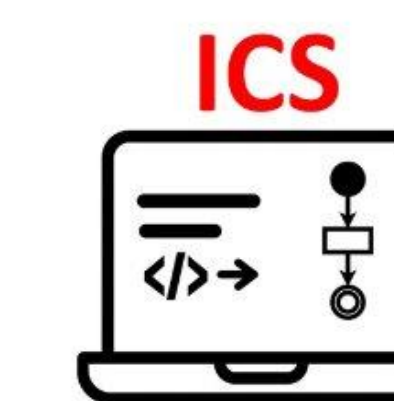
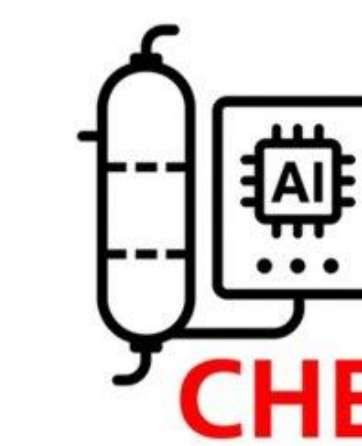


Smart Sorbent Systems: AI – Optimized Absorbent Materials For Oil Spill Remediation and Fluid Recovery

Zainab Kharidah, Fatimah Al-Saleh, Noor Alsaigh, Norah Alkhalifa, Reema Almutairi
Coach: Dr. Khadijah AlSafwan



