

Emulsion Behavior in Brine/AA/Oil Systems

Andrés A. Gardner, José A. Dapena, Carolyn A. Koh, E. Dendy Sloan

Center for Hydrate Research, Chemical and Biological Engineering Dept., Colorado School of Mines

Before Hydrates

Clathrate hydrates are non-stoichiometric crystalline structures that enclathrate small gas molecules. They can form in oil and gas flow lines and thus can cause flow assurance issues [3].

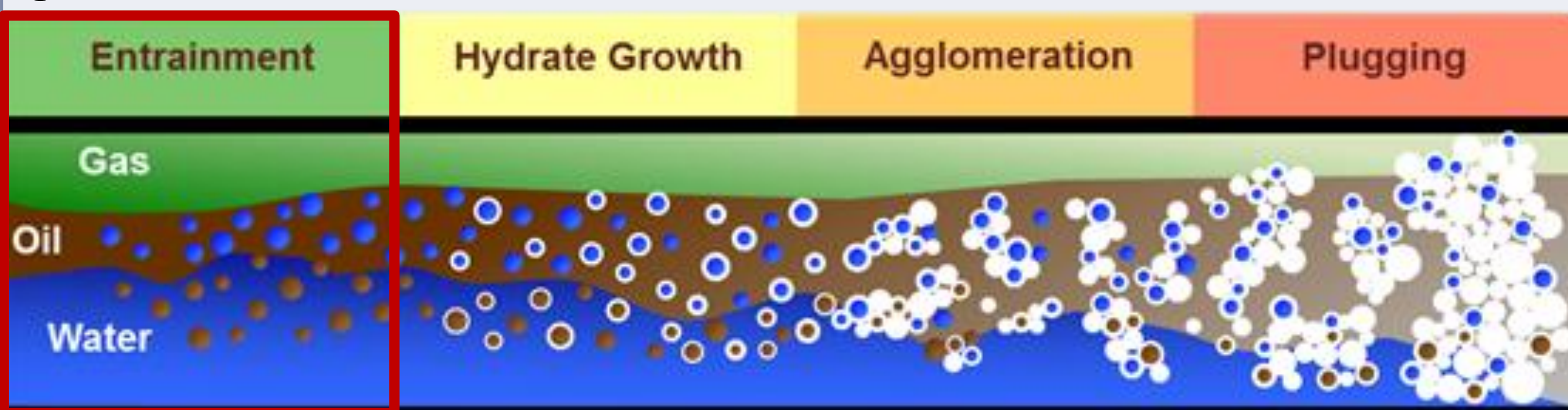


Fig. 1: Conceptual picture of hydrate plugging [1]

Water/oil dispersions play a key role in the hydrate formation process. Anti-agglomerants (AAs), surfactants used to prevent agglomeration, will affect the properties of such dispersions. Understanding these properties is essential for developing effective hydrate management strategies.

