



Design and Validation of a Liquid-Liquid Extraction Unit Operation

Experiment

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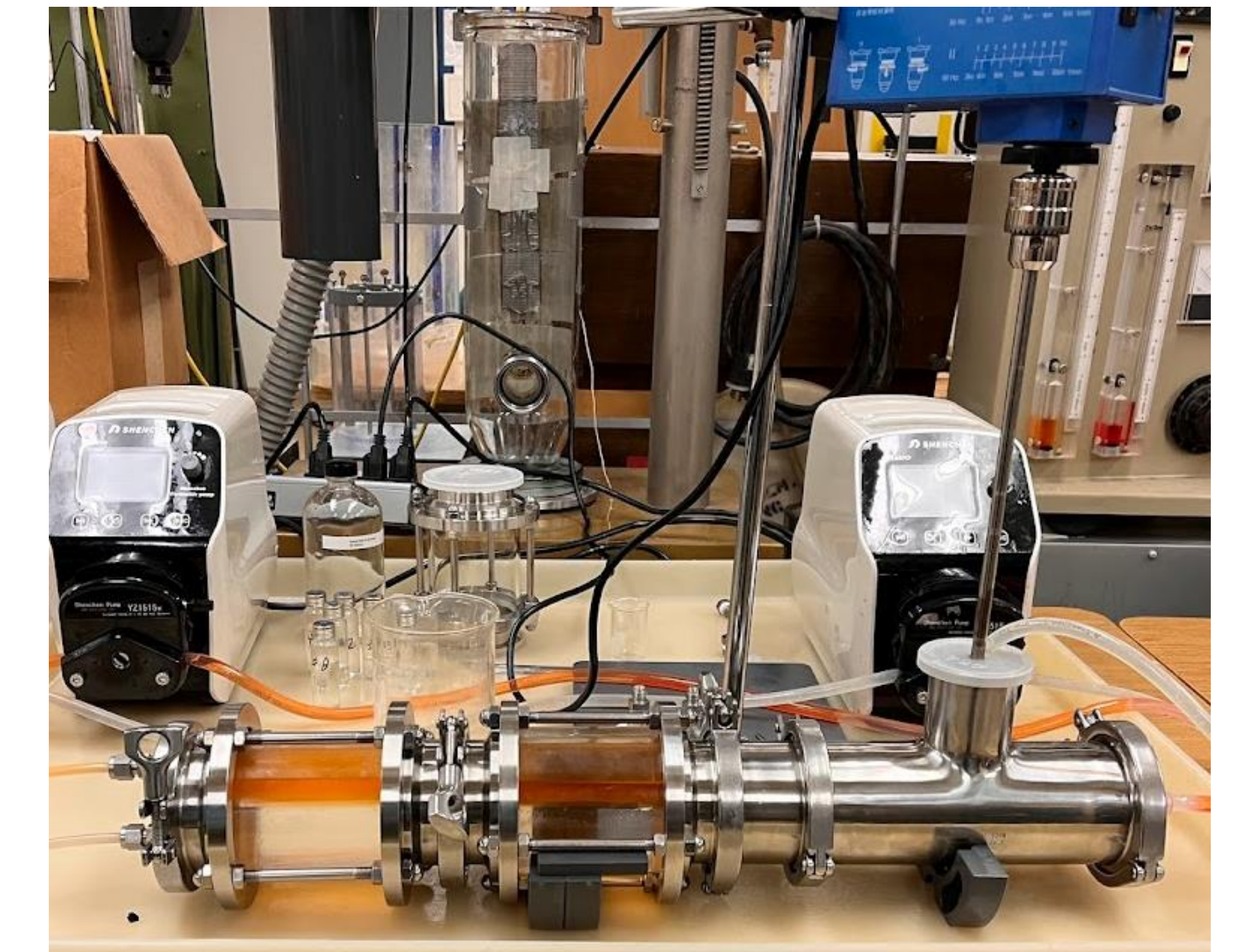
Research Objective: To effectively extract a liquid solvent in an aqueous water solution utilizing a sustainable liquid oil

