Hindered Transport and CO_2 Injection in Niobrara Samples

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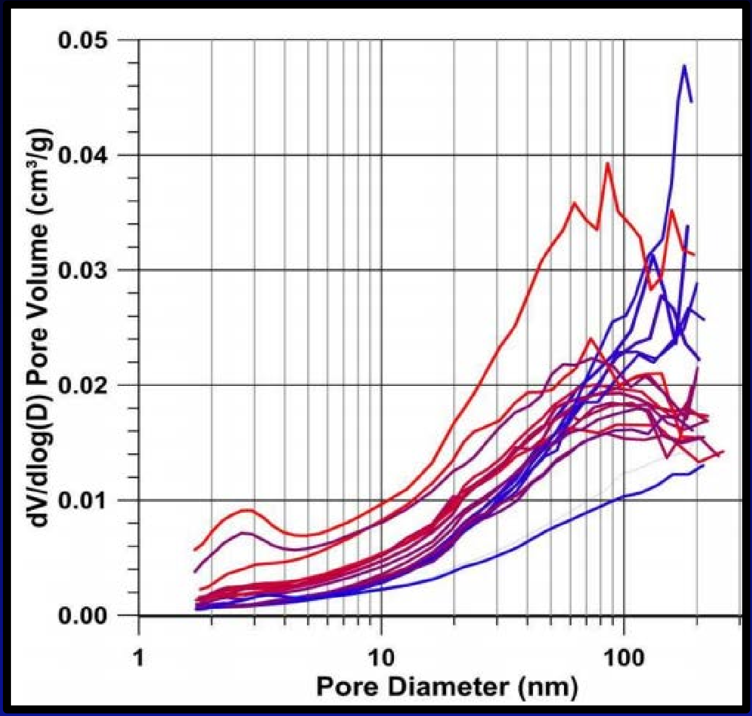
Problem Statement

- Portion of pores in Niobrara samples have comparable sizes with hydrocarbon molecules.

	Size (diameter), nm
Pore, Niobrara	1 -- >100
Paraffins	0.4 -- 1
Aromatics	1 -- 3



Pore Size Distribution of Niobrara Samples

Problem Statement

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

Hypothesis:

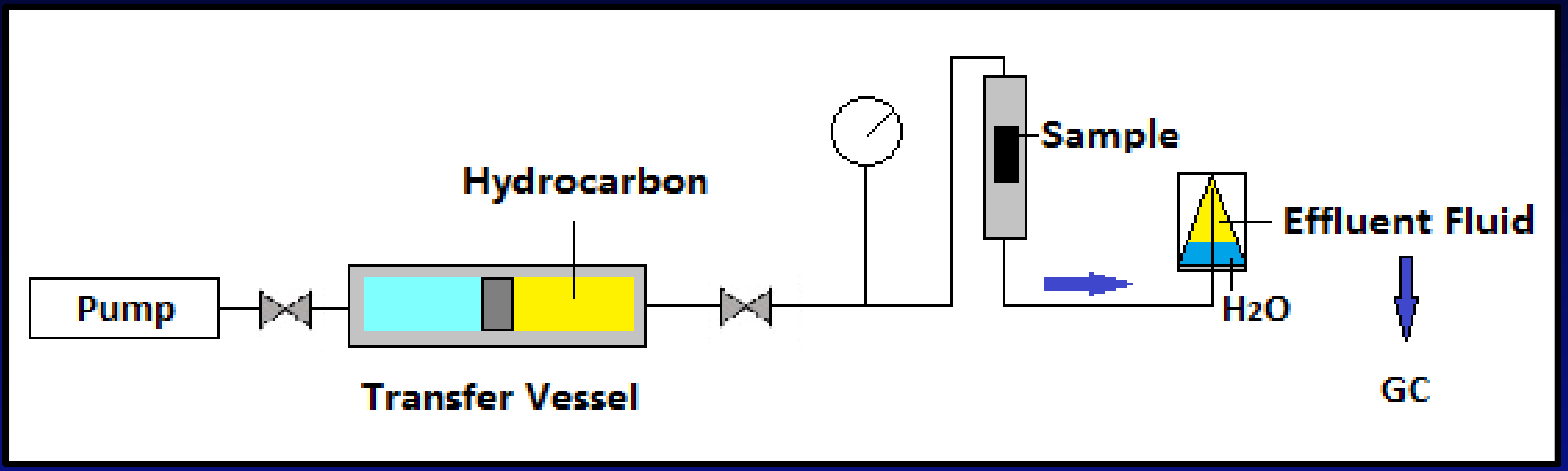
Light components can pass through.

Heavy components may be partially filtered (size exclusion ..?).

Objective

- Through experiments, explore the hindrance effect of Niobrara sample on hydrocarbon transport.
- Investigate factors affecting the composition change of hydrocarbon mixtures flowing through Niobrara sample.
  - Adsorption
  - Hydrocarbon species
  - Pressure
  - Temperature
  - Mineralogy

