DEVELOPMENT OF A REPEATABLE, ACCURATE CHAIN DRIVES DYNAMOMETER

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Friction; Experiments in Tribology; Mixed Lubrication, Chain

ABSTRACT

In recent years, there has been a resurgence of interest in understanding the performance of chain drives [1] [2]. This is due to the heightened attention paid to whole system efficiency for which power transmission is critical. In this work, we seek to motivate and describe a Transmitted Power Measurement (TPM) dynamometer for measuring friction in chain drives to a high degree of accuracy. Independent repeats of a baseline chain and commercially available lubricant combination across multiple test campaigns have yielded an uncertainty of <±1.75% of the measured power loss at the 99% confidence interval, this bounds of uncertainty is shown in Figure 1. as a percentage of power lost for a torque-speed map representing track cycling. This repeatability performance is of the same order of magnitude as the predicted GUM Method A measurement uncertainty and significantly better than the more conservative GUM Method B approach [3].

The development of this particular facility was motivated by the demands of high-performance sport, but has applicability to a wide variety of applications with similar power and speed envelopes. The dynamometer is designed to transmit prototypical powers based on the track cycling performance envelope. This allows the most accurate representation of boundary conditions for the chain, with a fixed centre-centre distance between two drivelines and a true tight and slack span. One driveline acts as a brake to the other and the apparatus can be driven with a twice-per-revolution varying torque input that mimics the rider power delivery. The speed and power envelope available using this experimental facility is far broader than that of the sporting application and therefore can be used to investigate other phenomena including higher frequency dynamics of the chain drive.

Rotating flange type torque transducers are employed in both drivelines. These must be isolated from high shaft-end radial loads by auxiliary shafts and bearings. The additional friction introduced by these components must also be compensated to reach a true measurement, and both simulation and empirical techniques have been investigated to this end, with empirical results ultimately being preferred.

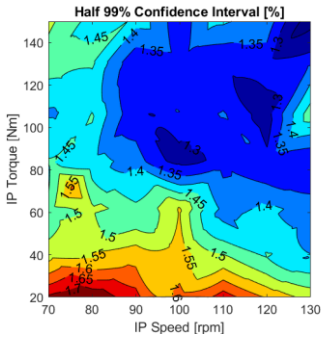

Figure 1. Example map of error bounds on chain drive efficiency.

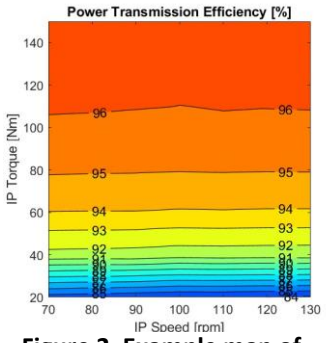

Figure 2. Example map of chain drive efficiency vs. input torque and speed.

Recent measurement campaigns have focused on understanding lubrication performance. Results are presented as a map against system input torque and speed from which properties such as tight span tension and contact pressures may be inferred; such a map, expressed as transmission efficiency, is hown in Figure 2. The measurement bandwidth allows the impact of dynamic phenomena in the chain such as transversal resonance and polygonal action to be identified in results and future research will further explore these effects and their interaction with lubrication.

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