Introduction/Motivation

- Liquid-Liquid Extraction (LLE) is prevalent in applications such as biomass purification, gas additives, and the food safety industries
- Used when distillation is not an option
- Build, design and test a LLE Unit Operations lab experiment
- Castor oil and Multitherm Heat Transfer Fluid were used to extract Ethanol (EtOH)

Methodology

- Continuous lab scale testing (2L & 2.5L) of castor oil in LLE
 - Samples taken incrementally
 - Used Thermo Scientific Trace 1310 GC
- Small scale testing of Multitherm fluid
 - Tested 1-5 wt% etoh solution & ratios of oil to aq (90:10, 80:20, 70:30, 60:40, 50:50)
 - Used Anton Paar Snap 41 Portable Alcohol Meter & GC
- Large scale testing of Multitherm fluid
 - Closed system
 - 80:20 etoh/water to oil
 - 3 wt% aq solution
 - Used Anton Paar Snap 41 Portable Alcohol Meter



Conclusions

- At best, 16.8% of 3 wt% etoh was removed from aq phase compared to 12.6% of 5 wt% etoh
- 80:20 etoh/water to oil ratio separated well
- Multitherm did not emulsify compared to castor oil
- Achieved research objective
- Partial implementation for unit ops lab experiment for Fall 2022

Recommendations

- Unit Ops Lab Experiment
 - Vary mixing and recirculation speeds
 - Drain chambers and vary EtOH concentration in water
- Continue exploration of various oil types

Acknowledgments

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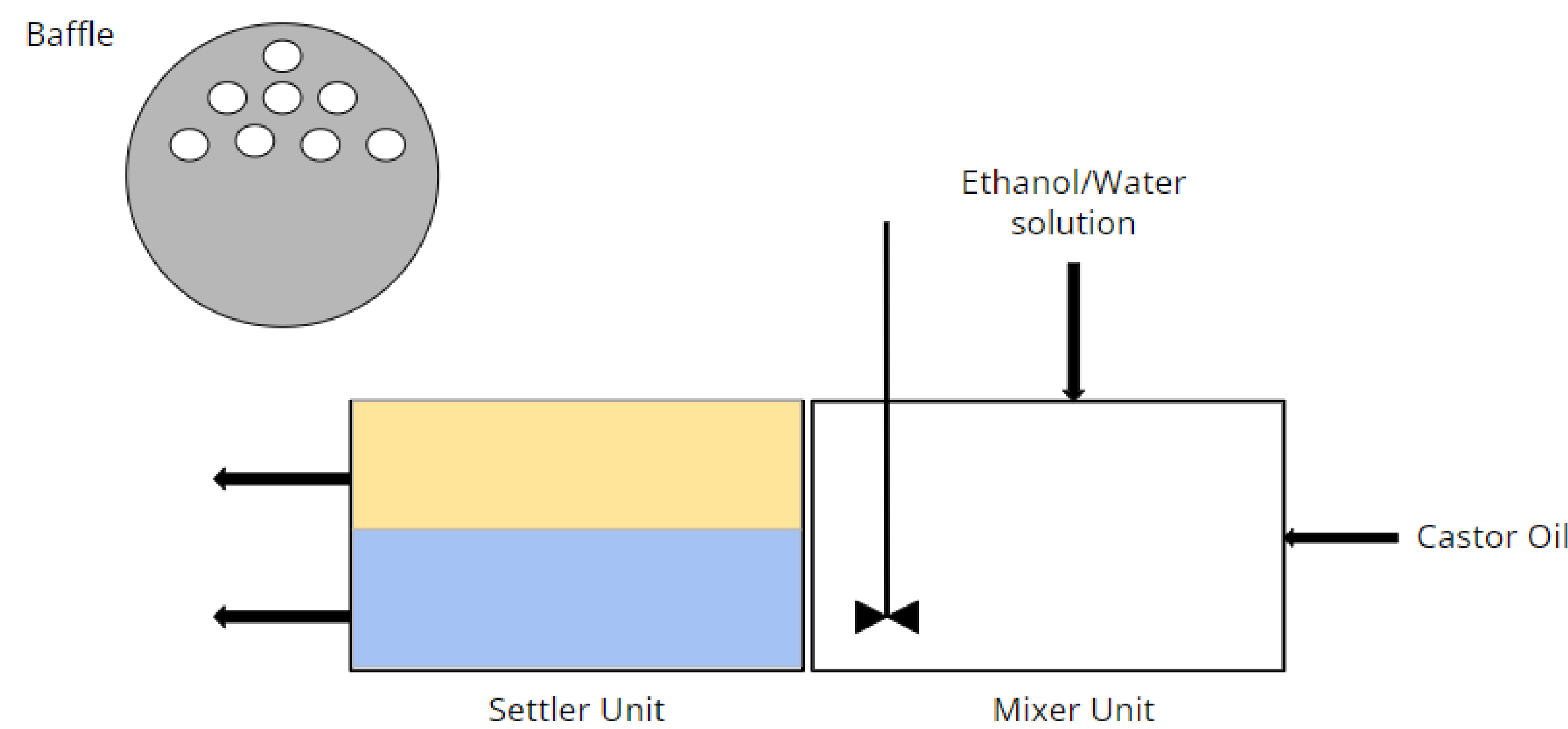