Experimental Setup



Experimental Setup

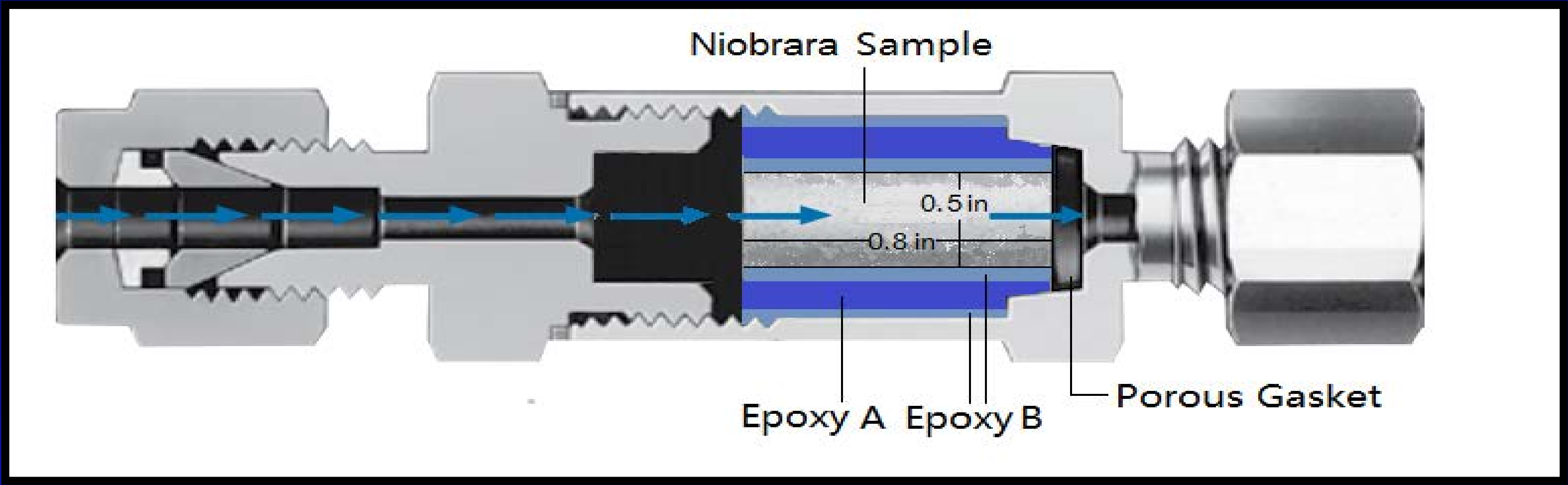
- **Gas Chromatograph**

  Agilent 7890B

- **Mini Core Holder**

  Modified from In-Line Filter

  Working Pressure: 0-2500 psi



Filtration Test

- Injection Fluid

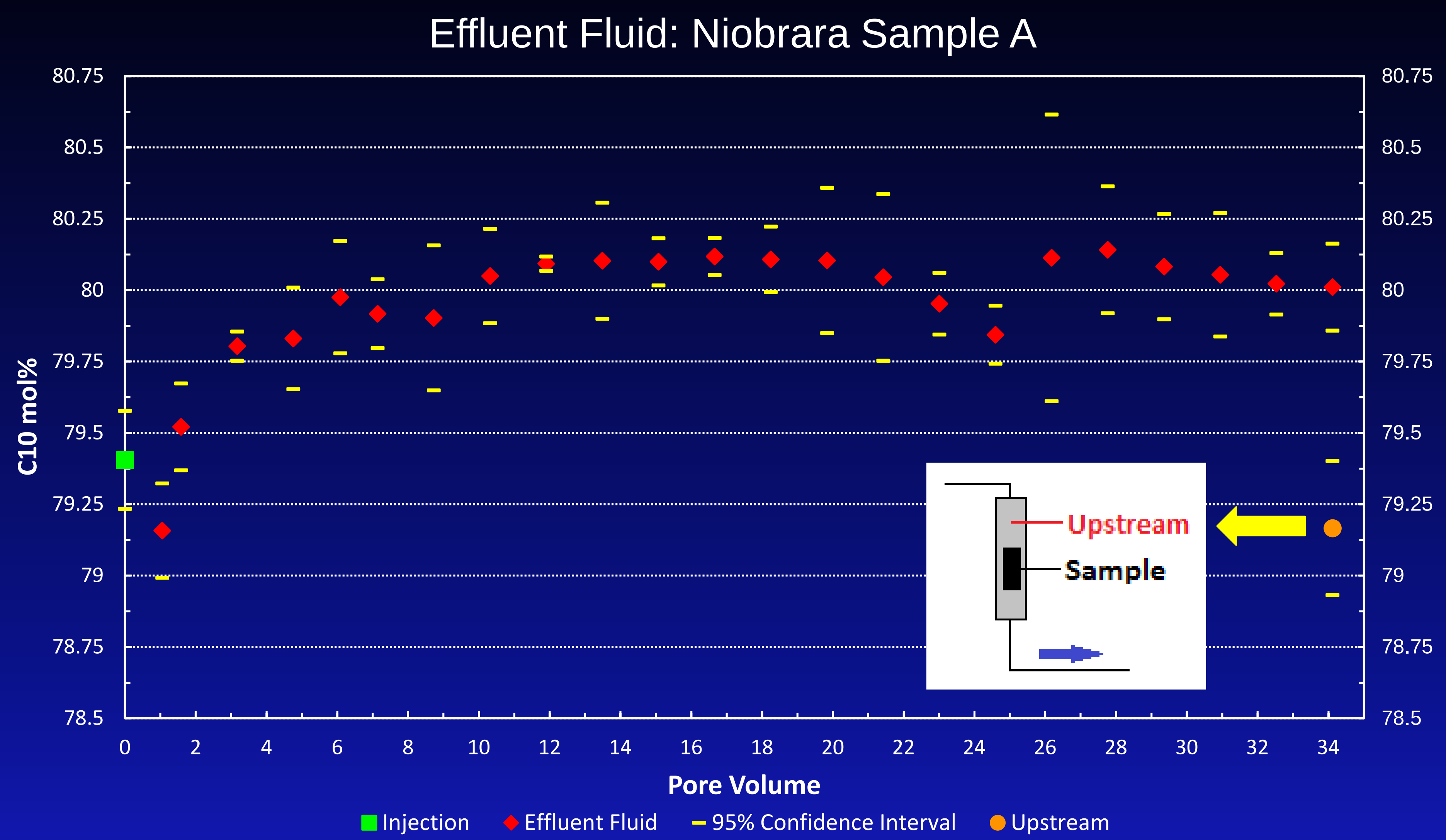
  Binary mixture of C_{10} and n-C_{17}

- Rock Samples

