Filtration Experiments in Niobrara Samples

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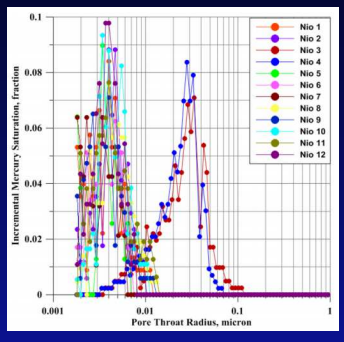
Problem Statement

- Sizes of pore throats of Niobrara samples and hydrocarbon molecules are in nanometer range

	Pore throat / molecular diameter
Niobrara B chalk	1 -- 85.2 nm
Niobrara	4.6 -- 11.9 nm
Paraffins	0.4 -- 1 nm
Aromatics	1 -- 3 nm
Asphaltene	5 -- 10 nm



pore throat size distribution of Niobrara sample

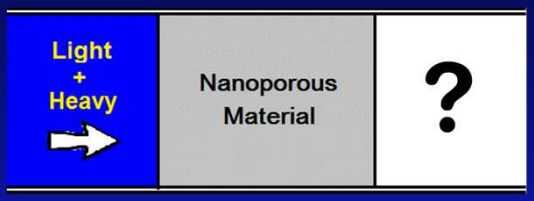
Problem Statement

- Niobrara sample may potentially act as a semi-permeable membrane

Hypothesis:

Light components can pass through

Heavy components might be hindered or filtered (partially/completely)



Objective

- Explore the membrane property of Niobrara sample
- Investigate factors affecting the membrane effect of Niobrara sample

Pressure

Temperature

Adsorption

Mineralogy

Hydrocarbon species

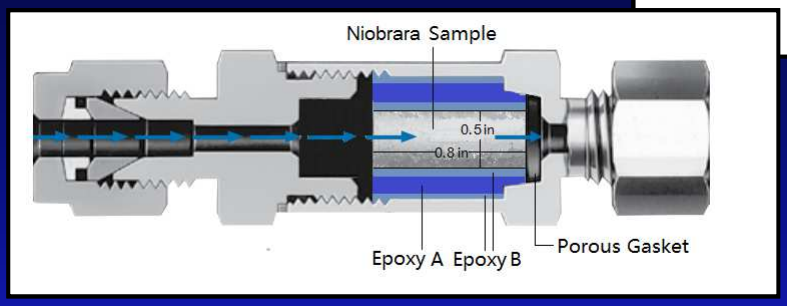
…

Experimental Setup

- **In-Line Filter**

  Pressure: 0-2500 psig

  Temperature: -20 °F to 100 °F



Result & Discussion

- Injection fluid

  Equal-volume mixture of C_7 and C_{10} → C_7 57 mol% C_{10} 43 mol%

- Produced fluid

Composition (mol%) of produced fluid from GC test

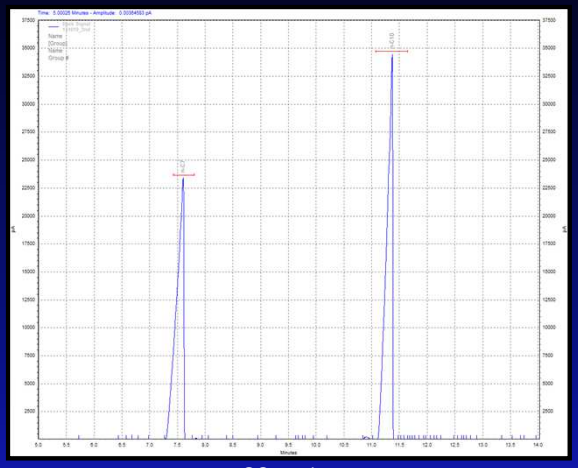
		1st test	2nd test	3rd test	4th test
Sample I	C_7	45	38	56	55
	C_{10}	54	62	44	45
Sample II	C_7	33	56	55	
	C_{10}	67	44	45	
Sample III	C_7	55	53		
	C_{10}	45	47		

Result presented at the previous meeting

Reason for C_7 mol% reduction was thought to be adsorption

Result & Discussion

- Gas Chromatography (GC)



