TEAM M111

Design of Nanoparticle-Based Formulation for Enhanced Oil Recovery in Saudi Carbonate Reservoirs

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CHE
MSE 3 PETE

Objective

Problem statement

Conventional EOR methods are limited in carbonate reservoirs, where up to 60–70% of oil remains unrecovered. High salinity and temperature reduce chemical effectiveness, while oil-wet surfaces hinder displacement. In addition, instability and excessive adsorption can lead to formation damage. Therefore, a stable and reservoir-compatible EOR solution is required.

Constraints

- Nanoparticle size ≤ **100 nm** to ensure pore compatibility
- Reservoir temperature up to **100˚ C**
- Brine salinity up to **150,000 ppm**
- Injection pressure below fracture limit
- Use of eco-friendly nanoparticles (SiO_2, TiO_2, Fe_2O_3)
- Limited experimental time due to long testing duration

Specifications

- NP diameter: **20–80 nm**
- IFT reduction: ≥ **40%** vs brine
- Permeability ratio: k_after / k_before ≥ **0.85**
- Pressure behavior: No runaway ΔP during injection
- Stability (thermal): ≤**10%** aggregation @ 100˚ C
- Incremental recovery: ≥ **10%** vs waterflood
- High-temperature stability: Stable ≤ 100˚ C
- Cost-performance: **10–20%** recovery gain with controlled cost increase

Prototype development

50:50 Ratio (3 Samples)			
Sample	TiO_2 (%)	SiO_2 (%)	Fe_2O_3 (%)
S7	50	50	0
S8	50	0	50
S9	0	50	50

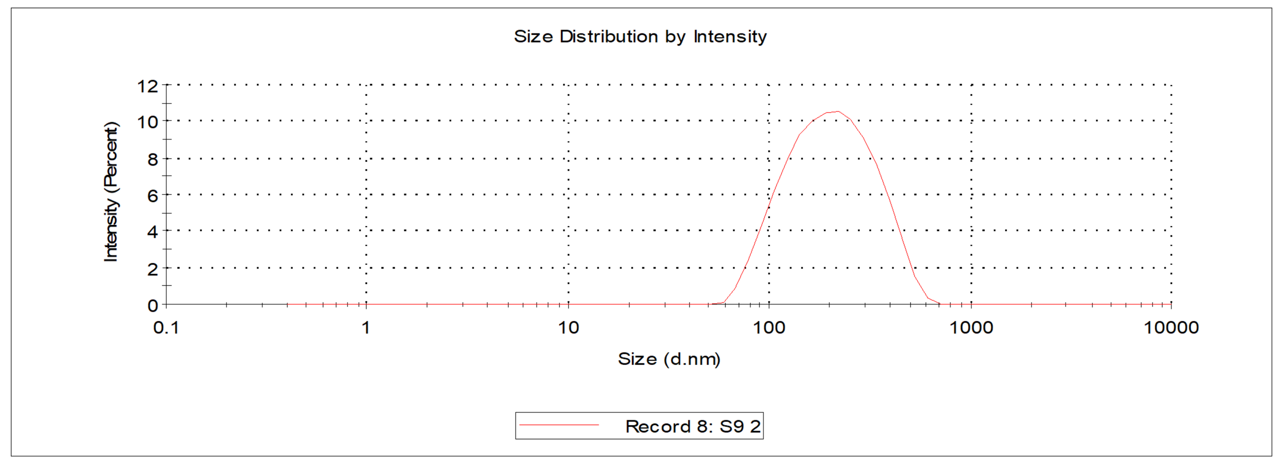
33:33:33 Ratio (1 Sample)			
Sample	TiO_2 (%)	SiO_2 (%)	Fe_2O_3 (%)
S10	33.3	33.3	33.3

Validation and Verification

Thermal aging

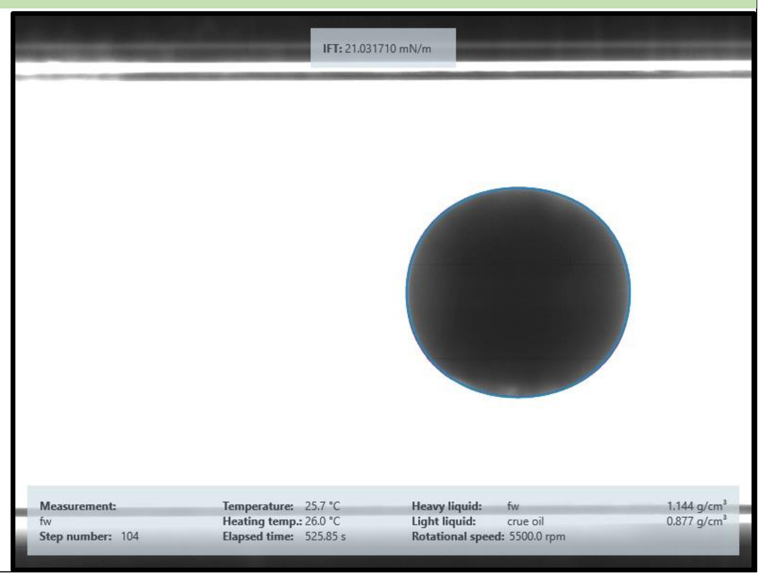
Fin DLS (week 2)

S9



IFT Results

S9

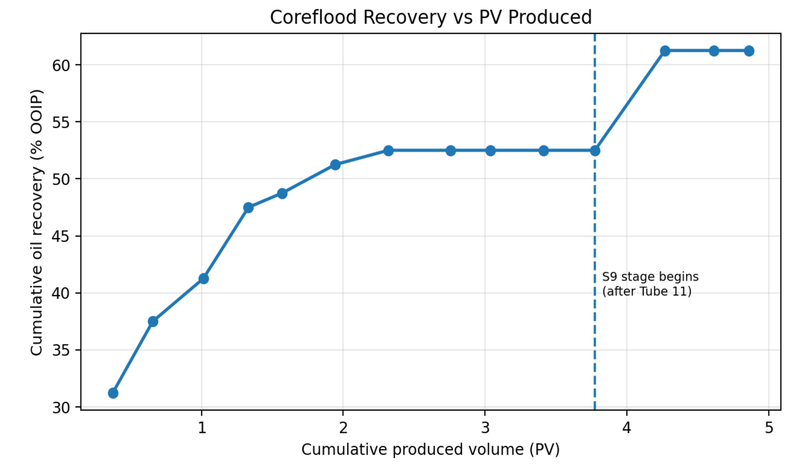


Zeta potential (mv)

S7	S8	S9	S10
-39.2	-35.3	-35.1	-31.5

permeability

Core Flood



Conclusions

8 cc	52.5%
OOIP	Baseline RF
61.25%	**%8.75**
Total RF	S9 ΔRF