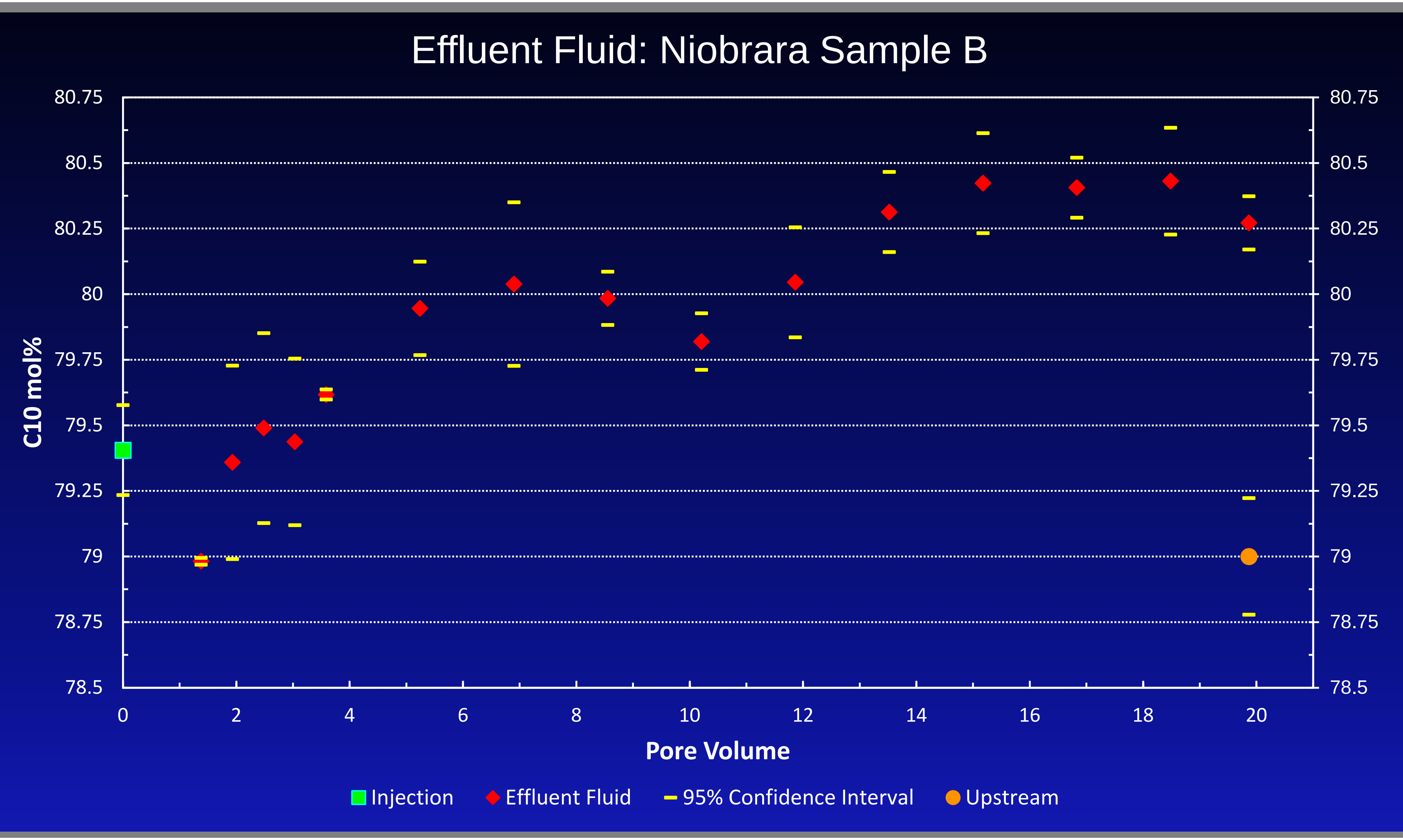
Sample		Length, in	Diameter, in	Pore Volume*, ml
Niobrara Shale	A	0.735	0.5	0.19
	B	0.704	0.5	0.18
	C	0.741	0.5	0.19
Berea Sandstone	A	0.738	0.5	0.47
	B	0.733	0.5	0.47
	C	0.705	0.5	0.45

*Pore volumes are calculated based on estimated porosity of 8% for Niobrara Shale and 20% for Berea Sandstone.