GC result

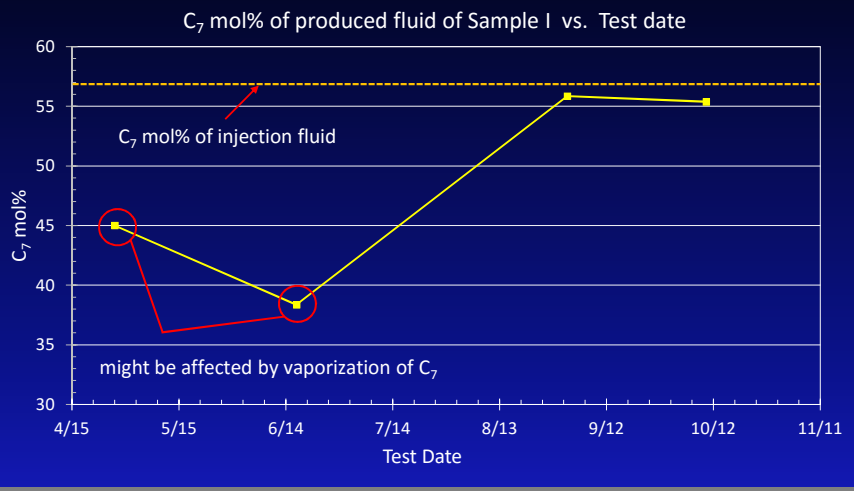
GC equipment

Sample vial

Result & Discussion

Sample I

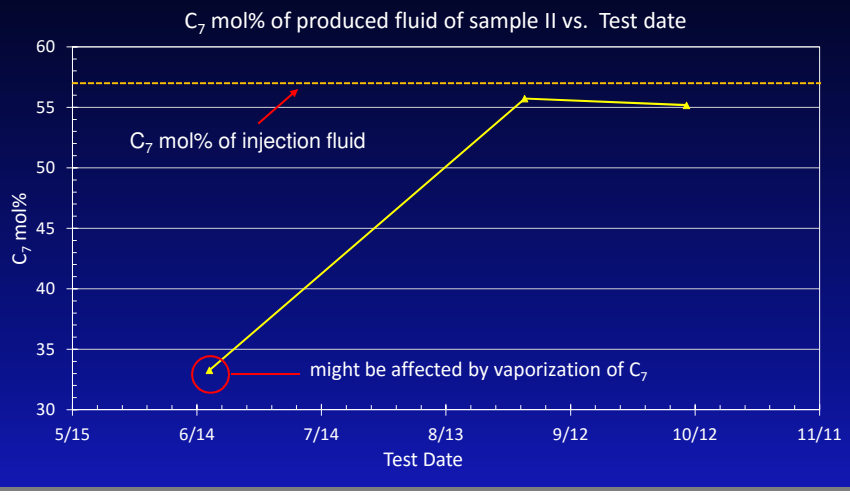
Experiment start date: 02/20/17



Result & Discussion

Sample II

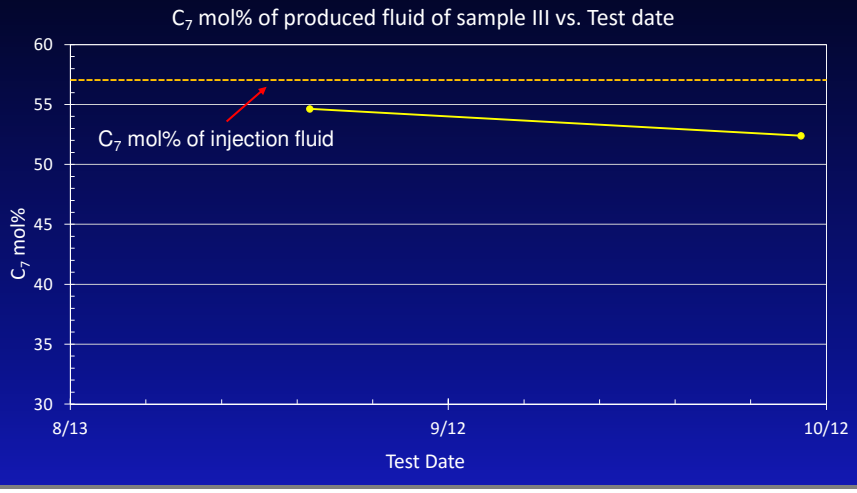
Experiment start date: 04/01/17



Result & Discussion

Sample III

Experiment start date: 05/01/17



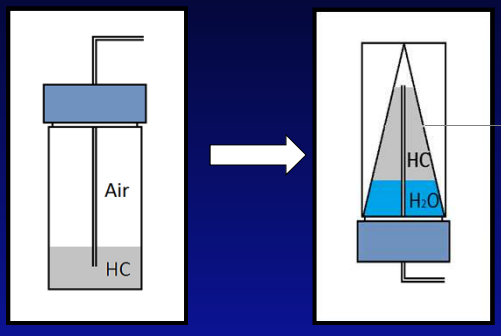
Conclusion

- Filtration experiments were conducted using alkane mixtures
- Fraction of C_7 is observed to decrease in produced fluids compared with injection fluid
- GC result of some data points might be affected by vaporization of C_7 (samples were not tested immediately after collection)
- Excluding the effects of vaporization of light component (C_7), no dramatic filtration effect observed for the transport of C_7 C_{10} mixture in Niobrara sample