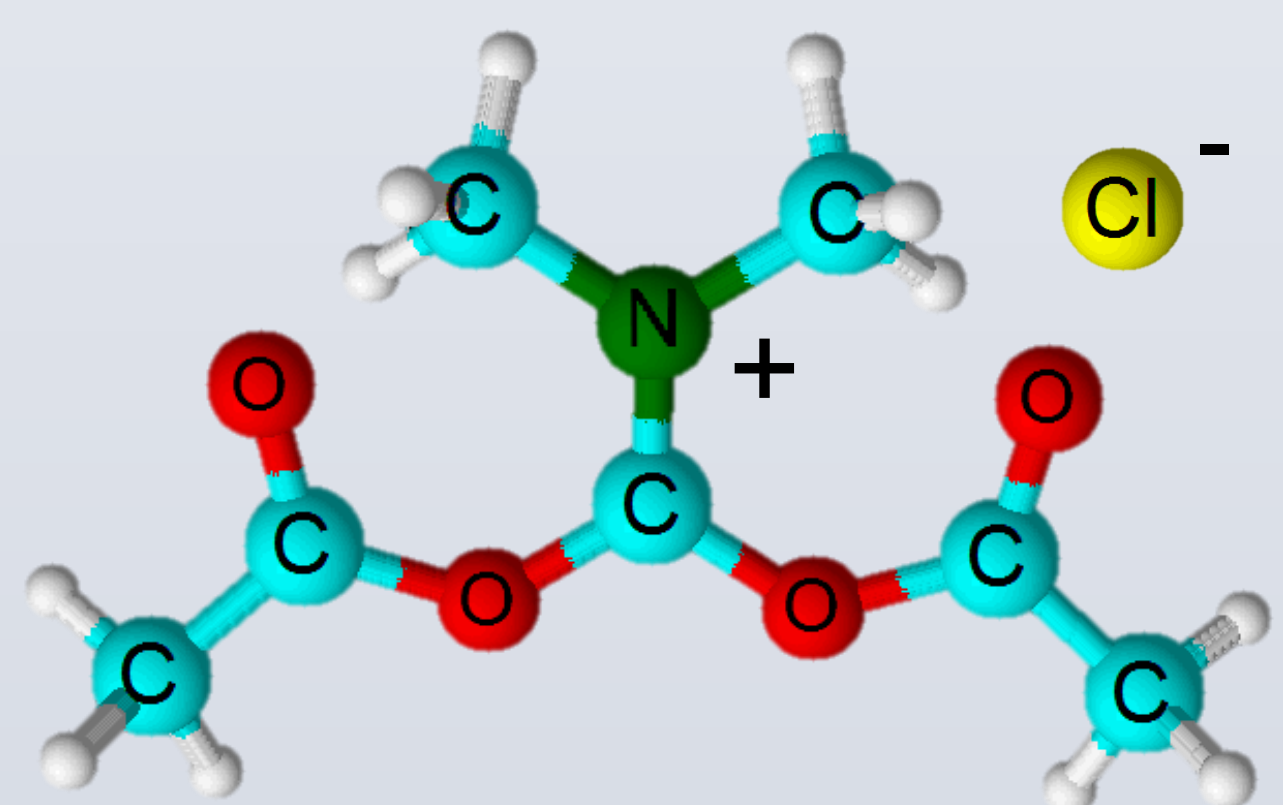


Fig. 2: Quaternary ammonium salt (AA) example [4]

A Quantitative Approach

A series of experiments were performed for further fundamental understanding of brine/AA/oil systems. The emulsion external phase was identified through conductivity measurements.