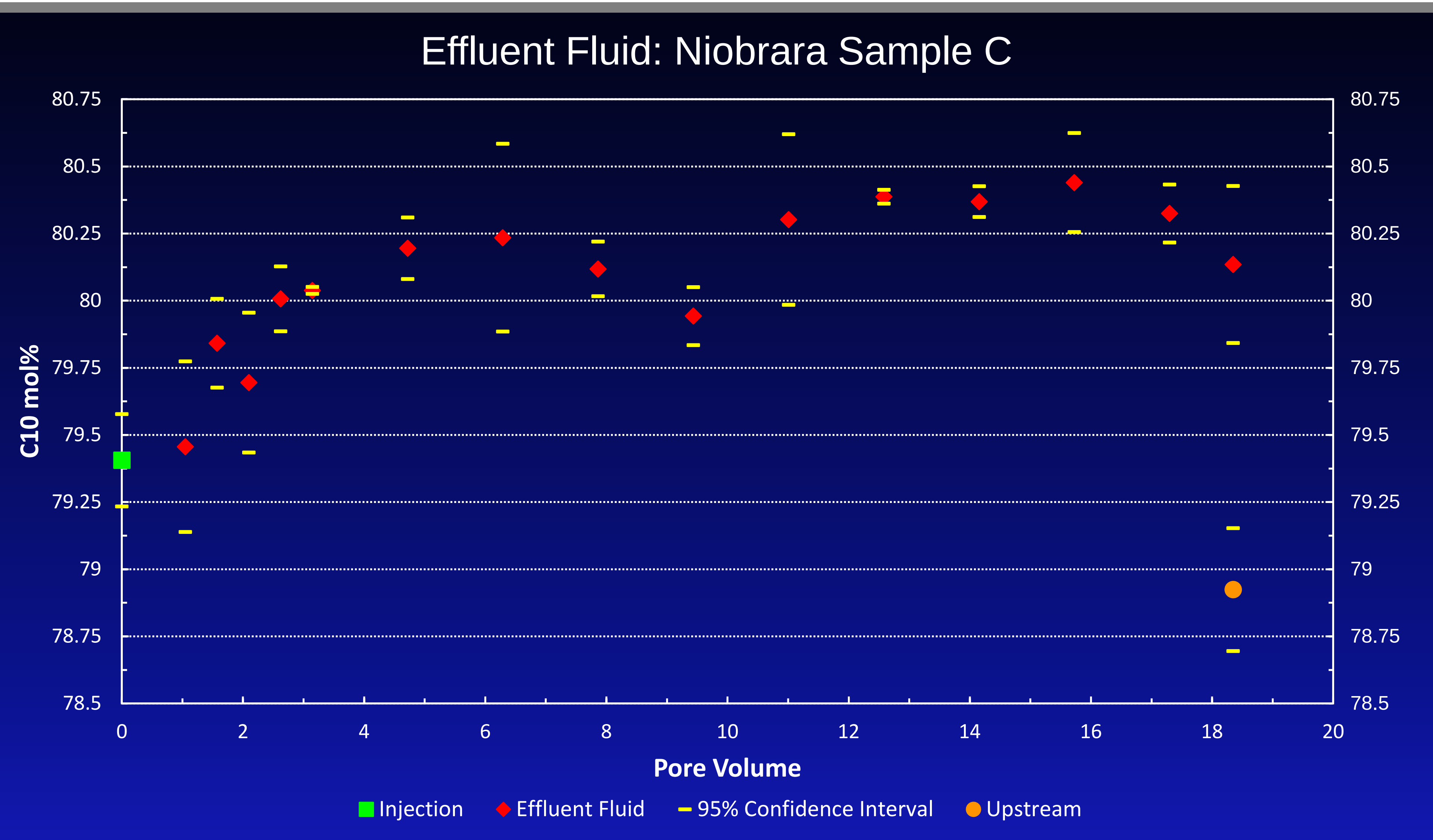
Result & Discussion



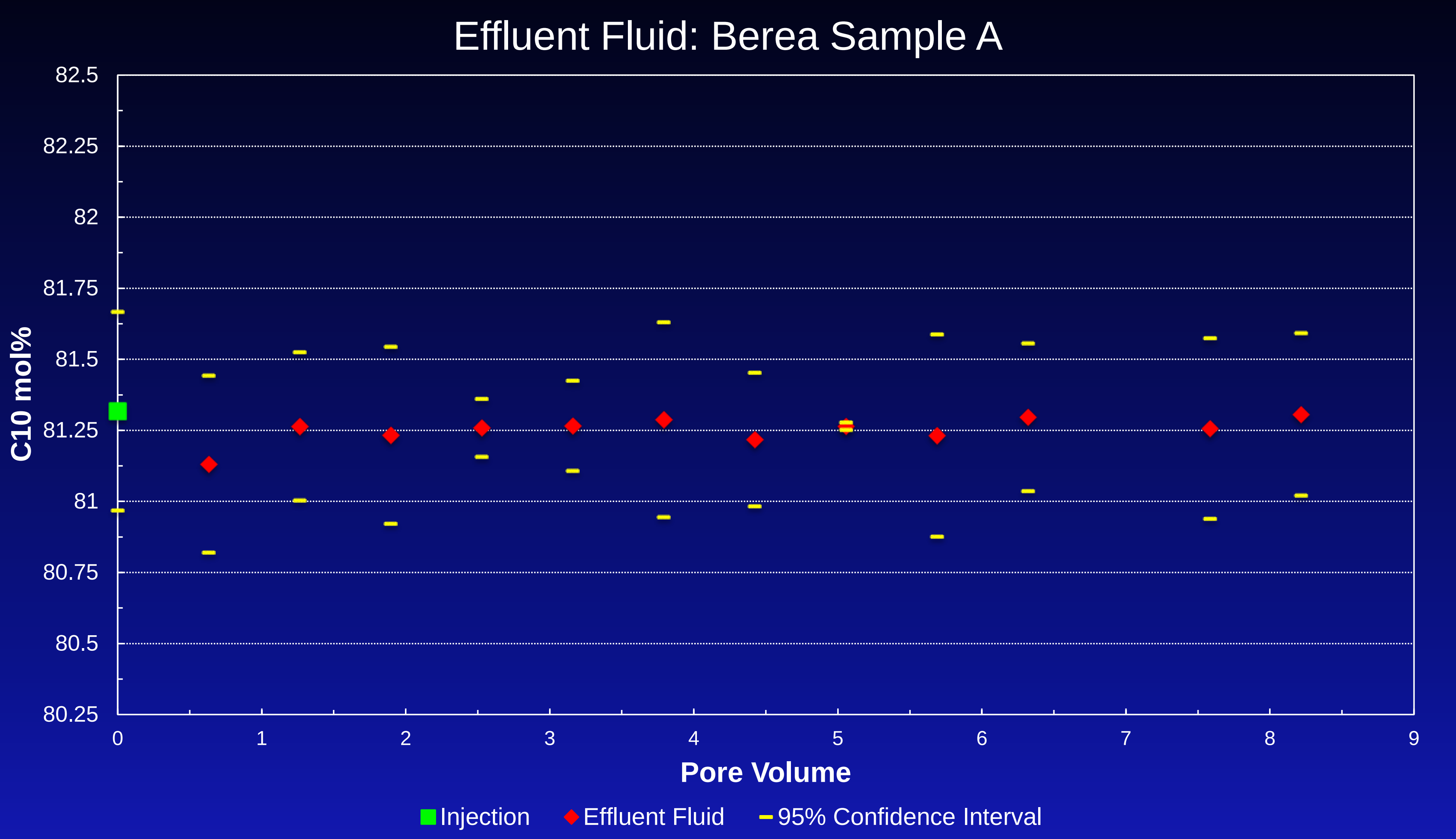
Result & Discussion



Result & Discussion



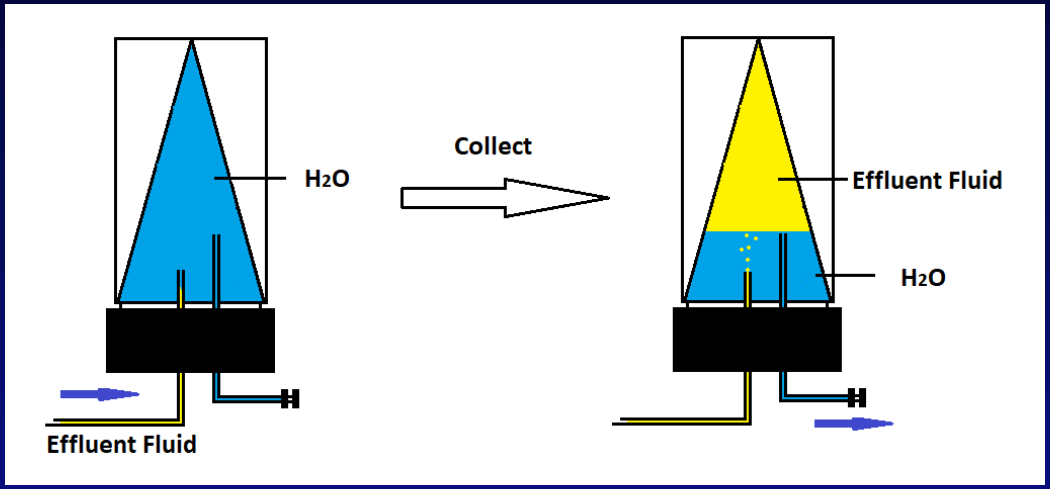
Result & Discussion



Result & Discussion

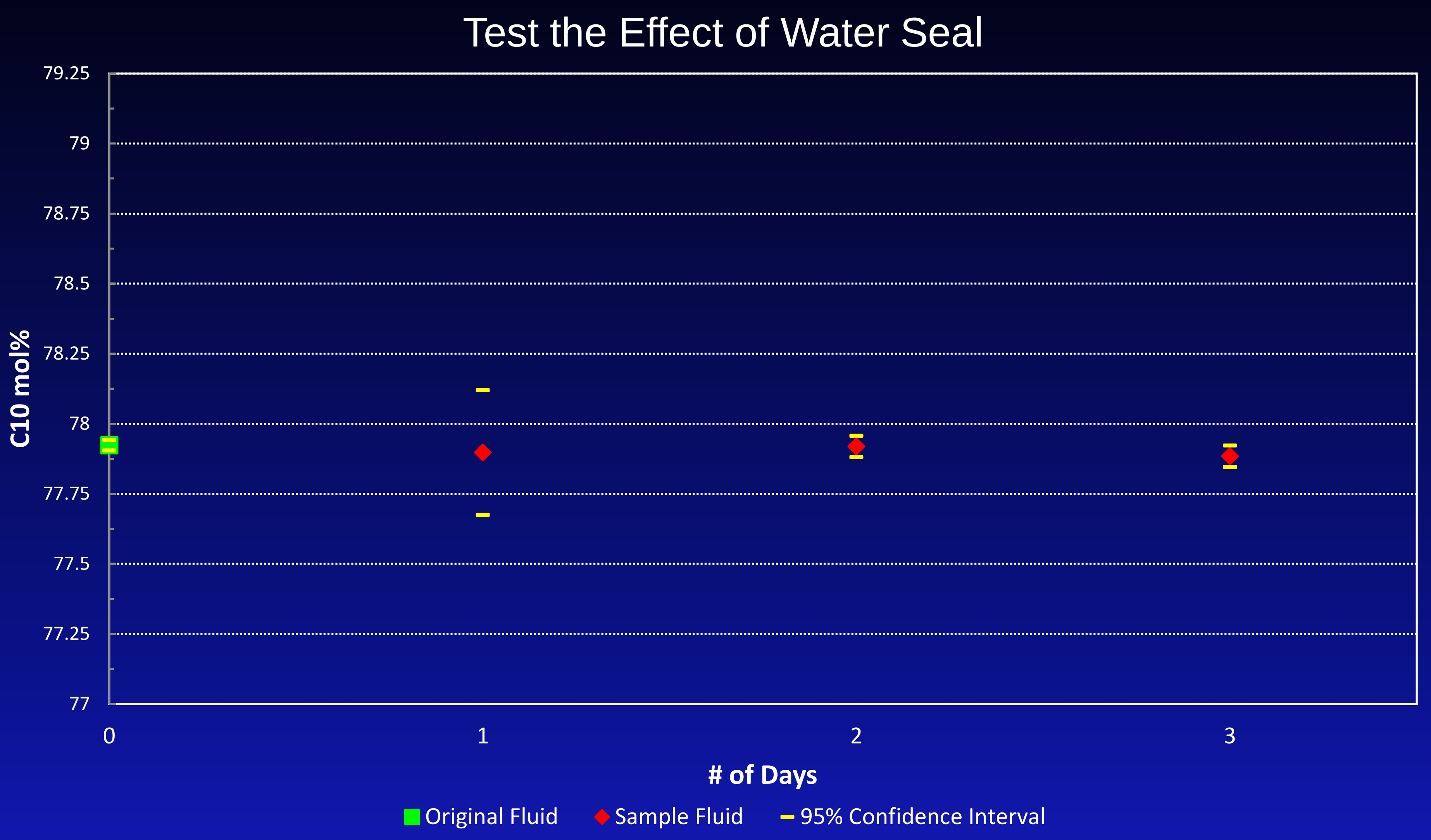
Improvement of Experimental Equipment and Process

