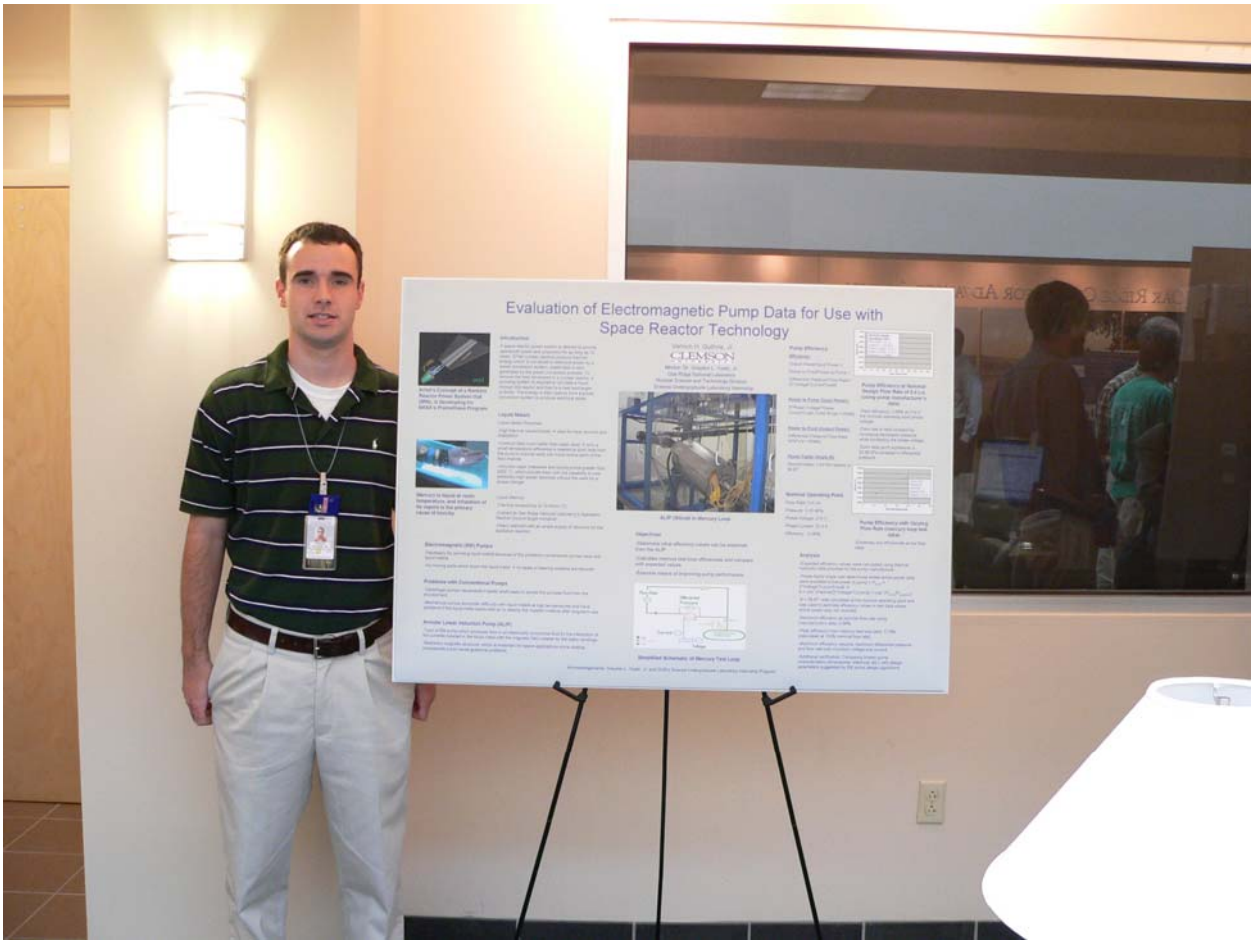
Evaluation of Electromagnetic Pump Data and Examination of Theoretical Mechanisms for Performance



The removal of heat developed in a nuclear reactor requires a pumping system to circulate a fluid through the reactor and then to a heat exchanger. Liquid metals are advantageous for use as the working fluid for cooling nuclear reactors because they have very high thermal conductivities and pumps can be used without moving parts. Electromagnetic (EM) pumps are often used for pumping liquid metals because of the problems conventional pumps have with liquid metals. Since EM pumps have no moving parts, they require no seals or bearing systems. The Annular Linear Induction Pump (ALIP) is a type of EM pump which produces flow in an electrically conductive fluid by the interaction of the currents induced in the liquid metal with the magnetic field created by the stator windings. Analysis of pump data obtained from a test loop containing an ALIP pumping liquid mercury provides insight into evaluating and maximizing pump performance. The product of differential pressure across the pump and volumetric flow rate through the pump is the work put into the fluid. Comparing this work to the product of the pump's input voltage and current allows the determination of pump efficiency. While pump data revealed efficiency values under 1%, these results were consistent with those expected for mercury ALIP pumps. The maximum efficiency calculated from test data was .78%. This value

occurred at a differential pressure of 114.4 kPa, a volumetric flow rate .616 l/s, and a pump input power of 8.98 kW. In comparison, the efficiency value was .99% when using the pump manufacturer's data at the nominal operating point of 253.3 kPa, .4 l/s, and 10.2 kW. This effort supports a larger project designed to develop a space reactor power system capable of providing spacecraft power and propulsion for as long as fifteen years.

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