Characterizing Electroosmotic Pumps for Potential Use in Liquid Jets

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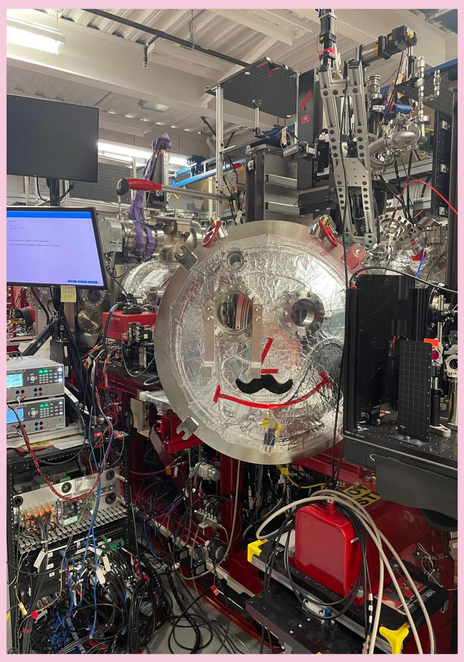
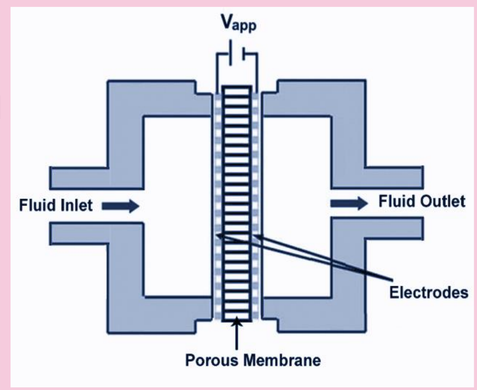
Purpose

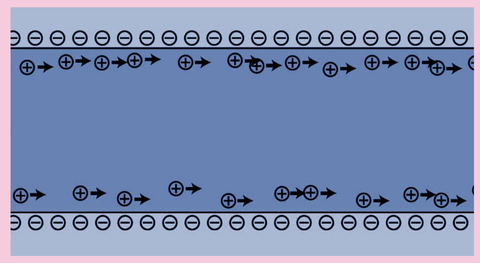
- Currently, our main type of pump that we use for liquid jets are HPLC pumps
- Uses pistons, whose pulsations can meddle with data
- Electroosmotic pumps have no moving parts and in theory provide a constant flow
- Uses for electroosmotic pumps:
  - Direct chemical delivery
  - Mixing
  - Drop on demand
  - Bio: indirect pumping of proteins
  - At any hutch!



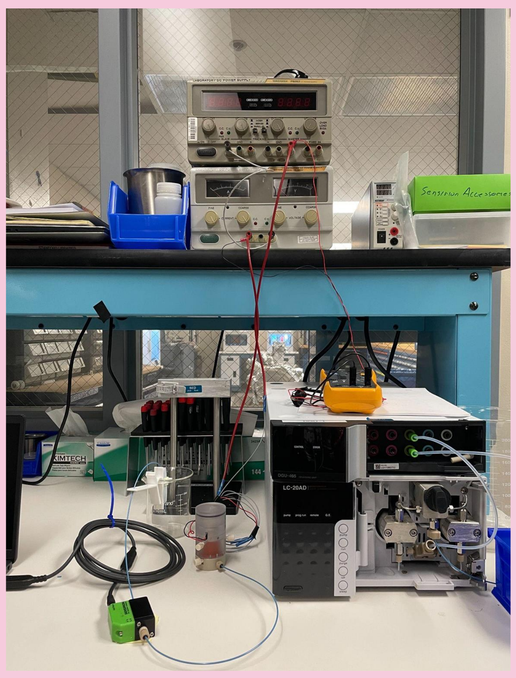
Background

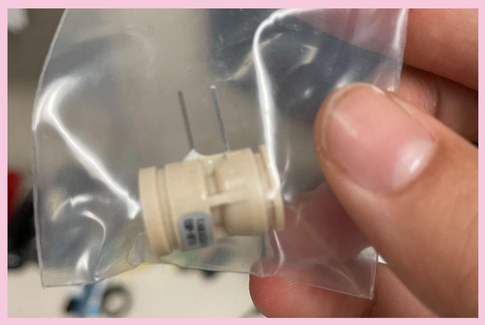
- When water or an electrolyte solution comes into contact with glass, plastic, or silica, it creates an electric double layer(EDL), where hydrogen ions from the solid's surface become attracted to the solution(e.g. the OH- part of water), creating a layer
- Zeta potential: the electrical potential at the shear plane, or the edge of the EDL. Electroosmotic pumps must have a high zeta potential in order to function
- Electrodes are applied at either end of the porous membrane, and a current is applied. Because of coulomb's law, a force is applied to the free-moving ions, which in turn pump the rest of the liquid
- A porous membrane (fritted glass in this case) increases the surface area for electrolysis to happen and provides an even flow
- Oxygen at the anode: $40H^- \rightarrow 2H_2O + O_2 + 4e^-$
- Hydrogen at the cathode: $2H^+ + 2e^- \rightarrow H_2$