3



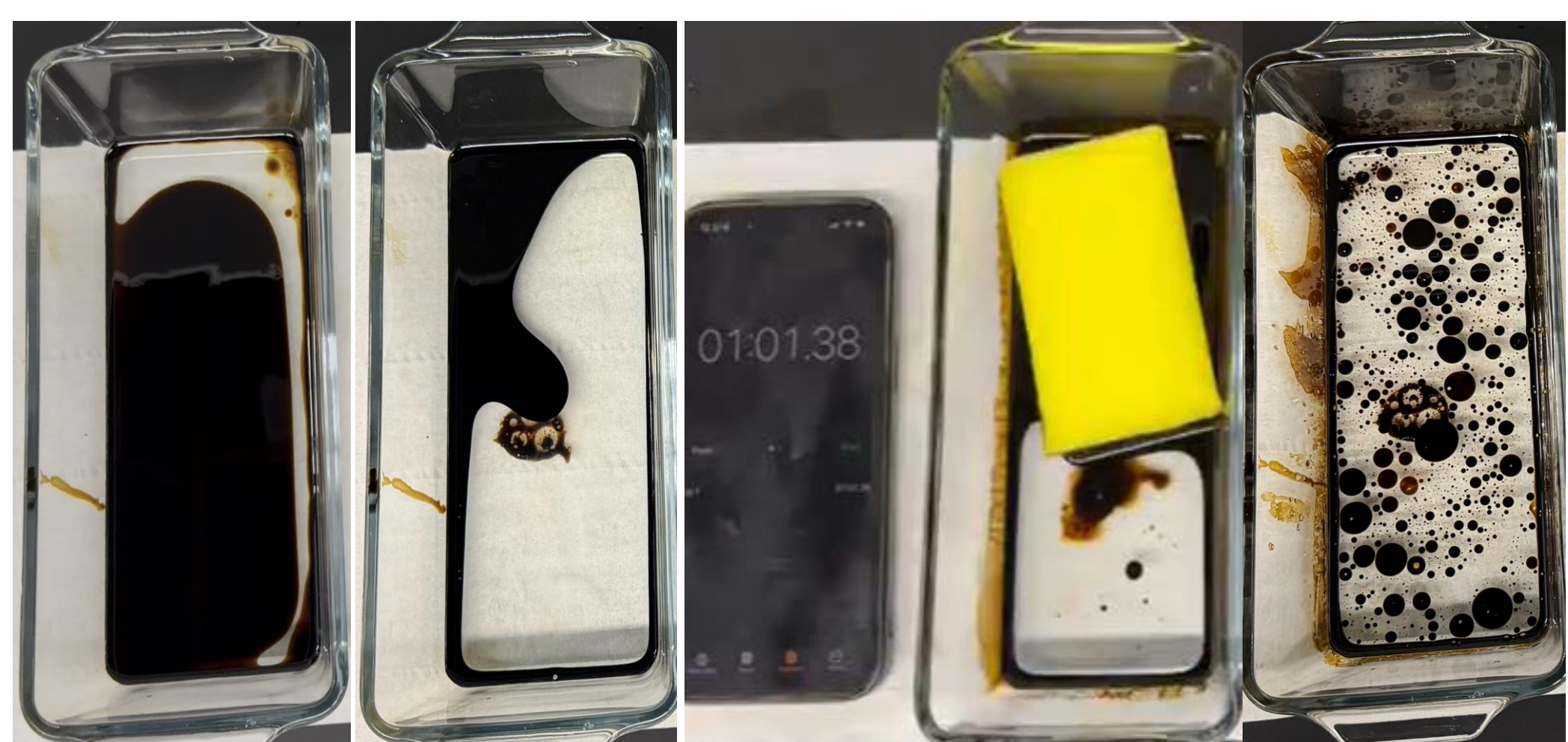
Problem Statement

Oil spills create significant environmental and economic impact, yet current solutions lack integrated evaluation and data-driven optimization. There is a need for a system that can systematically **analyze removal performance under controlled conditions**.

Objective

To develop an **integrated oil spill remediation system** that combines chemical treatment and sponge absorption, while linking **laboratory experiments with simulation through an interactive dashboard** to evaluate performance and identify optimal operating conditions.

PETE Experiments



