UNIVERSITY OF WISCONSIN-MADISON

THERMAL HYDRAULICS LABORATORY – LIQUID-SODIUM GROUP

Jordan Rein

PhD Candidate
Nuclear Engineering

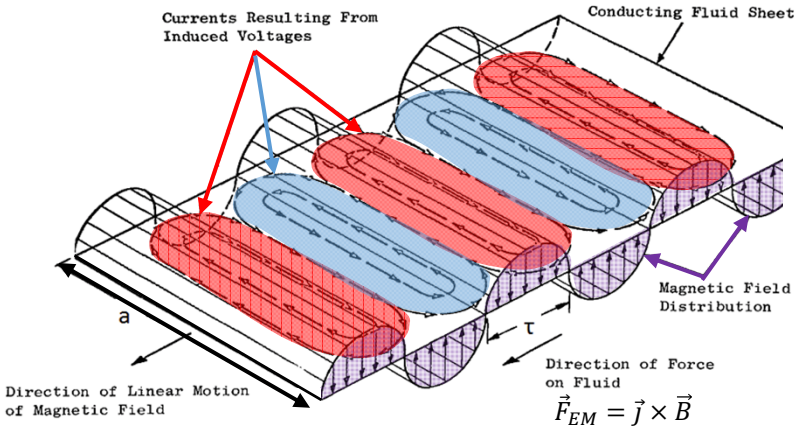
Advisor: Mark Anderson

Office: ERB 835
Email: jdrein@wisc.edu
Hometown: Wausau, WI

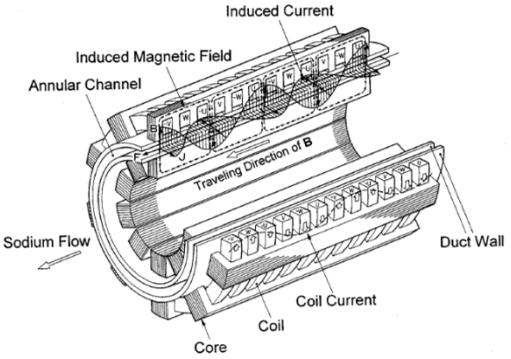
Project: Electromagnetic Pumps

Background

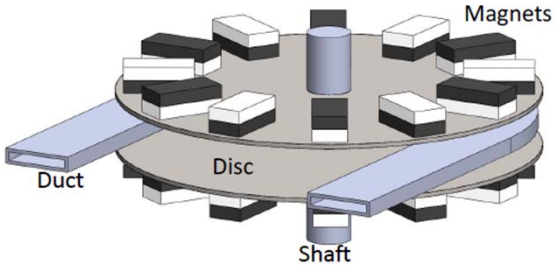
Electromagnetic Pumps use a traveling magnetic wave to pump electrically conducting fluids.



$\vec{F}_{EM} = \vec{j} \times \vec{B}$



Annular Linear Induction Pump (ALIP)



Moving Magnet Pump (MMP)

Advantages

- Hermetically sealed – only the pump conduit is in contact with the fluid.
- All components are external – repairs can be made while system stays sealed.
- Operates in any orientation – free surface is not required.

Disadvantages

- Low efficiencies relative to mechanical pumps.
- Stable operation becomes difficult as pump becomes larger.

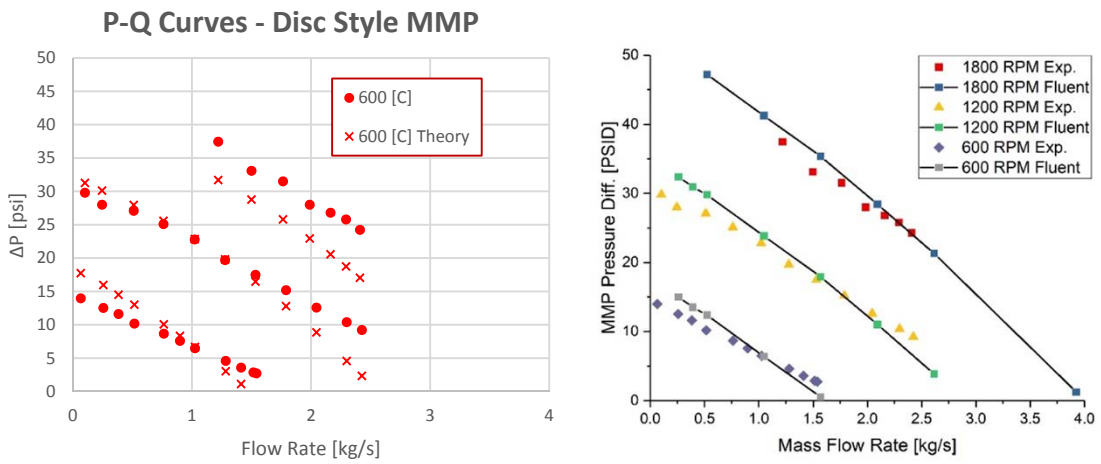
Project Goals

EM Pump Efficiency is impacted by three effects

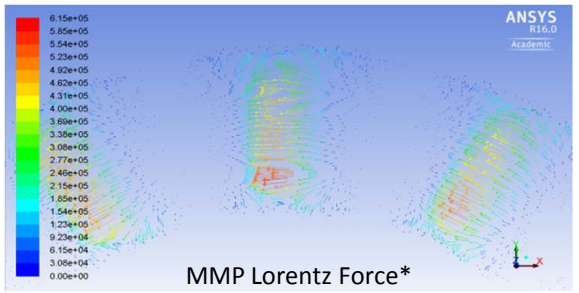
1. Transverse Edge Effect – Induced current loops connecting under active region of stator produce a non-uniform force profile near the pump sidewalls.
2. Longitudinal Edge Effect – Step change in magnetic field induces large and negative force oscillations at the pump inlet and outlet.
3. Magnetohydrodynamic Instability – EM forces in fluid flow become significant and impact pump stability.

To Improve Performance we will…

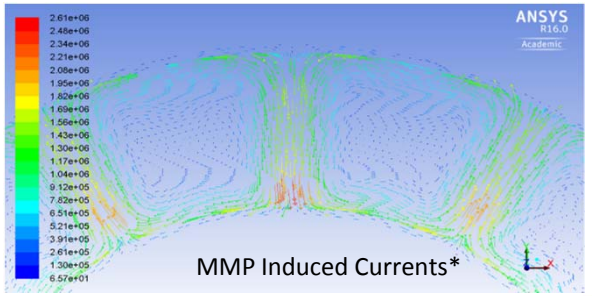
1. Produce practical EM Pump models using ANSYS/FLUENT which will guide research of Effects 1 and 2.
2. Benchmark models with Key experimental data.
3. Quantify Effects 1 and 2 with experimental measurements.
4. Optimize pump performance using an enhanced understand of Edge Effect Phenomenon.
   - Address Transverse Edge Effect in MMP
   - Address Longitudinal Edge Effect in ALIP



Experimental, Theoretical, and Numerical* performance curves for Disc Style MMP



MMP Lorentz Force*



MMP Induced Currents*

*ANSYS/FLUENT captures and numerical data courtesy of M.G. Hvasta