Figure 1: LLE Apparatus

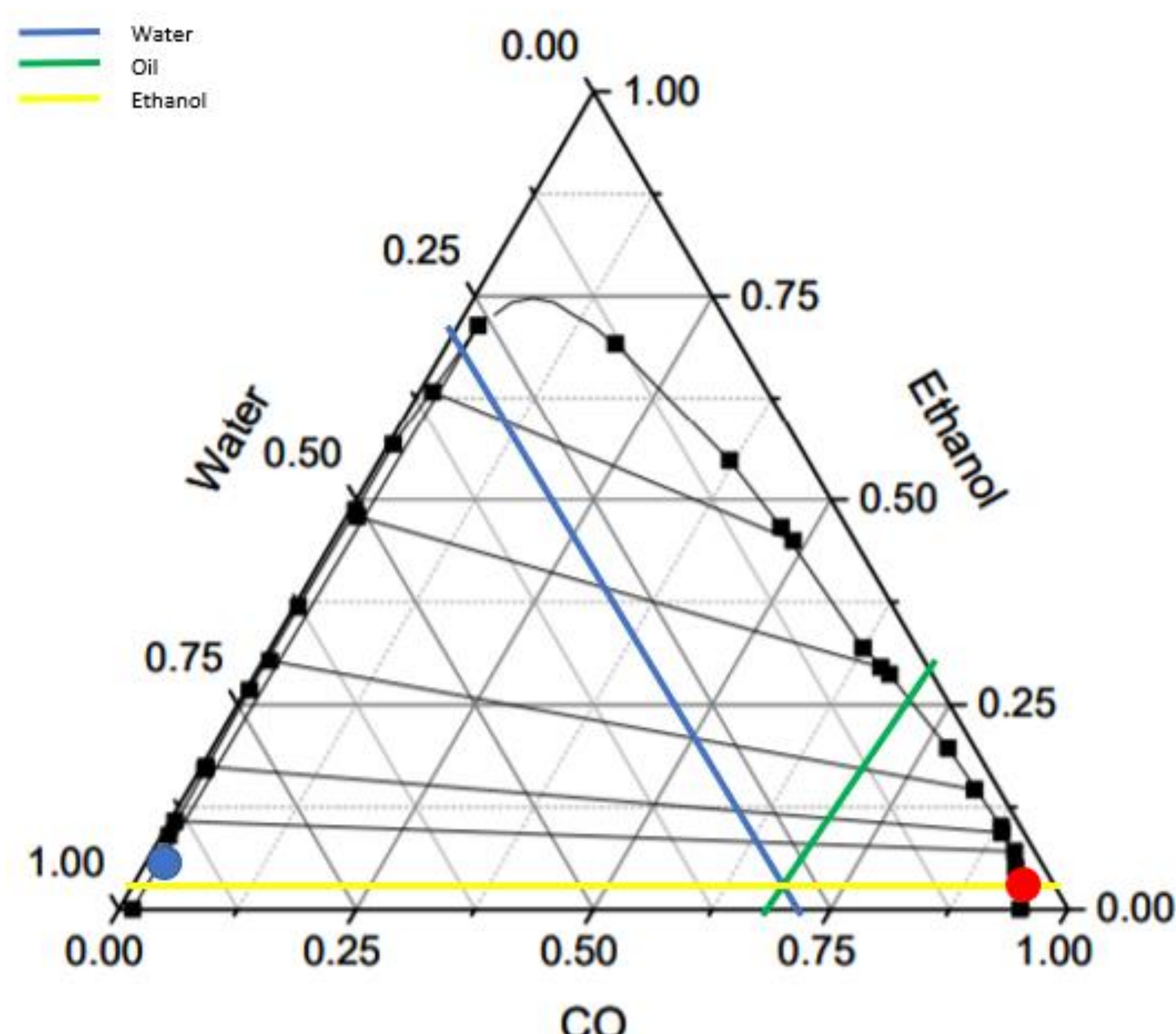


Figure 2: Water-Ethanol- Castor