Treatment for Flowback Marcellus Shale

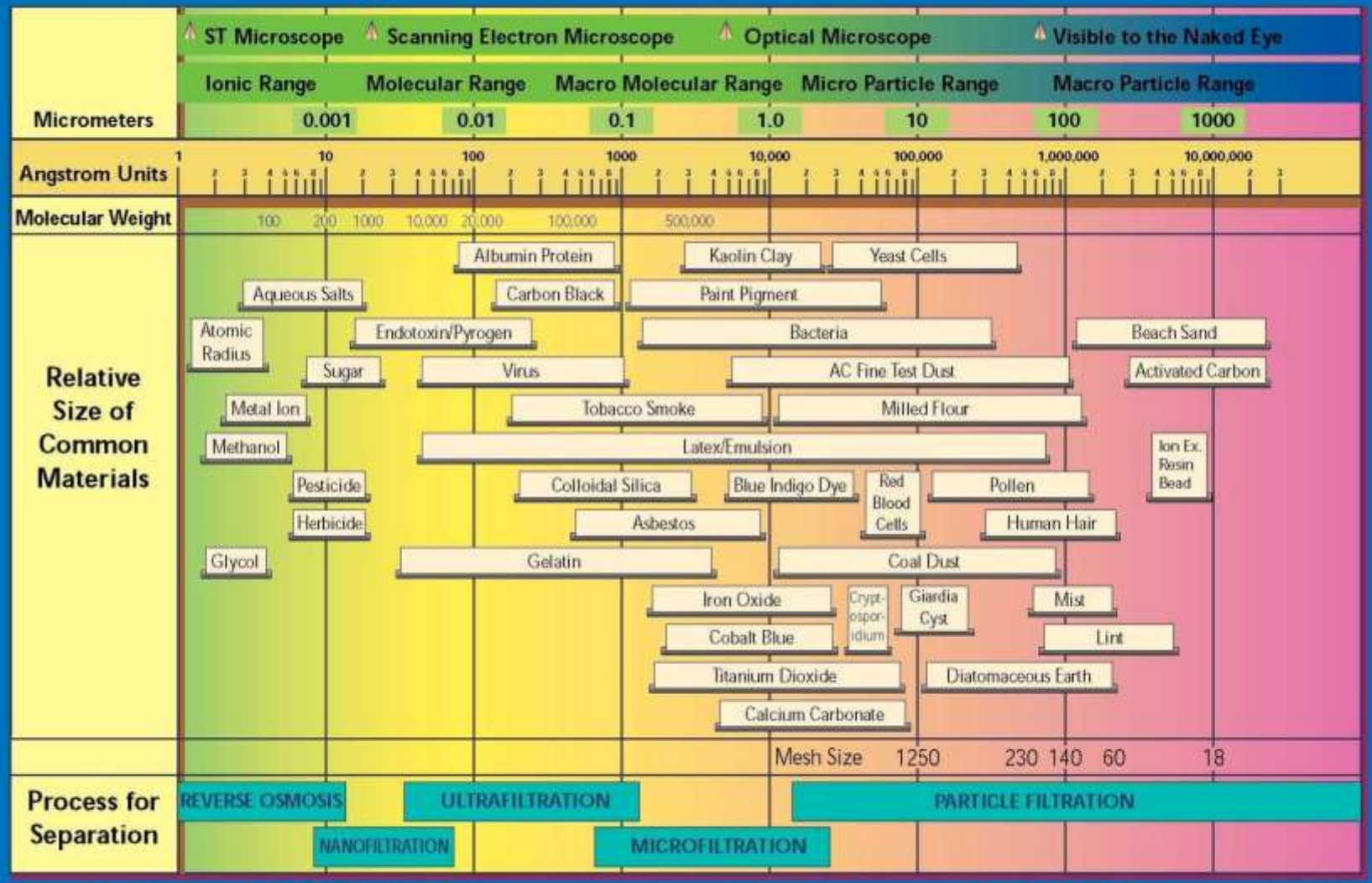
A Treatment Alternative Applying

VSEP by New Logic Research Technology Employing

Both Nanofiltration and Microfiltration

New Logic

The Filtration Spectrum