- Reduce evaporation of effluent fluid (HC) by water seal during collection phase.



- Perform GC test immediately after collecting each sample to reduce evaporation during waiting.
- Reduce the number of GC test for each sample from 5 to 2.

Result & Discussion



Result & Discussion

- Compared to the composition of initial injection fluid:

Niobrara Shale C_{10} mol% increases, n-C_{17} mol% decreases in the produced fluid.

n-C_{17} mol% increases in the remaining injection fluid (upstream).

Berea Sandstone No obvious compositional change in the effluent fluid.

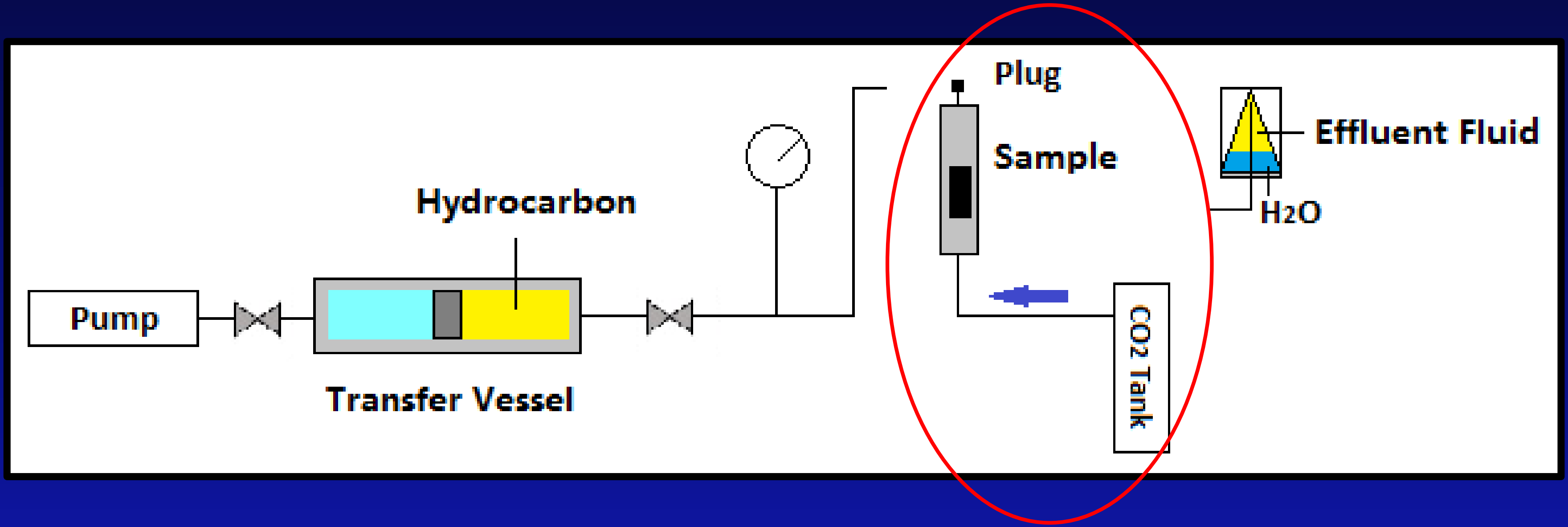
- To some extend, experimental results might demonstrate the existence of hindrance (filtration) effect in Niobrara Shale.