Future Work

- Collecting setup and experimental procedure need to be improved to reduce vaporization

$V_{vial} = 1\ cc$



current setup

improved setup

$V_{vial} = 0.3\ cc$

Future Work

- Frequency of sampling can be increased to have more data points

  volume needed for one GC test < 0.01cc

  production rate ≈ 1 – 3 cc / month

  } 10+ data points / month

- Hydrocarbons with larger molecular sizes should be tested.
- Develop a two-component transport model with adsorption/filtration to fit/match experimental data

References

Cho, Y., Eker, E., Uzun, I. et al. 2016. Rock Characterization in Unconventional Reservoirs: A Comparative Study of Bakken, Eagle Ford, and Niobrara Formations. Paper SPE 180239 presented at the SPE Low Perm Symposium, Denver, Colorado, 5-6 May. https://doi.org/10.2118/180239-MS

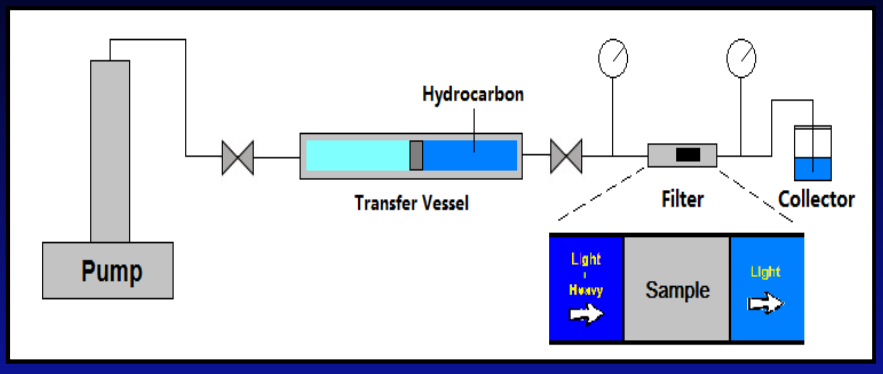
Kuila, U., Prasad, M., Derkowski, A. et al. 2012. Compositional Controls on Mudrock Pore-Size Distribution: An Example from Niobrara Formation. Paper SPE 160141 presented at the SPE Annual Technical Conference and Exhibition, San Antonio, Texas, 8-10 October. https://doi.org/10.2118/160141-MS

Nelson, P. H. 2009. Pore-Throat Sizes in Sandstones, Tight Sandstones, and Shales. *AAPG Bulletin* **93** (3): 329-340. https://doi.org/10.1306/10240808059

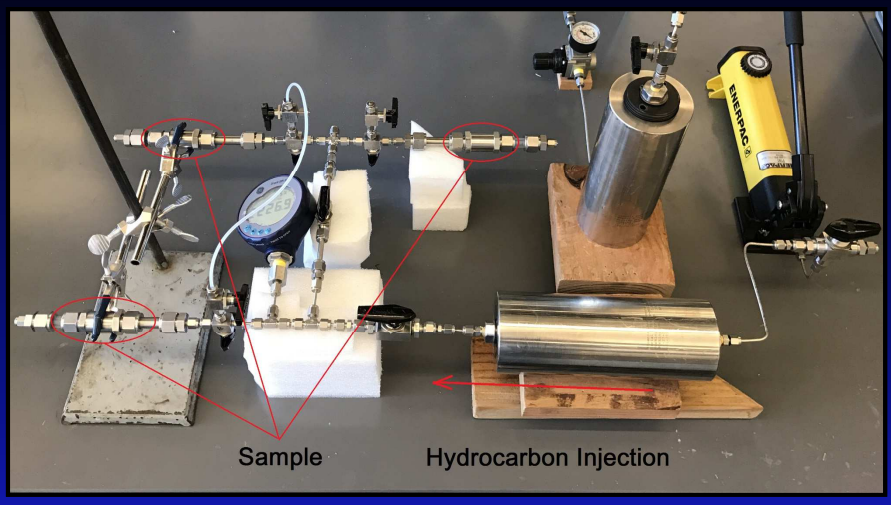
Thank You

Questions?

Experimental Setup



Experimental Setup



Experimental Setup

- **Niobrara Sample**

  Collected from Niobrara C

  Three-layer epoxy coated

  Curing under pressure