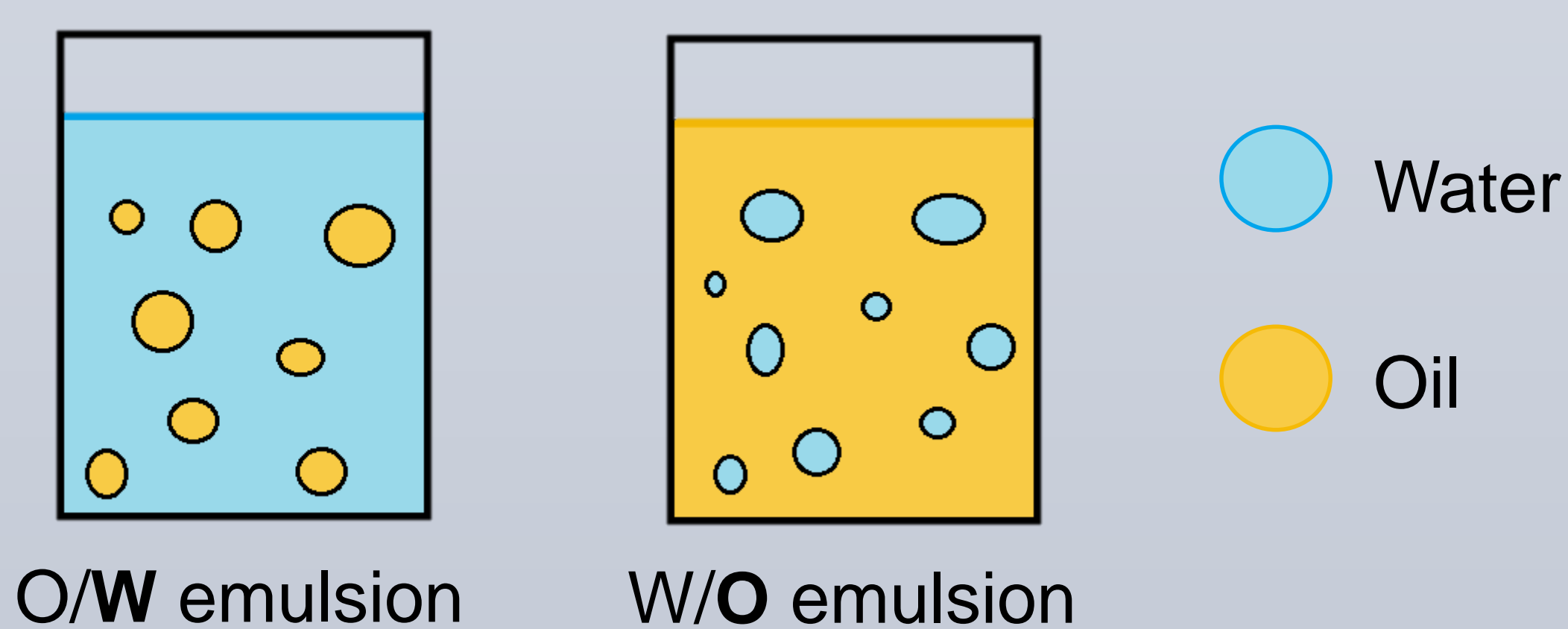


Fig. 3: Emulsion types [5]