Light component (C10) passes through.

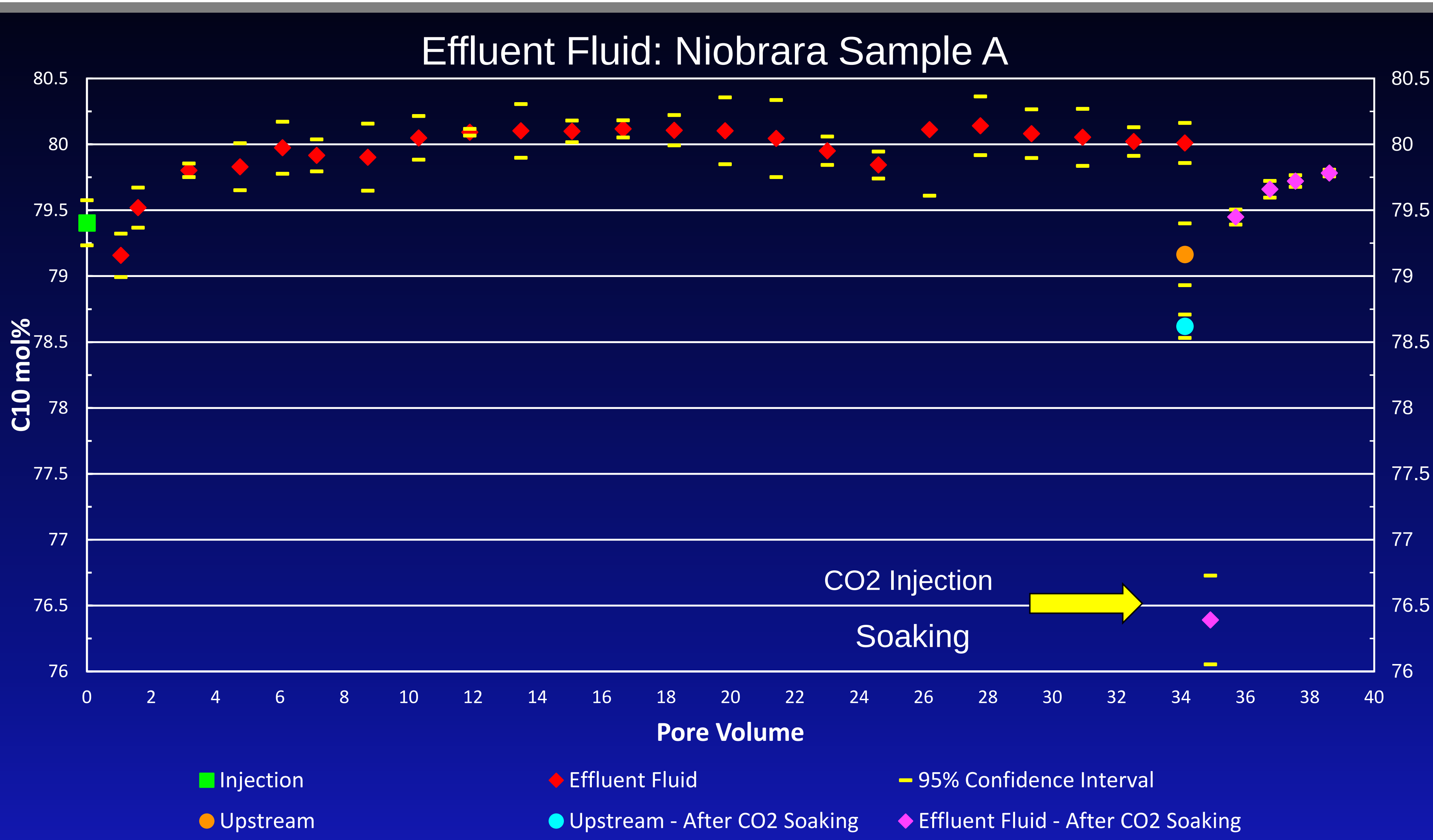
Heavy component (n-C17) is partially filtered.

CO2 Huff & Puff

- After shutting down hydrocarbon injection, backflush core sample with CO_2 at 600 psi.
- Soak for 10-12 days
- Resume production



Result & Discussion



Result & Discussion

- After CO_2 Soaking :

  C_{10} mol% drops in the remaining injection fluid (upstream fluid).

  n-C_{17} mol% increases in the remaining injection fluid.

- Resume Production:

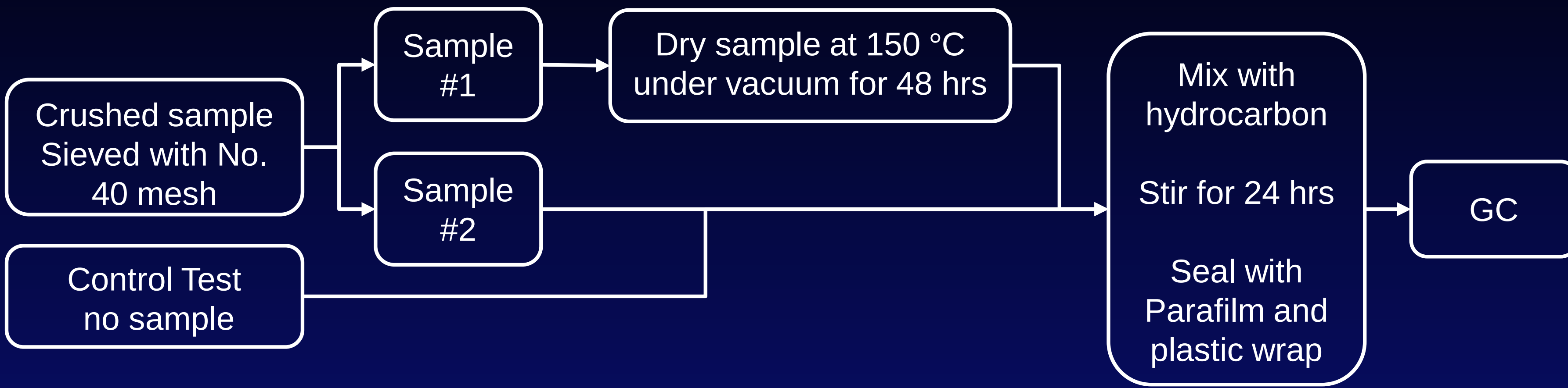
  C_{10} mol% significantly decreases in the produced fluid at early stage.

