Flow Visualization of Oil Flow inside a Gearbox Model

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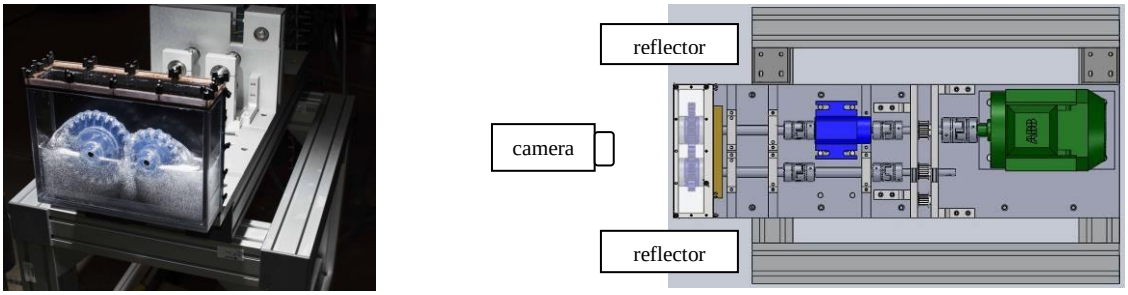
Gearbox is an essential element in power transmission. Efficient gearbox means efficient power transmission. Hence lower energy consumption. Losses in the gearbox can be sorted into two; load-dependent and load-independent losses. Load-dependent are related to friction, and load-independent losses are mainly related to lubricant. Load-independent losses are the focus of this paper.

An experimental rig (Chalmers gearbox rig) based on the FZG gear test rig was built. The test gears have a slight gap in between the mate teeth and are driven by slave belt and in order to eliminate contact (friction). The idea is to get pure load-independent losses.

Flow visualization study was chosen as a first method to study oil flow inside a gearbox. A set of external flash and a camera were used to capture instantaneous splashes in different pitch line velocity and different oil level. Hydrotreated process oil was used due to its transparency. The temperature of the oil was maintained at 40°C to match the viscosity of Castrol Syntrans 75W-85 at 90°C. Understanding the splash behavior are essential in order to understand the flow phenomena and to be able to study the flow further with more advance method, such as computational fluid dynamics (CFD) or particle image velocimetry (PIV).

Figure 1(a) shows the Chalmers gearbox rig and figure 1(b) shows the experimental setup. The camera is located in front of the test section and a flash is located on top of the test section. Three reflectors were used to make the lighting uniform. Two reflectors (see white box in figure 2b) located at the sides and one reflector under the test section.



(a) (b)

Figure 1: The experimental rig (a) The Chalmers gearbox rig (b) The experimental setup

The flow phenomena of oil flow inside a gearbox are quite complex, as seen in figure 2. There are free-surface flow, splash, drops, bubble formation, etc. In higher level of oil the bubbles form faster compare to the lower level. The advantages or disadvantages of presence of bubbles are not yet known, and need to be studied furthermore. The amount of oil that was dragged by the gear is increasing in the higher level oil, hence higher losses are generated.

(a) (b) (c)

Figure 2: Instantaneous splash with 0.06 m/s pitch line velocity and oil level at;

(a) Centerline (b) One tooth height small gear (c) 1 tooth height big gear

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