Hydraulic Fracking Water Treatment in Texas and North Dakota

Project Manager: Genel Abordo

Project Engineers: Cameron Patel, Cody Duncan, Caitlin McAlpine, Trevor Thomas, James Libby, Kerrick Ryan

Client/Consultant: Dr. Joon Min Faculty Advisor: Dr. Diego Rosso

Project Definition

Flo-Tech Engineering is developing a mobile treatment system for flowback and produced water from hydraulic fracturing operations. The water will be treated for fracking reuse. The system will be implemented in Bakken Shale in North Dakota and/or Eagle Ford Shale in southern Texas.

Design Constraints & Parameters

Extensive research was required to determine which site areas to develop and the current technologies used to treat the water involved in hydraulic fracturing. Flo-Tech used the BKT facilities for testing treatment alternatives. Nano-filters were selected after extensive testing.

- Create a treatment process that costs less than 2 dollars per barrel (.048 dollars per gallon)
- Follow local chemical companies' water quality requirements for re-use
- Design a dynamic system that can support a mobile treatment train to accommodate the rapidly growing/ changing industry

Design Approach

Background Research
- Site Constraints
- Local Regulations
- Chemical Company Blends
- Treatment Options
- Feasibility and applicability of treatment technologies

Testing Phase
- Membrane comparison
- Determine optimal membrane

Design Configuration
- Treatment Flow Chart
- Treatment System Layout
- Process and Identification Diagram

Fig 2: FMX-B Class Bench-top model used for preliminary testing

Preliminary Results

- Testing of four filters for effectiveness at treating turbidity, conductivity, and total solids while maintaining flux
- Produced water and flowback feed water
- FMX B-Class testing filter

Fig 3. Permeate Water Samples
(From right to left: Feed, 150 kda Permeate, 100 kda Permeate, 10 kda Permeate, NF270 Permeate)

Preliminary Equipment:
- Dow NF270 filter (nanofiltration)
- Anti-fouling Membrane (FMX S class) by BKT

Time (min)	Temp (celsius)	Turbidity (Ntu)	pH	Conductivity (mS)		Flux (mL/min)
100,000 Dalton UF		Pressure= 5 Bar		feed	permeate	
0	18.5	2.66	5.98	37.79		28
15	19.7	0.64	6.09	37.73	17.17	24.6
30	20.6	3.32	6.36	37.71	17.18	22.8
45	21.3	0.25	6.7	37.62	17.34	22
60	23.95	0.26	7.37	37.77	17.58	20.4
150,000 Dalton UF		Pressure= 5 Bar		feed	permeate	
0	23.2	0.83	7.38	37.47	16.84	38
15	24.2	0.48	7.55	37.51	16.95	20
30	24.9	0.34	7.63	37.49	16.95	18.6
10,000 Dalton UF		Pressure= 5 Bar		feed	permeate	
0	25.3	2.51	7.7	37.25	15.42	36
15	26.2	0.29	7.82	7.15	17.01	23.6
30	26.9	0.36	7.84	36.41	16.86	21.6
NF270		Pressure= 12 Bar		feed	permeate	
0	24.45		7.19			25.8
15	25.3	0.55	7.34	37.21	13.33	24
30	27.7	0.23	7.42	37.39	13.347	23.8
45	28.9	0.15	7.51	37.46	12.8	23.8
60	30.1	0.28	7.62	37.56	13.11	23.8

Fig 4. Preliminary Testing Results

Environmental Documentation

- Halliburton Loophole
- Texas Railroad Commission
- Department of Mineral Resources in North Dakota

Cost Estimation

- Treatment costs can be broken down into two categories: setup and operation

$$C1Treatment = C1Operation + C1setup$$

- $C1setup$: Cost of mobile rig transportation and setup at the frac site
  - Includes setup labor. Operating is not included
- $C1Operation$: Cost associated with capital and operating related to equipment, chemicals, waste disposal, and maintenance

Plan for Next Phase

30% design
- Finish testing and select membrane, Determine system flow capacity
- Schematic of the mobile treatment system,
- Treatment process flow diagram
- Refine Cost estimate

70% design
- Progress report will be submitted to BKT

100% design
- The final design consists of a 2-D layout of the treatment system and a Process & Instrumentation Diagram

References

Acharya, H. (2011). Cost Effective Recovery of Low-TDS Frac Flowback Water for Re-use. Department of Energy, Final Report. Retrieved January 20, 2014, from http://www.netl.doe.gov/File%20Library/Research/Oil-Gas/FE0000784_FinalReport.pdf