Experimental Set-up

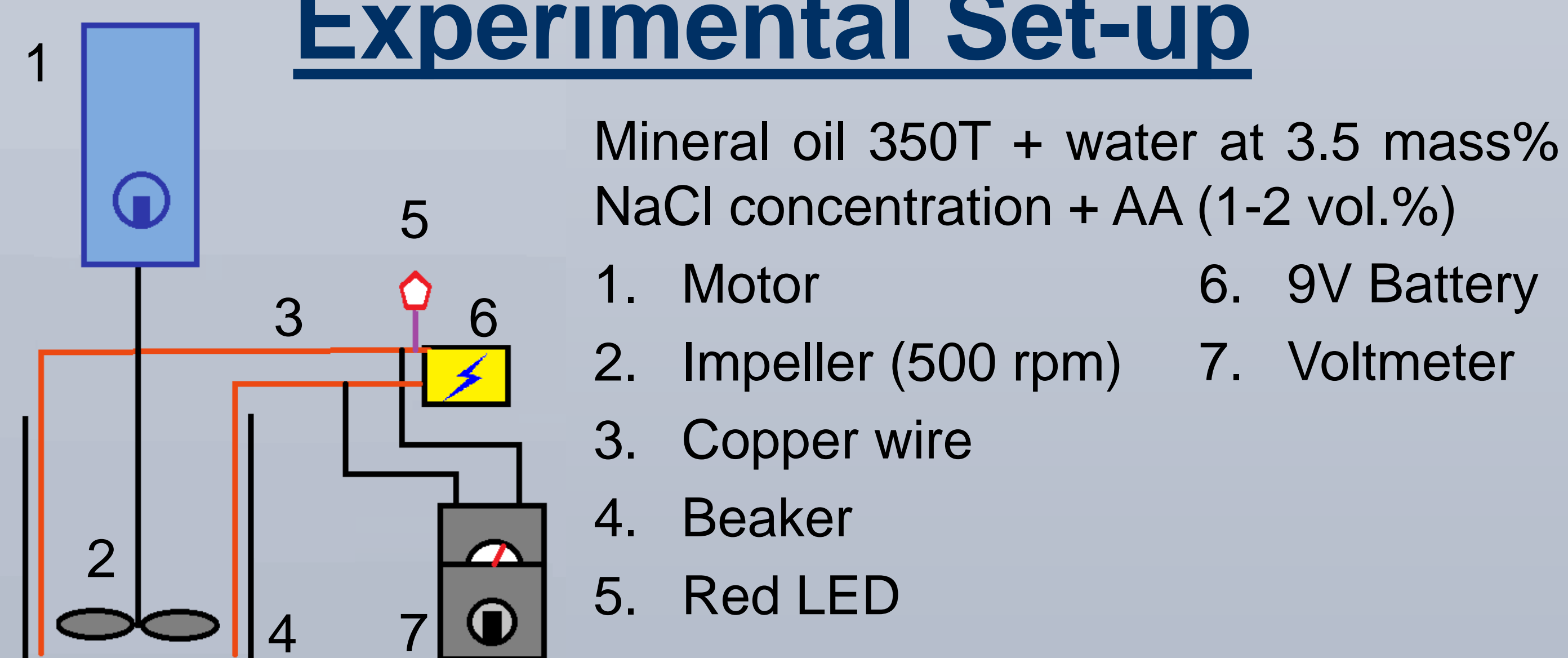


Fig. 4: Schematic of experimental set-up

Inverting Emulsions

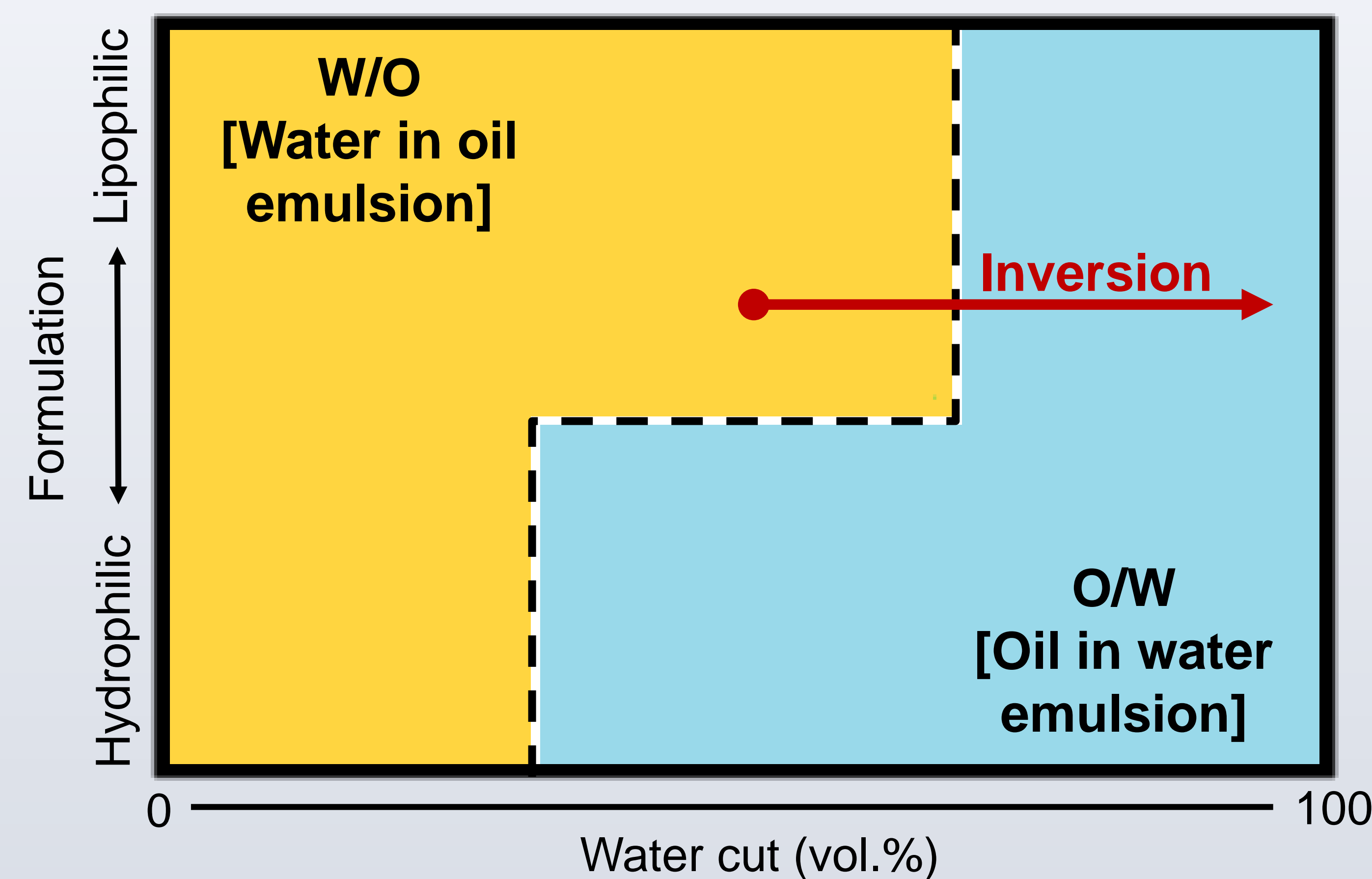


Fig. 5: Phase diagram of oil/water dispersions [2]