Specifications

Recovery $\geq 70\%$
Cost ≤ 1000 SAR/unit
Min oil area condition identified
Volume ≤ 100 cm³
Floating ≥ 1 min
User workflow ≤ 30 min
Image upload & retrieval (≤ 5 MB)
Auto-generated experiment report

CHE

PETE

SWE

Constrains

$T \leq 80^\circ\text{C}$ (regeneration)
Flash point $\geq 60^\circ\text{C}$
Oil–water ratios: 90:10, 70:30, 50:50
Salinity: SW, 1/2 SW, 1/4 SW, DI
Oil-wet sponge behavior
Complete data entry enforced
Secure backend API handling

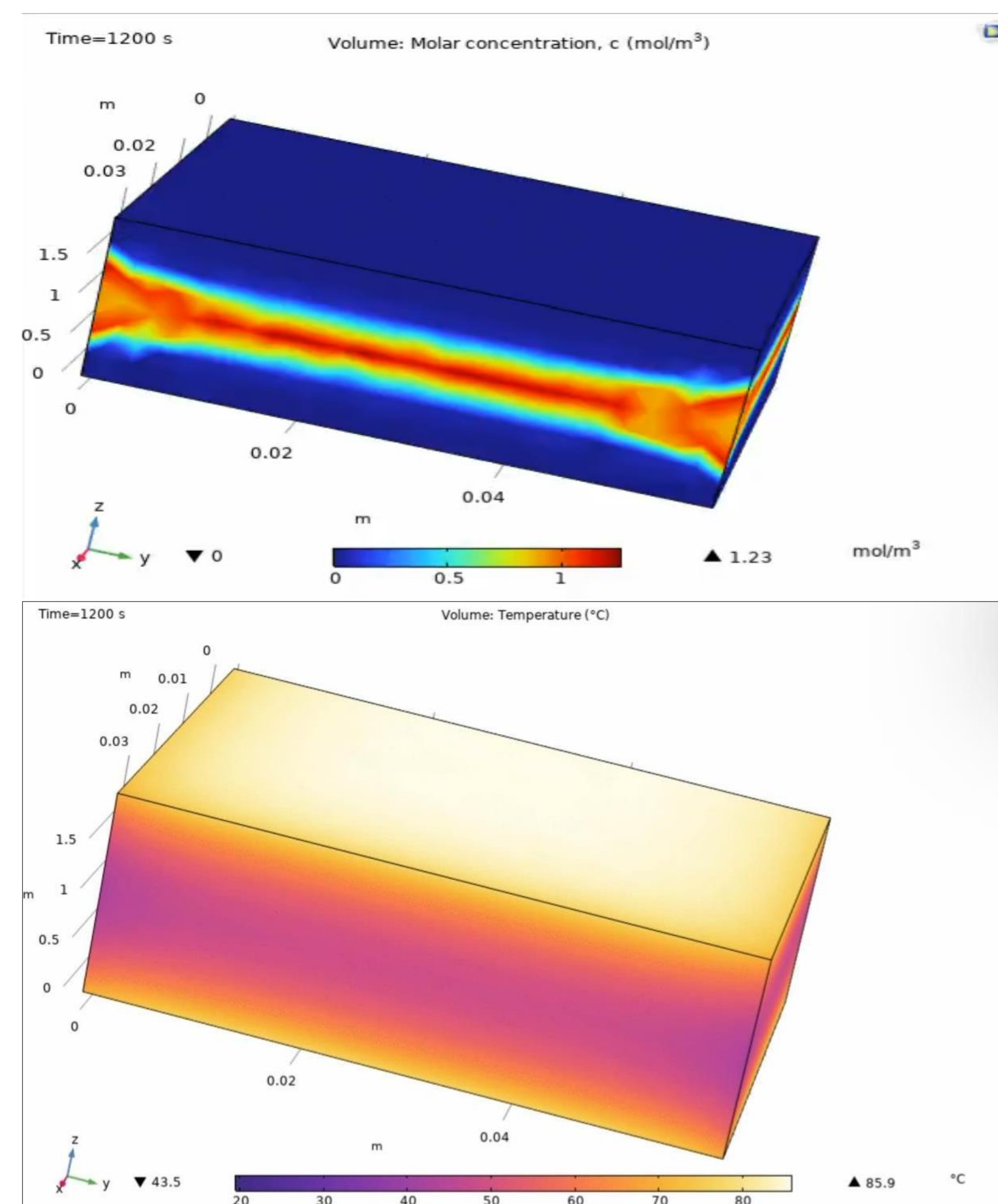
Image-based oil area reduction
PETE + CHE data unified in dashboard
LLM-generated structured reports