Oil - Ternary Diagram

Results

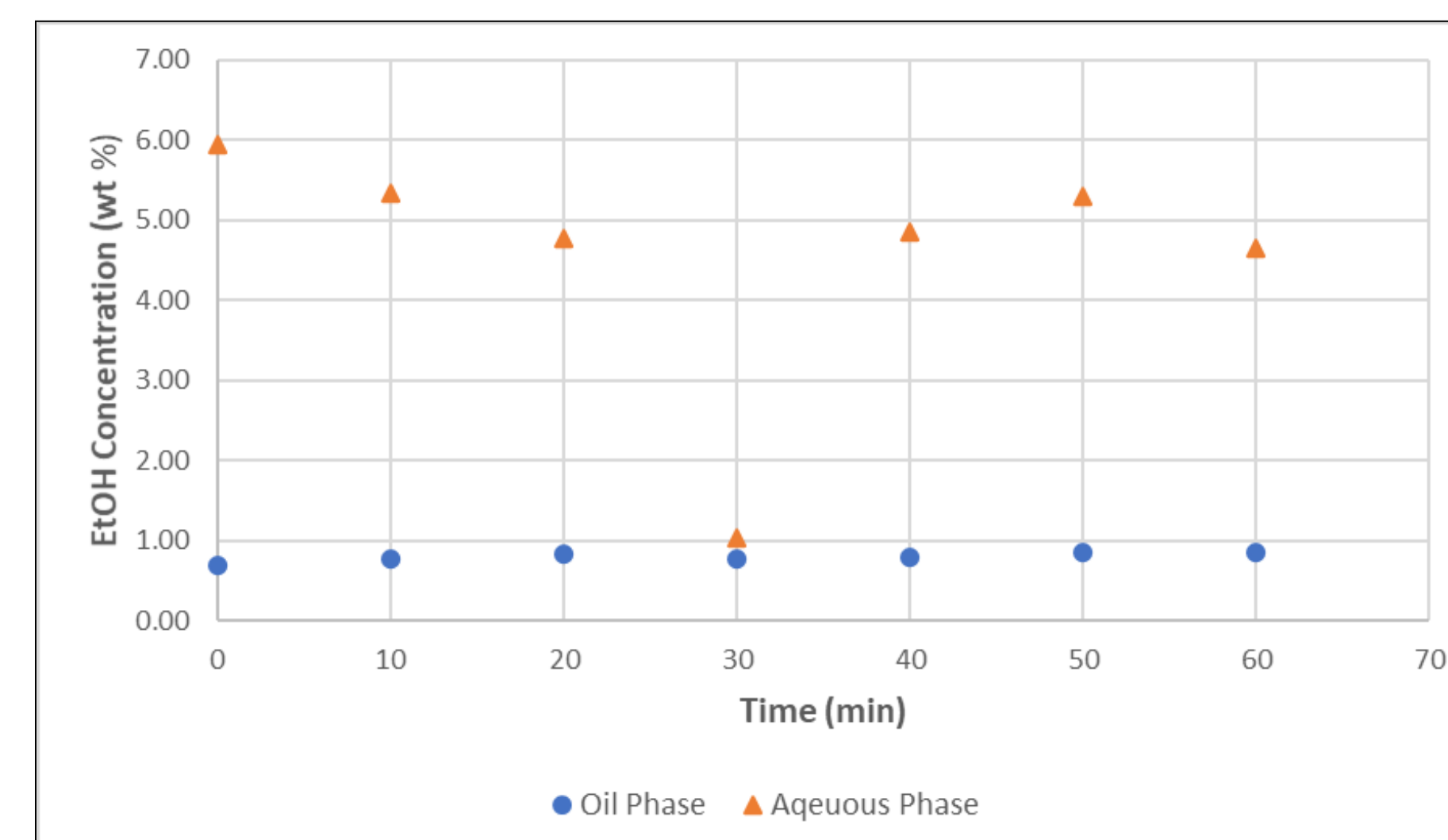