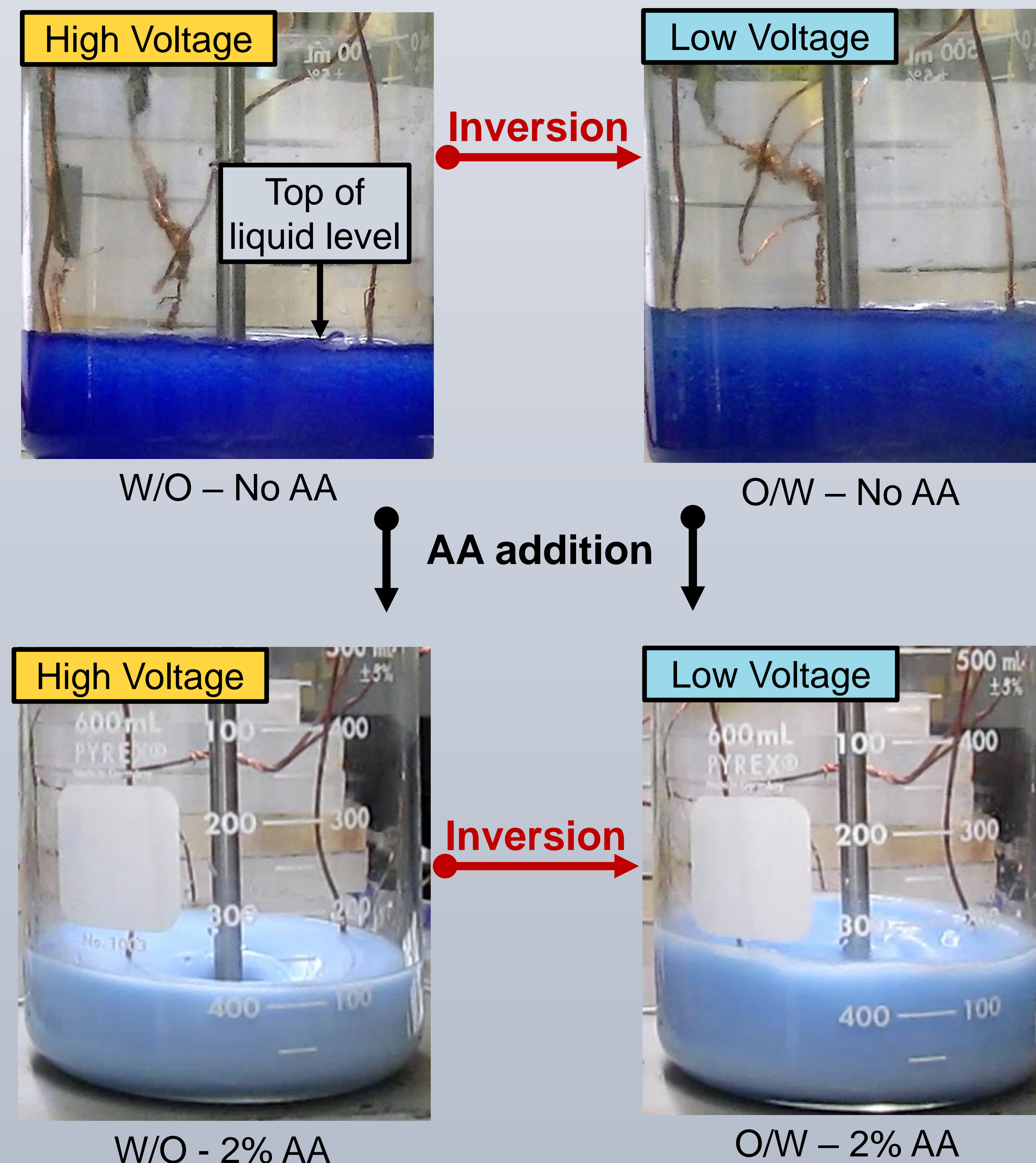


Fig. 6: Dispersion tests

Results and Discussion

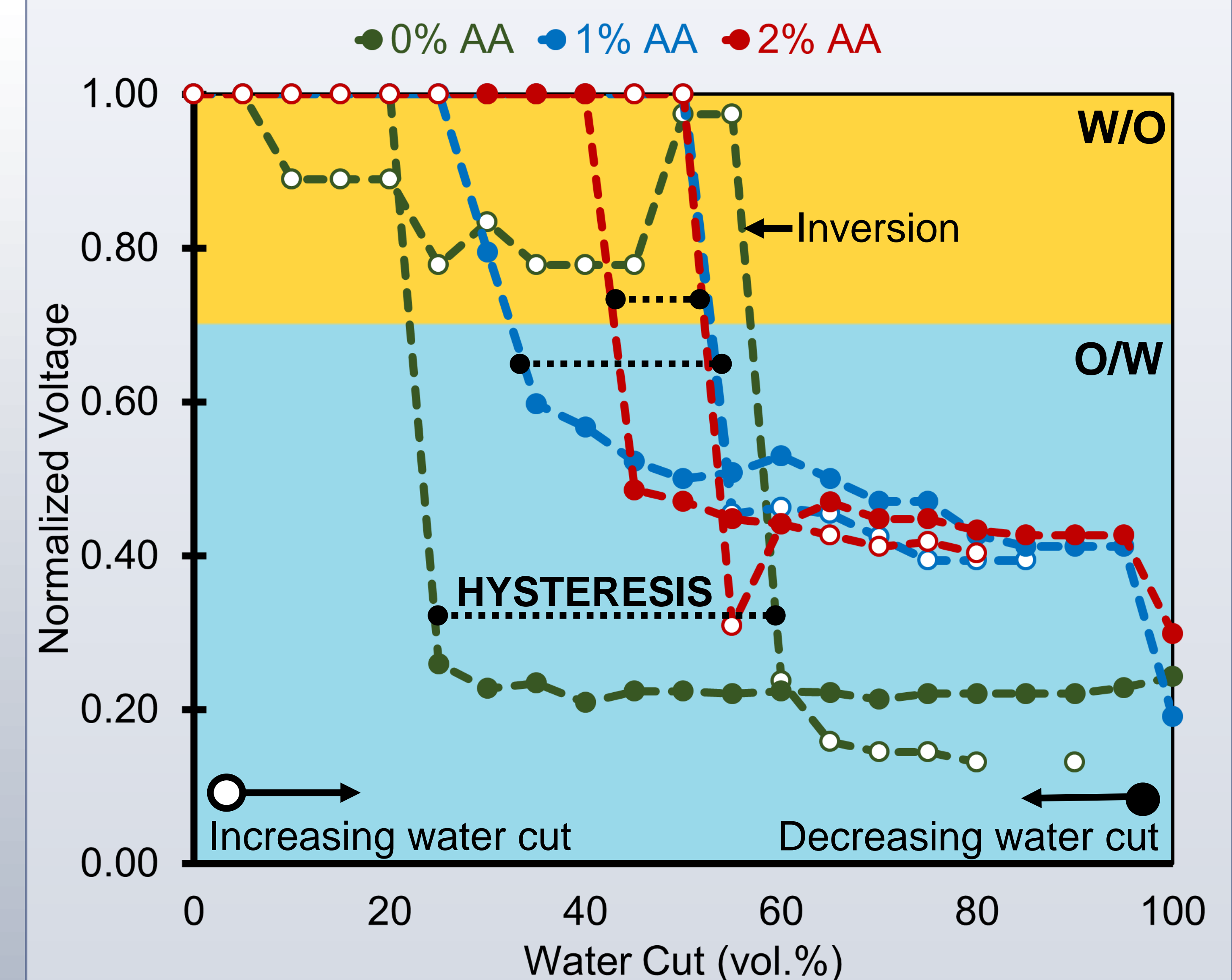


Fig. 7: Voltage readings during dispersion tests

A Reduced Hysteresis

As the AA concentration increases, the hysteresis decreases.

- 2 vol.% AA resulted in a 62.5% smaller hysteresis than 0 vol.% AA.

The AA promoted the coalescence of oil droplets, resulting in oil continuous emulsions at higher water cuts.

Further studies could address:

- Experiments with cyclopentane hydrates
- Low temperatures
- High pressures
- Tests with other AAs

References

- [1] A. A. A. Majid. PhD thesis, Colorado School of Mines, 2015.
- [2] J. Salager, et. al. Industrial & Engineering Chemistry Research, 39(8):2665–2676, 2000.
- [3] E. D. Sloan and C. A. Koh. Clathrate Hydrates of Natural Gases. CRC Press, 3rd edition, 2007.
- [4] A. A. A. Majid, et. Al. Proceedings of the 8th International Conference on Gas Hydrates, 2014.
- [5] D. P. Greaves. PhD thesis, Colorado School of Mines, 2007

Acknowledgements

Support for this poster came from National Science Foundation award DMR-1461275, REU Site: Research Experiences for Undergraduates in Renewable Energy, Dr. Stone, the Center for Hydrate Research, Dr. Majid and Dr. Khan.