Test Rig Design for Compact Variable Displacement Vane Pump

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ABSTRACT

Variable displacement vane pumps (VDVP) are one type of positive displacement pumps used in automatic transmission vehicles for lubricating the gears, cooling the transmission and actuating the clutches. Though fixed displacement pumps are widely used, they output a constant effective flow at a given speed. Depending on pump sizing considerations, the pump can be oversized at high speeds because flow demand of the transmission is independent of engine speed. The excess flow returns to the tank through an orifice that causes the oil to heat up, increasing the energy required for cooling and reducing the efficiency of the transmission. A VDVP is used because the effective flow is adjustable to meet transmission demands any speed. The VDVP studied in this paper is unstable because of a feedback loop between pressure fluctuations at the pump’s outlet and the control system. To design a better VDVP with increased stability and controllability, a simulation model of the current pump design needs to be validated against measurements. Therefore a test rig design with required pump modifications is proposed in this study. Six pressure sensors are installed such that they measure the pressure in each of the pump’s displacement chambers. A LVDT is used to measure the pump’s eccentricity changes as the displacement is varied. Part of this study was to develop a custom MATLAB script that combines all the sensor data to show a pressure profile for each displacement chamber. The pump modifications for sensor installation and test rig implementation was designed.

KEYWORDS

Variable Displacement Vane Pump, Pump Modelling, Experimental Test Rig, Model Validation, Pressure Fluctuations, Sensor Post-Processing, Automatic Transmission.