  C_{10} mol% bounces back to the same level of original injection fluid,

  then gradually increases.

Adsorption Test

- Procedure



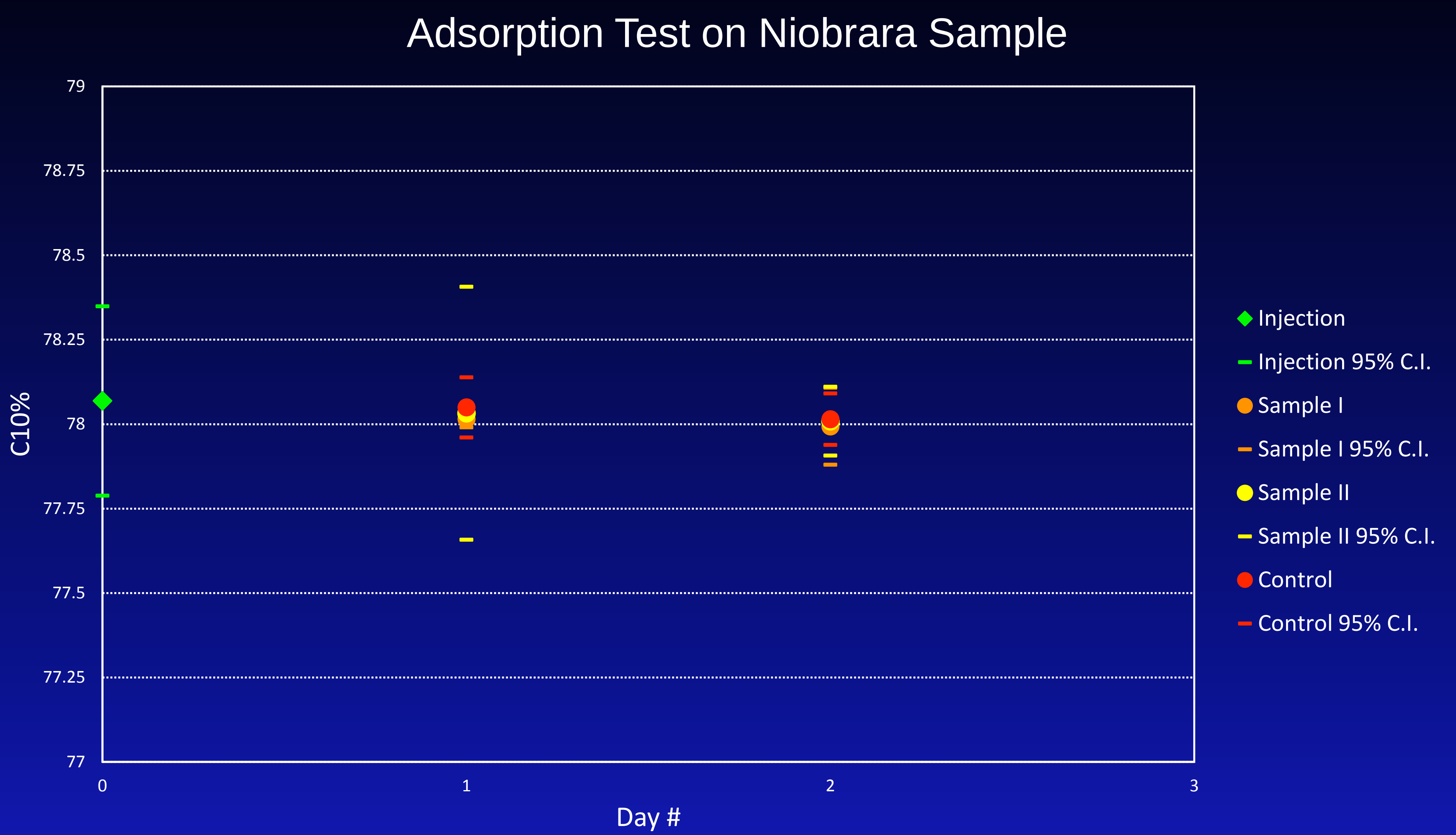
- Binary mixture of C_{10} and n-C_{17}

Component	Concentration, mol%
C_{10}	78.07
n-C_{17}	21.93

- Niobrara sample and hydrocarbon mass

Sample #	1	2	Control Test
Sample mass, g	2.78	2.71	- -
HC mass, g	8.04	8.05	8.03

Result & Discussion



Result & Discussion

- No obvious adsorption preference between C_{10} and n-C_{17} has been clearly detected.

References

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Thank You

Questions?