The Design of Low-Inertia, High-Speed External Gear Pump/Motors for Hydrostatic Dynamometer Systems

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ABSTRACT

The demand for transient dynamometer testing systems is on the rise in the automotive industry. A useful power transmitting device for these systems is a hydraulic pump/motor due to its extremely low-inertia and minimal maintenance requirements. For a high-speed hydrostatic dynamometer system to be commercially acceptable, a pump/motor capable of speeds in excess of 8,000 RPM must be available with appropriate power capacity. Current industrial solutions offer speeds up to 3,000 RPM and 5,500 RPM respectively for external gear and piston pump designs and are therefore unsuitable for testing the upper speed ranges of numerous currently produced automotive engines.

In this study, the effects of various pump housing, thrust plate and gear designs are examined utilizing Simerics' PumpLinx pump/motor specific CFD software. As speeds increase, external gear pump/motors can suffer from severe cavitation damage due to the fluid vapor produced when the gears disengage after the contact point passes the centerline of the mesh zone in the theoretical intake region. The pump/motor design must be optimized to decrease the speed of vapor bubble collapse and minimize the volume of vapor produced in the intake region. The proposed method is via controlled pressure application and the introduction of high pressure leakage from the outlet to the inlet. Once a suitable design is found, a prototype will be built and tested for wear on the gear sets and bearings at various speeds above 3,000 RPM and load pressures up to 5,000 psi.