Figure 3: 50:50 Castor Oil/Aq

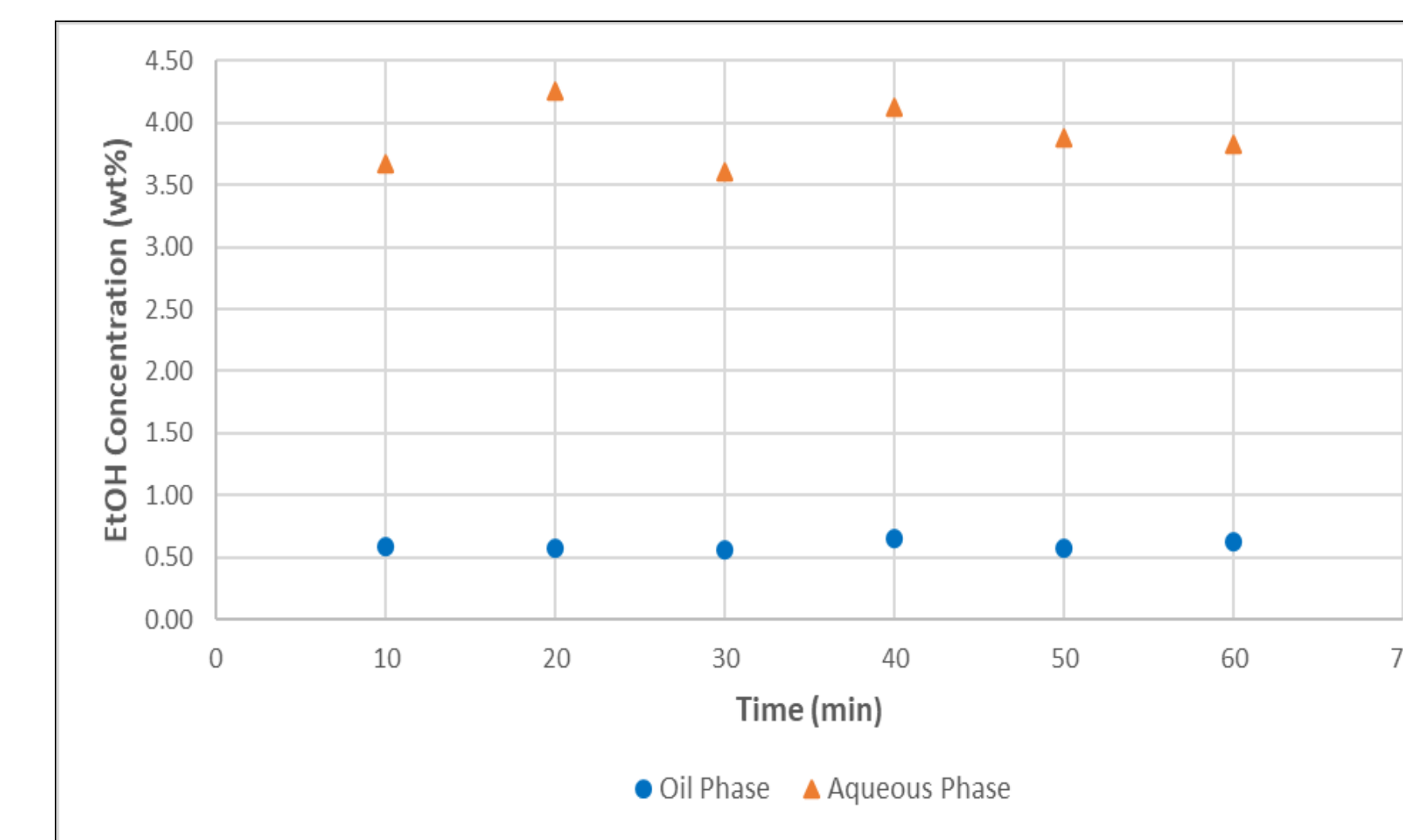


Figure 4: 70:30 Castor Oil/Aq

