EXPERIMENTAL STUDY OF THE MIXED-ELASTOHYDRODYNAMIC TRANSITION WITH LOW VISCOSITY LUBRICANTS

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Mixed Lubrication; EHL; Lubricant additives

ABSTRACT
The friction in passenger car engines plays a crucial role in fuel overconsumption. To minimize friction and reduce these energy losses, new surface coatings and new low viscosity lubricants were developed and their combined use needs to be evaluated. The contacts in engines cover all lubrication regimes and, therefore the Stribeck curve appeared as the appropriate tool for this evaluation. Even if this curve exhibits the three main lubrication regimes, the transition between the mixed (ML) and the elastohydrodynamic (EHL) lubrication must be determined accurately with additional traction experiments. We attempted to find how surface coating and low viscosity lubricants shift the onset of ML.

We performed Stribeck and traction experiments at moderate speed (10^{-3} – 1 m/s) and pressures (0.1 – 1 GPa), for three lubricants of viscosity ranging from 30 to 50 mPa.s at 22°C (base oil, base oil + viscosity index improvers and fully formulated oil) and several surfaces (quartz, sapphire, steel with or without DLC coating). Two ball-on-disc tribometers were used: the IRIS tribometer and the Mini-Traction-Machine (MTM). The surface speeds were controlled independently, and the normal and tangential loads were measured simultaneously. Also, the IRIS tribometer was equipped with an interferometry system allowing the measurement of the contact area and the lubricant thickness distribution. The experimental conditions for the traction experiments were carefully chosen to completely separate the surfaces and minimize the temperature increase. For the Stribeck experiments, a moderate Sliding-Rolling Ratio (SRR = 25%) was chosen to avoid surface wear at low speed. Materials and methods were detailed in [1].

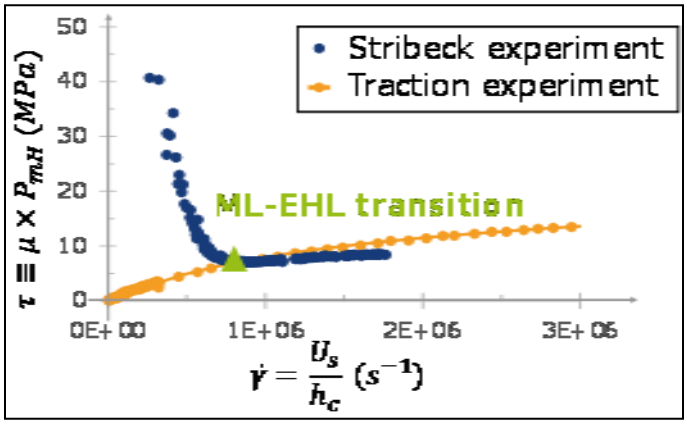

Fig.1 Stribeck and traction curves allowing to define the mixed-EHL transition (example with a low viscosity base oil: steel/steel, mean Hertz pressure 440MPa, Stribeck SRR 25%, inlet oil viscosity 23 mPa.s at 27°C)

The transition was defined as the intersection of the Stribeck curve with the traction curve presented in Fig 1. At this point, the friction becomes higher than the viscous shear stress. The influence of parameters such as the pressure or the sliding will be commented and finally, the role of our surfaces and our lubricants on the ML-EHL transition will be explained.

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REFERENCES
[1] J. Bonaventure, "Influence of random surface roughness on friction in elastohydridynamic, mixed and boundary lubrication", PhD thesis, Ecole Centrale de Lyon, 2017.