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A Fast Model for the Simulation of External Gear Pumps

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ABSTRACT

External gear pump is an important category of positive displacement fluid machines used to perform the mechanical–hydraulic energy conversions in many fluid power applications. An efficient numerical simulation program is needed to simulate the system in order to provide a direction for design purpose. The model consists of a lumped parameter fluid dynamic model and a model that simulates the radial micro-motions of the gear's axes of rotation. The system consists of a set of ordinary differential equations related to the conservation on mass of the internal control volumes of the pump, which are given by the tooth space volumes of the gears. Flow connections between the control volumes are introduced, as laminar or turbulent orifices to model the displacing action and the internal leakages of the unit. In order to optimize the numerical solution, the whole system is described in C++ and the ODEs are solved using linear multistep methods. The results of the simulation successfully match the experimental results as well as the predictions of a previously developed simulation tool. The results detail several features of the model, such as its capability of predicting the instantaneous tooth space volume pressure, the micro-motion of the gears and the outlet flow oscillations. The simulation model can be utilized in future research on external gear pump, as well as for design purposes. In particular, with its simulation swiftness the model is particularly suitable for virtual prototyping within numerical optimization procedures.

KEYWORDS

External gear pump, numerical simulation, fluid power system