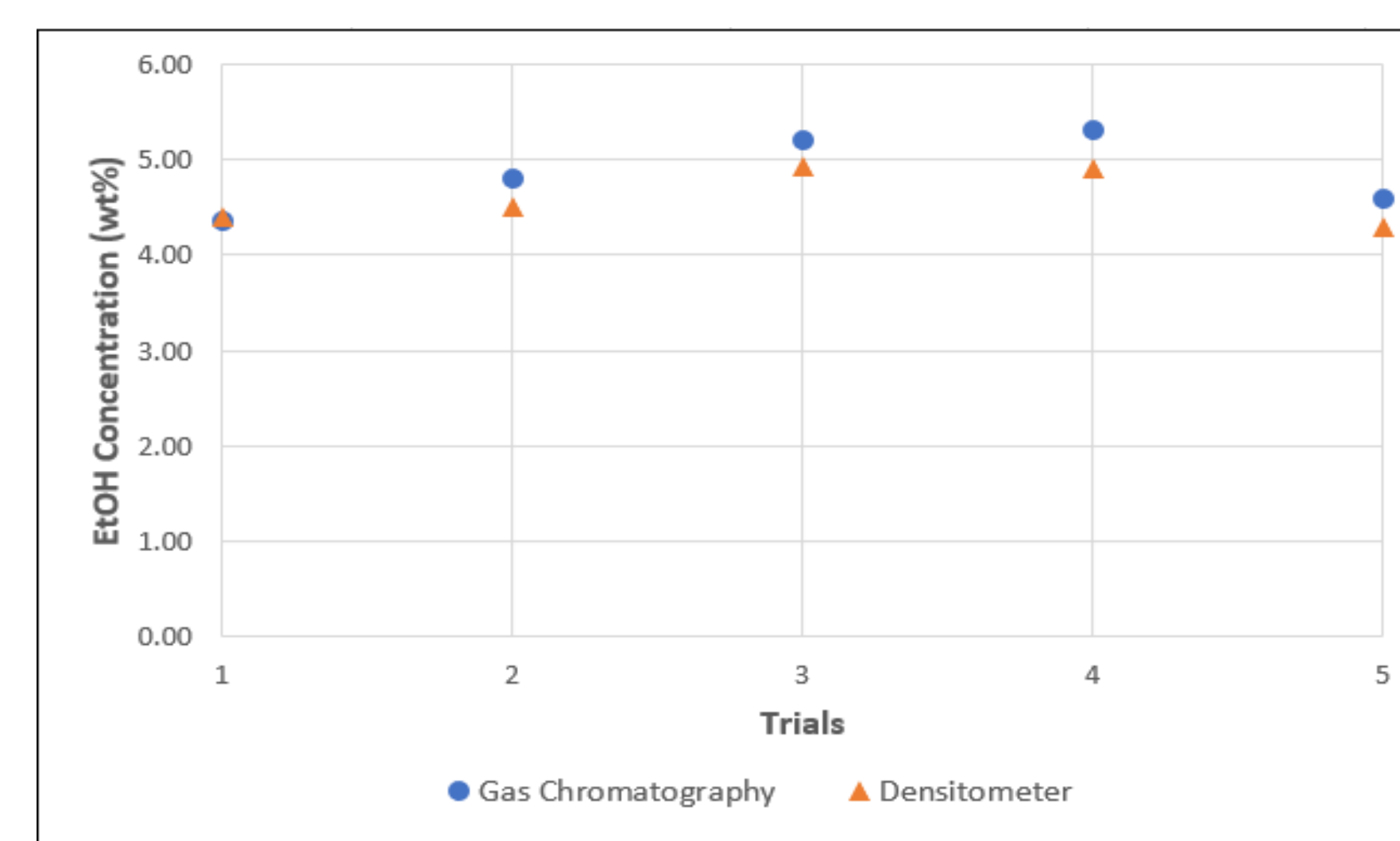


Figure 5: Densitometer vs GC Readings for 80:20 Aq/Multitherm

