Design and Analysis of Magnetic Suspension for New Artificial Heart

Paul Allaire
Department of Mechanical and Aerospace Engineering,
University of Virginia, Charlottesville, VA 22904-4746, U.S.A.
pea@virginia.edu

Abstract: Artificial hearts have been developed with magnetic suspension for the last 20 years, starting at the University of Virginia. A new axial flow path, magnetically suspended artificial heart-the Lifeflow-is currently under development. The magnetic suspension consists of two permanent magnet biased active radial bearings and an axial permanent magnet thrust bearing. The radial bearings are six pole bearings which employ self sensing. The pump rotates at approximately 7,000 rpm with a flow rate of approximately 5 liters/min and a pressure rise of 100 mm of Hg. The magnetic suspension system consumes only about 2 watts due to the combined use of the permanent and active magnetic bearings.

A finite element analysis has been carried out to determine the magnetic properties of the magnetic suspension system. The thrust bearing has been constructed to not require a thrust disk-which permits a very streamlined flow path for the blood through the pump. The properties of the permanent magnetic thrust bearing-magnetic flux, load capacity, axial/radial stiffness have been determined. For the active radial bearings, the bias flux, radial load capacity, open loop stiffness and current gain have been calculated. A magnetic suspension test rig has been constructed and experimental tests are ongoing.

One of the features of most current artificial heart pumps available for human implantation is that only the motor current is available to monitor the operating condition in the pump when implanted. This low level of monitoring is not sufficient to effectively monitor heart pump performance when implanted. For example, many current artificial heart pumps are subject to thrombus formation which can lead to strokes. New features of the Lifeflow pump include pressure sensors to determine the pressure at the inlet and the discharge regions of the pump, impeller radial displacements during implanted pump operation. These operating system measurements, as well as motor currents, will be sent via wifi to the monitoring medical team. It is expected that active, remote monitoring of these pumps will assist in maintaining safe pump operation.