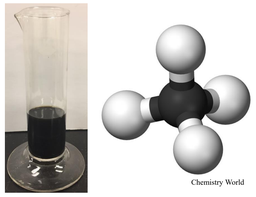
Investigating Asphaltene Stability in Crude Oil During Carbon Dioxide Injection

Sherif M. Fakher | Advisor: Dr. Abdulmohsin Imqam
Petroleum Engineering

Motivation



Chemistry World

Hydrocarbons are usually thought of as being a fluid (gas or liquid)

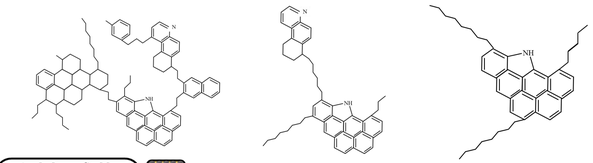
Asphaltene is a solid component of the crude oil that is stabilized via resins or as a nano-colloid

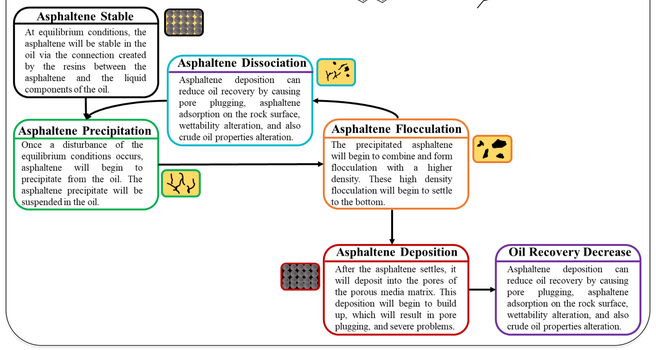
Halliburton, 2012

It can cause severe production problems and safety hazards in wellbores, equipment, and pipelines

Objective

- Investigate the factors that may impact asphaltene stability in the crude oil and quantify the effect of these factors.
- Determine how to reduce asphaltene precipitation and deposition and how to mitigate or alleviate asphaltene buildups

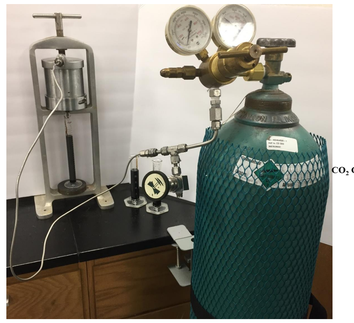




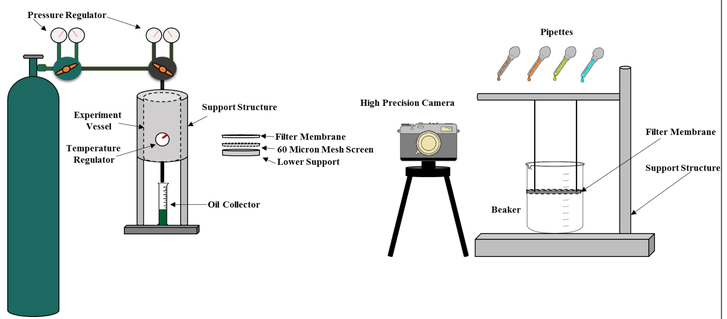
Experimental Materials

- Specially designed filtration setup
- Crude Oil from Kirk Lease, Kansas
- Stainless Steel tubings and connections
- High pressure CO_2 cylinder
- Filter membranes with pore sizes of 0.2, 10, and 100 nm, and 2.7 µm
- High precision camera
- Chemical agents (water, heptane, kerosene, naphtha, and xylene)
- Transparent 1000 ml glass beaker
- Pipettes (plastic and glass)
- Asphaltene Saturated Filter membranes

