LUBRICATION OF ROLLING BEARING IN THE STARVED REGIME BY DROPLET ON DEMAND

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KEYWORDS
Fluid lubrication; EHL; Experiments in tribology; Droplet on Demand

ABSTRACT

Rolling element bearings are widely used to enable rotary motions whilst positioning components. To enable a long life and reduced friction, rolling element bearings are lubricated. Lubrication is realised with grease, oil-bath, or oil-air. In all cases the lubrication relies on the oil to form a lubricant film that is thick enough to separate the steel surfaces of the bearing components.

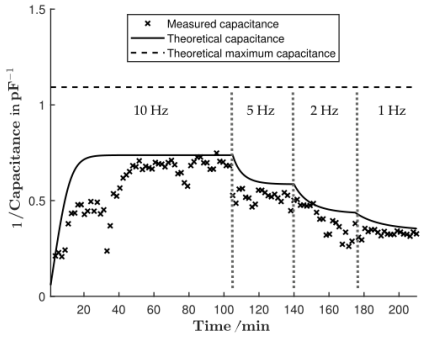
Whilst the losses of correctly lubricated bearings are small, the amount of rolling element bearings and long operating times cause a substantial energy loss globally.

By reducing the amount of lubricant surrounding the rolling elements, churning loses can be reduced. Furthermore, loses can be minimised by operating the contacts (elastohydrodynamic (EHL) contacts) in the state of starvation. This means that the lubricant in the inlet meniscus is reduced. While this leads to a reduced film thickness, compared to the state of fully flooded lubrication, it can be maintained as long as no asperity contacts occur and the temperature does not rise above critical values.

In this work we present a mechanism for (re)lubrication control to maintain a minimal level of lubricant in the bearing. By using inkjet technology a Droplet on Demand (DOD) supply is realised. An inkjet micropipette system is used to eject picolitre droplets at a controlled frequency onto the raceway of a rolling element bearing.

The droplets are controlled in shape, speed, and volume. DOD was so far tested on single model ball-on-disc contacts [1] and gear teeth [2]. We demonstrate the feasibility of the mechanism for Deep Groove Ball Bearings (DGBB). It is shown that DOD lubrication enables operation of a bearing in the starved lubrication regime, at a stable film thickness level which can be controlled by the droplet size and frequency.

By implementing an electrical capacitance measurement system on the rolling element bearing, the film thickness in the contacts can be monitored. Fig 1 shows the behaviour obtained when lubricating a cleaned bearing with 9 pL at a frequency of 10 Hz. This shows that a film forms and can be maintained at a constant starved level (below the value expected for full film).



Note: 1/Capacitance is proportional to Film thickness

Fig 1: Droplet on demand lubricated DGBB6008 capacitance over time with a droplet frequency of 10, 5, 2 and 1 Hz and a droplet volume of 9 pL at 700 rpm and 500 N axial load. Starting with a clean bearing.

When reducing the amount of resupplied lubricant the film thickness will be even lower. These low films can be maintained for long periods of time.

By using the electrical measurement and variable relubrication, we could show that continuous operation is possible.

REFERENCES

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