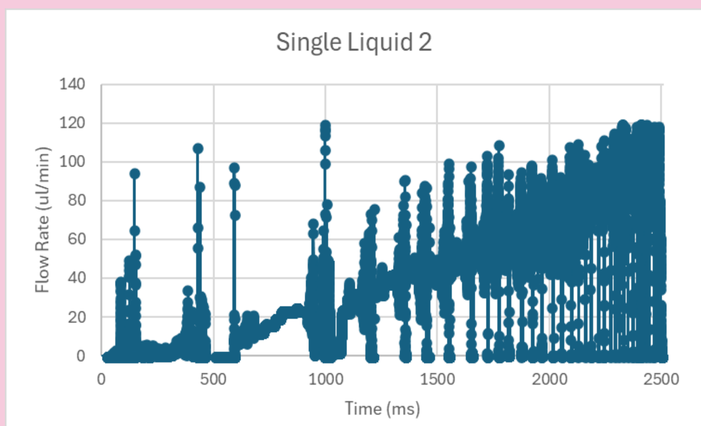


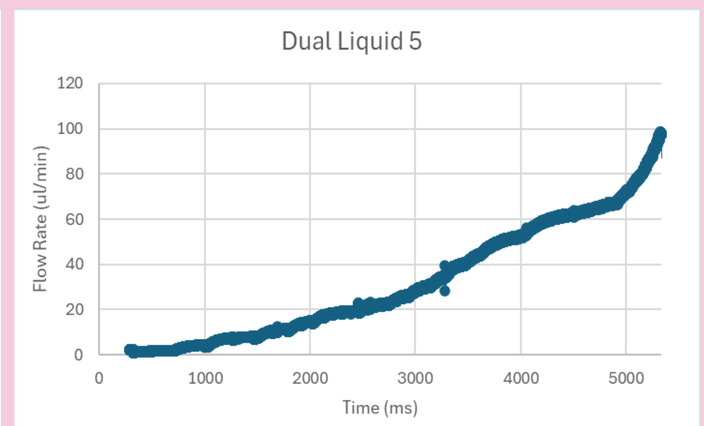
Setup





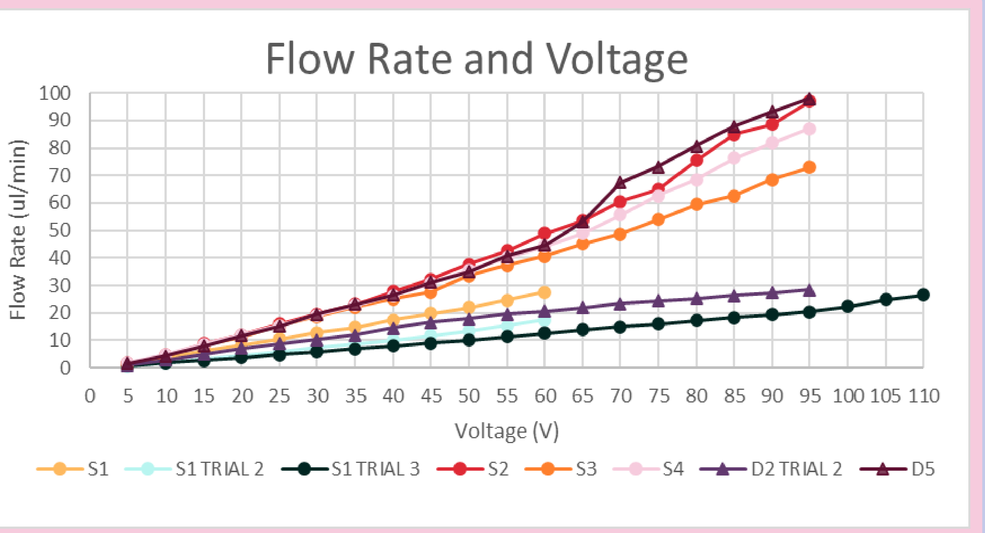
Results





- Air bubbles formed during electrolysis proved to be a major issue as they would 1. Cause fluctuations in the flow meter's output, making it hard to read and 2. Corrode the anode through the production of oxygen gas. A two-liquid system pump solved the former, but not the latter.
- Electrode corrosion greatly decreased flow rate, as shown below
- Random variations in data I was not able to determine the source of or solve

Results Cont.



Conclusion

- Because of air bubble formation, electroosmotic pumps are not the most ideal pump to use for liquid jets
- As of now there is no simple or efficient way to get rid of gas formation at the electrodes
- Stable flow is a must-have in many liquid jets, if not all
- Will be trying different electrolytes
- Potential pumps I may experiment with during the next couple of weeks:
  - Syringe pump- moves a syringe plunger at a controlled rate, pulsation-free
  - Electromagnetic/magnetohydrodynamic pump- uses an electric current runs through a conductive fluid and a magnetic field

Acknowledgements

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References

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