Experimental Setups

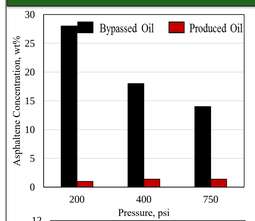


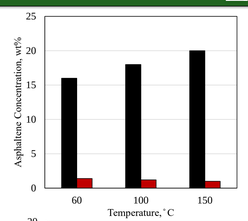
Asphaltene Stability Setup

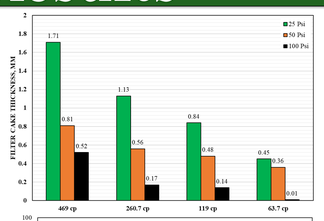


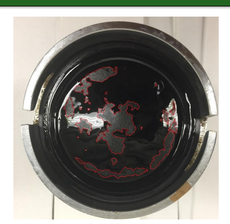
Asphaltene Mitigation Setup

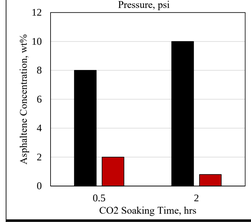
Results

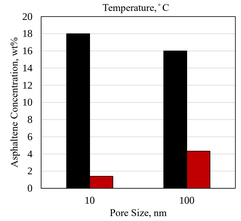


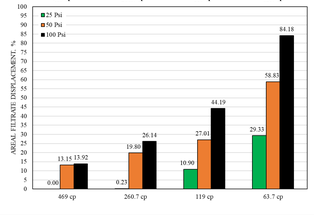


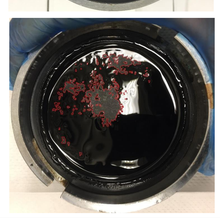




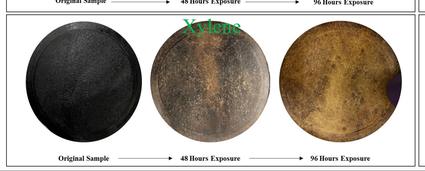


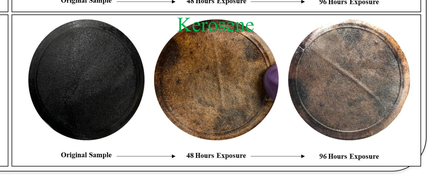






Water
(Reference Agent)





Conclusions

- The reservoir thermodynamic conditions were found to have a strong impact on the stability of the asphaltene in the crude oil.
- Increasing the carbon dioxide injection pressure resulted in a decrease in the asphaltene filter cake thickness and an increase in the areal filtrate displacement.
- Heptane could not be used as an effective chemical agent for asphaltene mitigation since the asphaltene is insoluble in heptane.
- Although asphaltene was soluble in naphtha, the chemical agent could not mitigate the asphaltene plugging well.
- The two most effective chemical agents used in this research for asphaltene mitigation were kerosene and xylene. Overall, xylene was the best agent.

Selected Publications

1. Fakher, S. et al. Critical review of asphaltene properties and factors impacting its stability in crude oil. J Petrol Explor Prod Technol (2019). https://doi.org/10.1007/s13202-019-00811-5.
2. Fakher, S. et al. An experimental investigation of asphaltene stability in heavy crude oil during carbon dioxide injection. J Petrol Explor Prod Technol (2019). https://doi.org/10.1007/s13202-019-00782-7.
3. Fakher, S. and Imqam, A., 2018. An experimental investigation of immiscible carbon dioxide interactions with crude oil: Oil swelling and asphaltene agitation. https://doi.org/10.1016/j.fuel.2020.117380.
4. Fakher, S. and Imqam, A., 2020. Asphaltene precipitation and deposition during CO2 injection in nano shale pore structure and its impact on oil recovery. https://doi.org/10.1016/j.fuel.2018.10.039.
5. Fakher, S. et al., 2019. The Effect of Unconventional Oil Reservoirs’ Nano Pore Size on the Stability of Asphaltene During Carbon Dioxide Injection. Carbon Management Technology Conference. doi:10.7122/CMTC-558486-MS
6. Fakher, S.. Et al., 2019. Roadmap to Asphaltene Characteristics, Properties, and Presence in Crude Oils Based on an Updated Database From Laboratory Studies. Carbon Management Technology Conference. doi:10.7122/CMTC-558560-MS.
7. Fakher, S., 2019. Investigating Factors that May Impact the Success of Carbon Dioxide Enhanced Oil Recovery in Shale Reservoirs. Society of Petroleum Engineers. doi:10.2118/199781-STU.

Acknowledgment

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