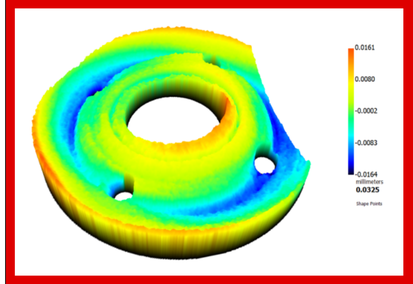
Section A-A

Flange material: A36 Steel

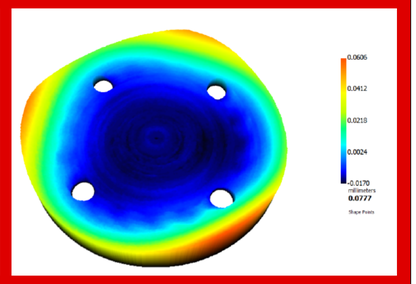
Green section $\sigma_{max\ internal}$ = 2.5 psi

Blue section $\sigma_{max\ bolt}$ = 10 MPa

Flange Surface Roughness Measurement



Top Flange
2.90 microns RA



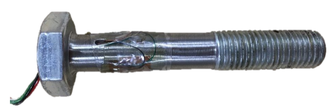
Bottom Flange
2.03 microns RA

Test Rig Sensors

- Ideal Gas Law used to measure leak rate (PV=nRT)
  - nRT held constant
  - $P_1V_1 = P_2V_2$
  - Leak rate = $\frac{\Delta V}{\Delta time}$

Omega RTD Sensor

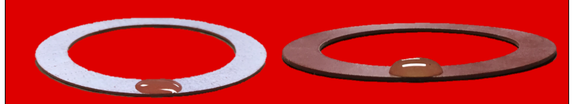
Kulite Pressure Transducer



Strain Gauged M10 Bolt

Preliminary Gasket Results

Paper Gasket Testing



No Oleophobic Solution

Impregnation Oleophobic Solution

Fiber Felt Testing

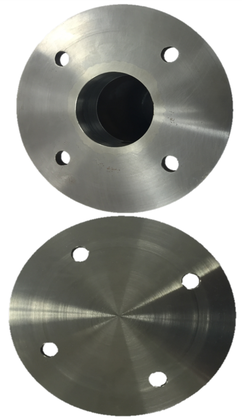
No Oleophobic Solution

Impregnation Oleophobic Solution

Spray Oleophobic Solution

Fabricated Components

Test Rig mock up assembly



Test Rig flanges

Future Work

- Setting up the lab for experimentation
- Collection, manipulation, and analysis of data
- Final experimental comparison/deduction

Acknowledgements

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