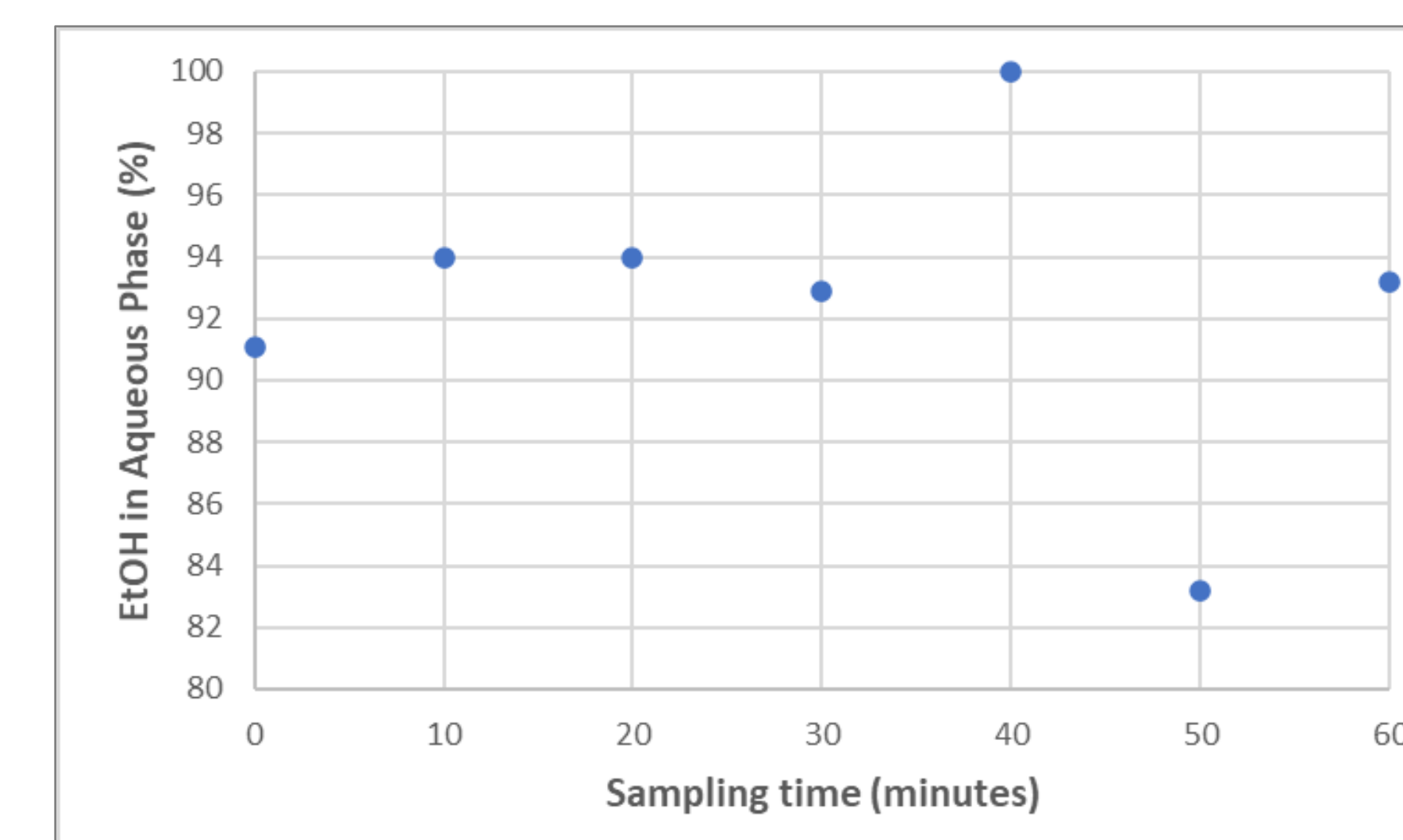


Figure 6: Large Scale 80:20 Aq/Multitherm