

ABSTRACT

Wilfong, Gabriel J. M.S.E., Purdue University, May 2011. Design and Dynamic Analysis of High Speed On/Off Poppet Valves for Digital Pump/Motors. Major Professor: Dr. John H. Lumkes, Jr.

The main goals of this research were to model, design, fabricate, and test an on/off valve suitable for digital pump/motors. Preliminary modeling and comparison of valve designs led to the decision to pursue a two stage bi-directional check valve design (BDCV). A lumped parameter coupled multi-domain model was developed to evaluate the dynamic performance of the BDCV main stage and was used in an iterative design process to specify design traits of the main stage valve.

A prototype BDCV main stage was designed and manufactured. Steady state and dynamic measurements were taken of the valve to validate the model and the design. The main stage valve operated faster during active checking (2 to 3 ms) compared to passive checking (60 to 100 ms). Finally, experimental testing of a single piston pumping chamber was conducted to demonstrate the prototype's bi-directional functionality. Two different control methods of the BDCV were successfully implemented to achieve variable displacement of the test stand. From this testing it was concluded that the BDCV is capable of enabling variable displacements on a digital pump/motor.