

P#72

Development of an Axial Permanent Magnetic Bearing to Improve a VAD Drive System

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Subject: Pump engineering: device design / engineering methods

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Purpose: Permanent Magnet Brushless DC (BLDC) drives are often used in radial flow blood pumps due to their ability to utilize the available axial area of the rotor. However, one potential disadvantage of this type of motor drive is the high attractive forces between stator and rotor. For this reason the use of a small permanent magnet bearing (PMB) was investigated for the compensation of these forces allowing for improved motor efficiency.

Methods: Finite Element Method (FEM) simulations of the electromagnetic fields were performed on a number of PMB topologies to determine the forces and tilt moments. Prototypes of the most promising topologies were evaluated in combination with a BLDC drive using a force transducer. Force and tilt moments between rotor and stator were measured for gaps between 0.5mm to 1.5mm. To assist in balancing the axial force, the axial positioning of the PMB in relation to the motor teeth was also investigated.

Results: The maximum axial force of the magnetized PMB was expected to be 53.7N at 0.8mm using FEM simulations. Force transducer measurements under the same conditions produced an axial force of 50.3N, verifying the FEM simulations. By decreasing the operational gap between the motor and rotor, the axial force and motor efficiency increased significantly. Compensation of this higher axial force could be achieved with the PMB, however with an increase of unstable tilt moments. The tradeoff between efficiency and tilt moment can be made depending on the characteristics of the rotor bearing system.

Conclusions: A PMB was successfully developed to compensate the high axial attractive force of a BLDC drive, allowing for higher motor efficiencies. The high tilt moments which were consequently generated must be compensated by a hydrodynamic or active magnetic bearing system.