Soft EPM Valve Design

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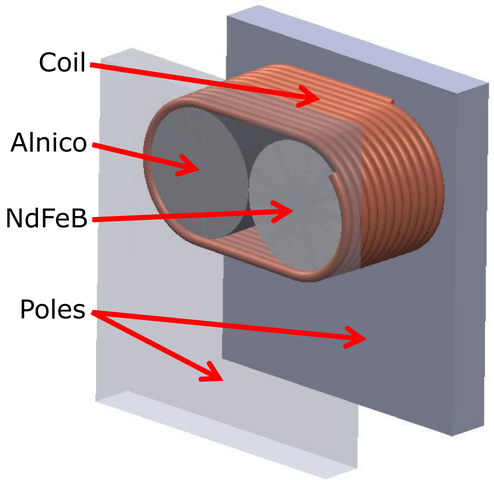
Background

Soft Robots: Inspired by Nature, Built for Adaptability offer flexible, lightweight, and safe alternatives to rigid robots, excelling in unstructured environments.

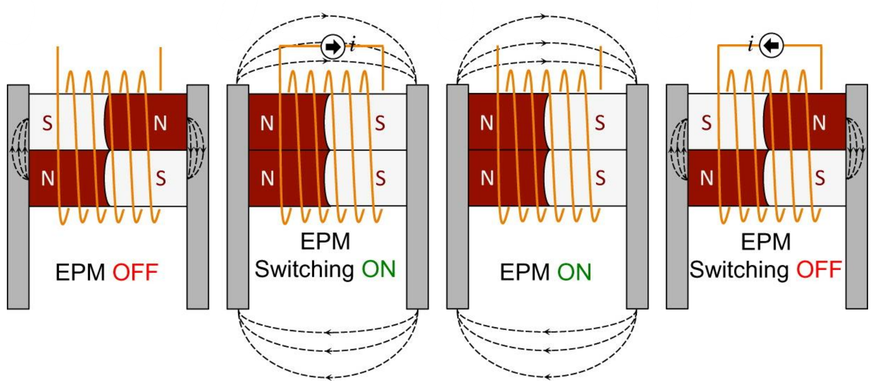
Electropermanent Magnet (EPM) for Soft Valves combine the properties of permanent magnets and electromagnets, using NdFeB and Alnico magnets to create a switchable magnetic field.

Aim

Make an electrically driven soft bistable valve to control liquid metal flow into a soft actuator, from a Magneto-hydrodynamic (MHD) pump.



Electropermanent Magnet (EPM) Components



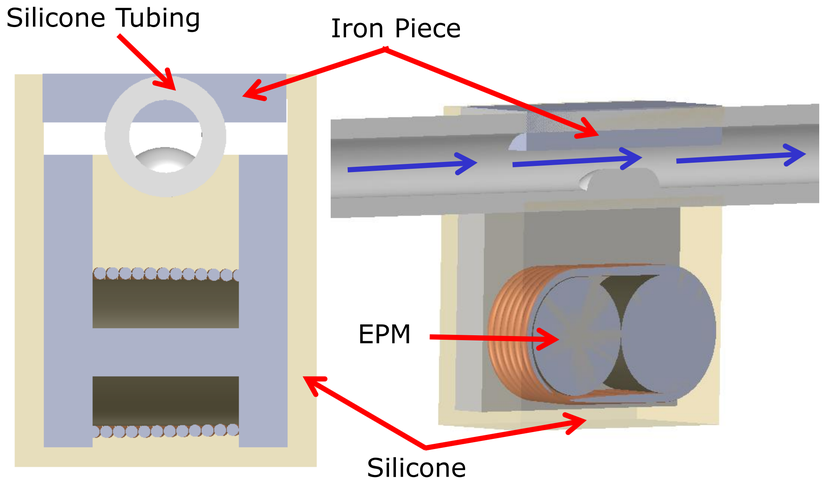
Flux pathway and magnetization states of EPM [1]

Chosen Actuator

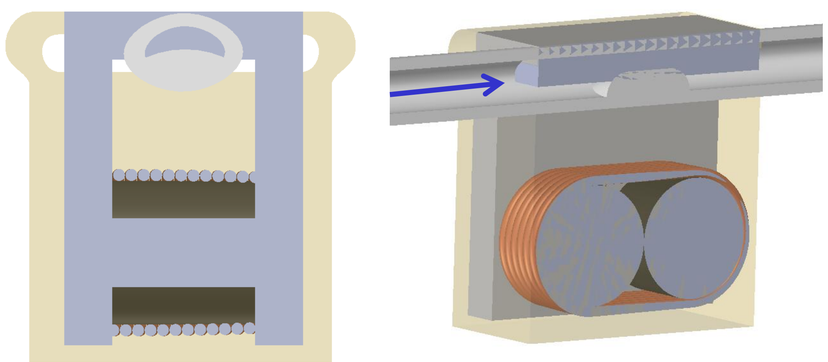
An EPM actuator was selected for its fast-switching speed (<1 second), low voltage requirements, and no continuous power demand to maintain the valve's state.

Proposed approach

An EPM embedded in a silicone structure controls a diaphragm valve, pulling an iron piece to block flow when activated and allowing flow when deactivated.



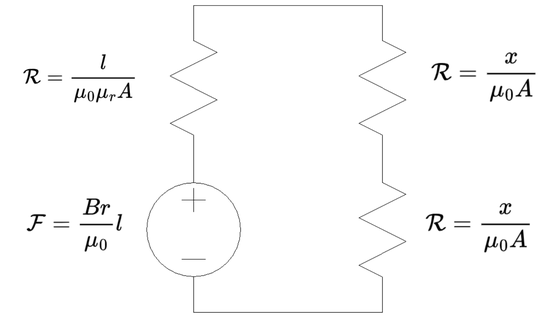
Front and side section views of EPM valve in open state



Front and side section views of EPM valve in closed state

Next Steps

Analyzing design, building and testing



Magnetic circuit of EPM

Intended Outcomes

Innovation: Integrates EPM technology in a silicone structure for bistable liquid metal control in soft actuators.

Impact (Kaitiakitanga): Designed with a focus on sustainability by minimizing energy consumption and waste during manufacturing. The use of durable materials like silicone, PM magnets, copper coil, and iron ensures long-term performance and reduces the need for frequent replacements.

Adaptability: Design for diverse environments, offering versatility and reliability across applications.

References

[1] J. I. Padovani, S. S. Jeffrey, and R. T. Howe, "Electropermanent magnet actuation for droplet ferromicrofluidics," TECHNOLOGY, vol. 4, no. 2, pp. 110–119, 2016, doi: 10.1142/S2339547816500023.