Conclusion

The system successfully integrates **chemical treatment and sponge absorption**, achieving best performance at **DI salinity and 90:10 ratio**. The **3:7 formulation** showed highest effectiveness, with confirmed **oil-wet, stable sponge behavior**, demonstrating strong potential for **data-driven remediation**.

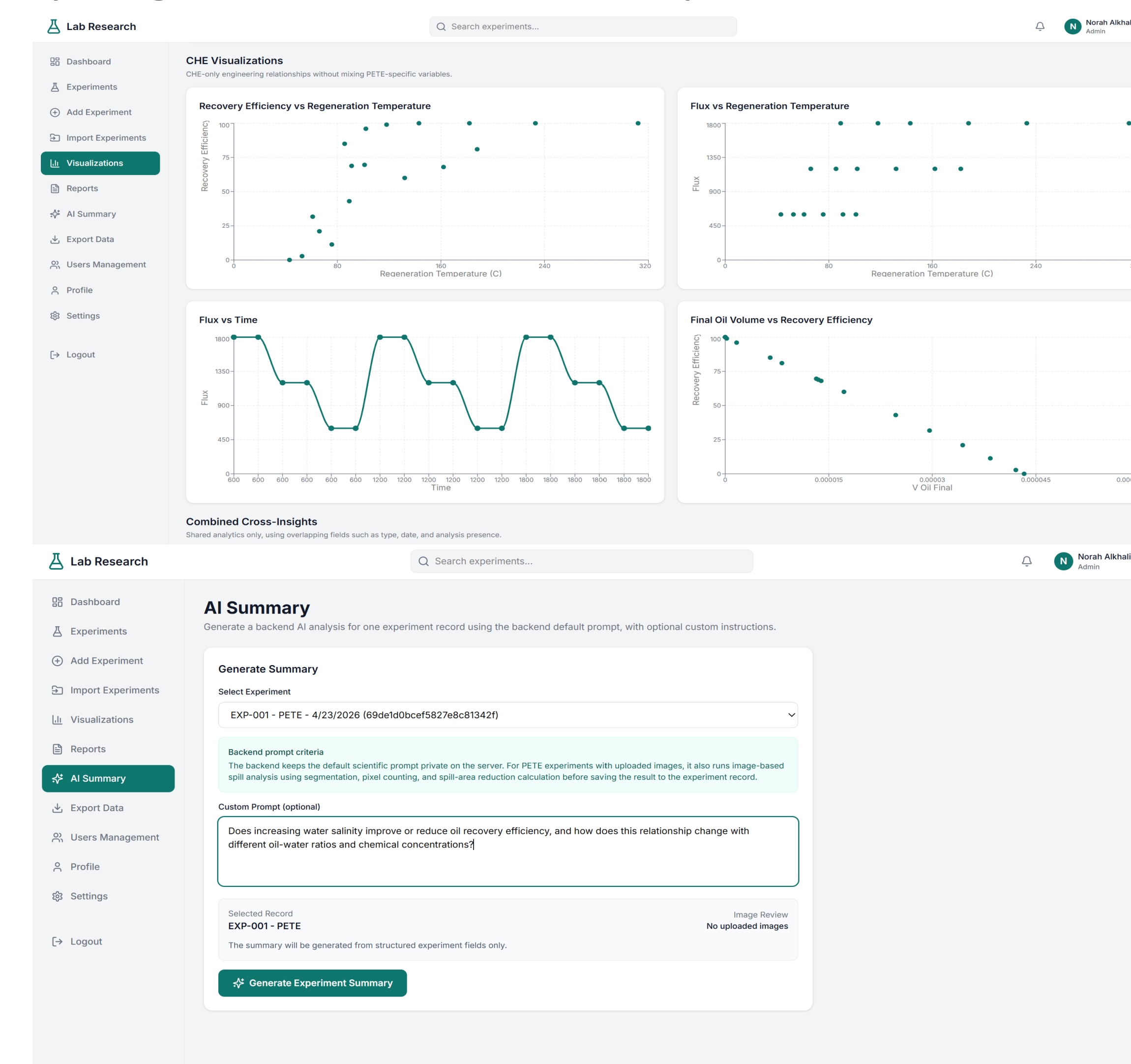
CHE Simulation

$T_{\text{max}} = 85.6^\circ\text{C}$, recovery = 85%



Final Dashboard

Dashboard visualizations, AI prompting, and automated reports for CHE and PETE experimental analysis.



Scientific Experiment Analysis Report

Generated: 5/9/2026, 2:53:30 AM
Experiment Type Filter: PETE
Date Scope: All past data
Matched Records: 37

Overview
This report details the results of a laboratory experiment dataset, comprising 37 distinct experimental records exclusively categorized as PETE (Polymer-Enhanced Thermal Emulsification) experiments. The dataset encompasses measurements collected within a highly concentrated temporal window, specifically on April 23, 2026, despite a filter scope indicating 'ALL_PAST' records. The scientific context of these experiments likely involves the investigation of emulsification processes under varying environmental and chemical conditions, with a focus on understanding the interactions between oil, water, and chemical agents.

Key Measurements
The aggregate analysis of the PETE experiments reveals an average water salinity of 24.96, an average oil-water ratio of 70.84, and an average chemical concentration of 0.66. Detailed examination of individual records indicates that water salinity was systematically varied across discrete values of 0, 1.2, 1.4, and 100.0, suggesting investigations into fresh, brackish, and highly saline conditions. Similarly, oil-water ratios were observed at controlled levels of 50.5, 70.3, and 90.1, while chemical concentrations were set at either 0.5 or 1.0. Notably, no images were uploaded for any of the 37 experiments, resulting in a total uploaded images count of 0.

Observations
The dataset's temporal scope, despite being filtered for 'ALL_PAST', is notably restricted to a single day, 2026-04-23. This highly condensed date range suggests either a focused experimental campaign executed within a short timeframe or an artifact of the data collection window, rather than a broad historical accumulation. The uniform absence of entries in the 'analysis' field across all experiments indicates that the provided data consists solely of raw experimental parameters and immediate measurements, without any recorded post-experimental interpretation or derived results. Furthermore, the complete lack of 'uploadedImages' for all 37 PETE experiments represents a significant data quality limitation, particularly if visual documentation is a standard or critical component for the qualitative assessment or detailed analysis of these experiments. The discrete nature of the 'waterSalinity', 'oilWaterRatio', and 'chemicalConcentration' values strongly implies a controlled, possibly factorial, experimental design, aimed at assessing the impact of specific parameter combinations rather than exploring continuous response surfaces. Since no CHE experiments are included in this dataset, no comparative analysis between PETE and CHE records can be performed.

Conclusion
The analyzed dataset, consisting solely of 37 PETE experiments conducted on 2026-04-23, systematically explores the effects of distinct water salinity, oil-water ratio, and chemical concentration parameters. While providing quantitative measurements for these conditions, the absence of recorded analysis or visual documentation limits comprehensive scientific interpretation.