1 Micron (1 x 10^{-6} Meters) = ~ 4 x 10^{-5} Inches (0.00004 Inches)

1 Angstrom Unit = 10^{-10} Meters = 10^{-4} Micrometers (Microns)

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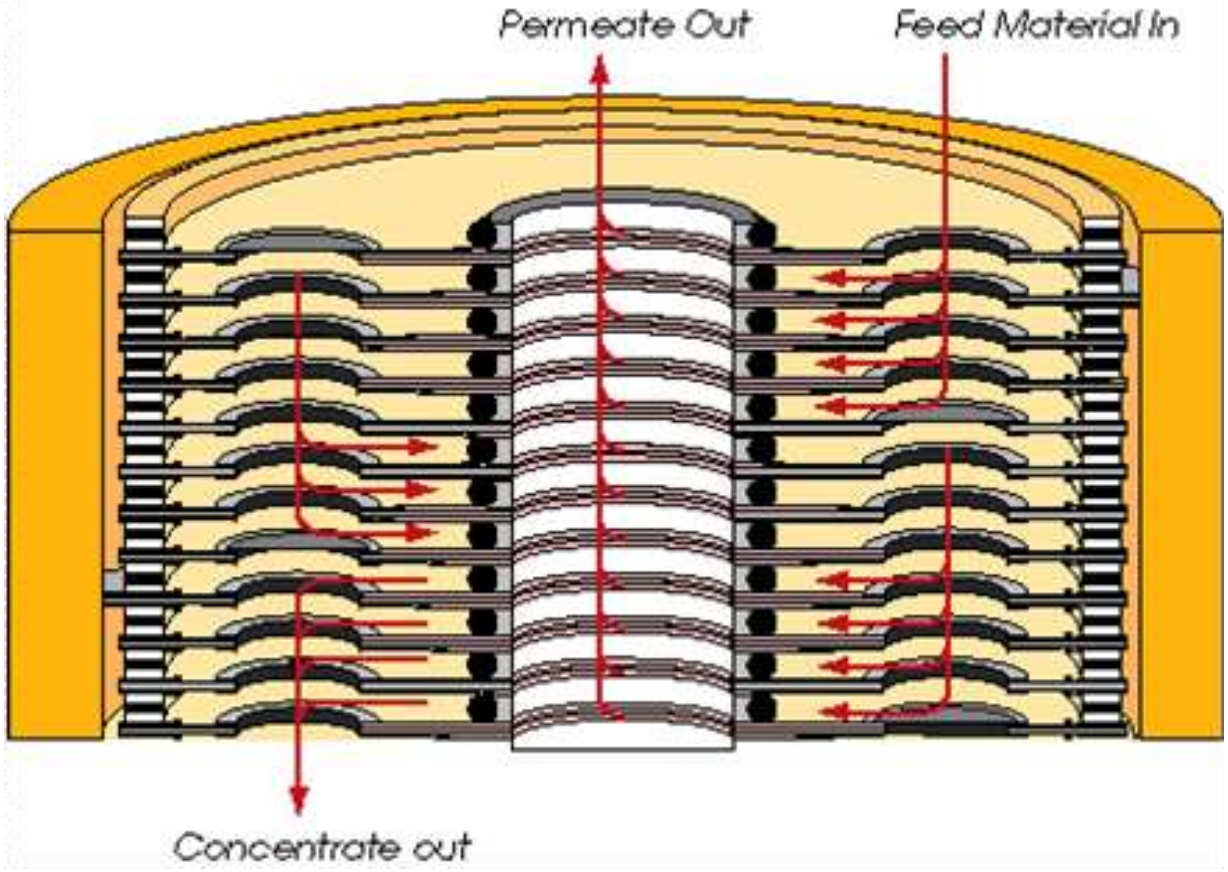
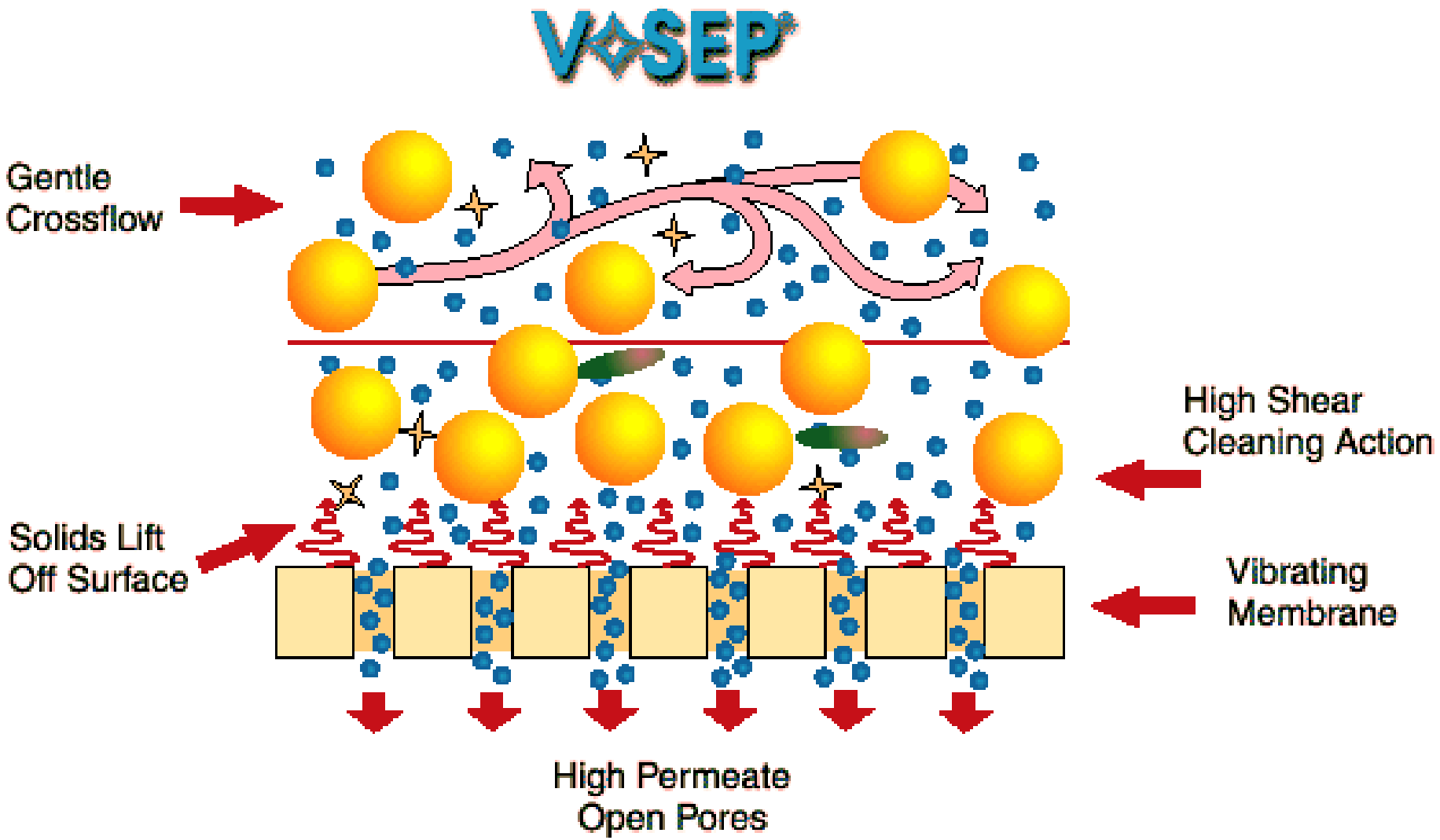
Filter Pack Cross Section




VSEP
Gentle
Crossflow
High Shear
Cleaning Action
Solids Lift
Off Surface
Vibrating
Membrane
High Permeate
Open Pores


ALTOM

VSep Pilot Unit

VSep Pilot Unit

Flowback Volume and TDS versus time

A Vertical Well

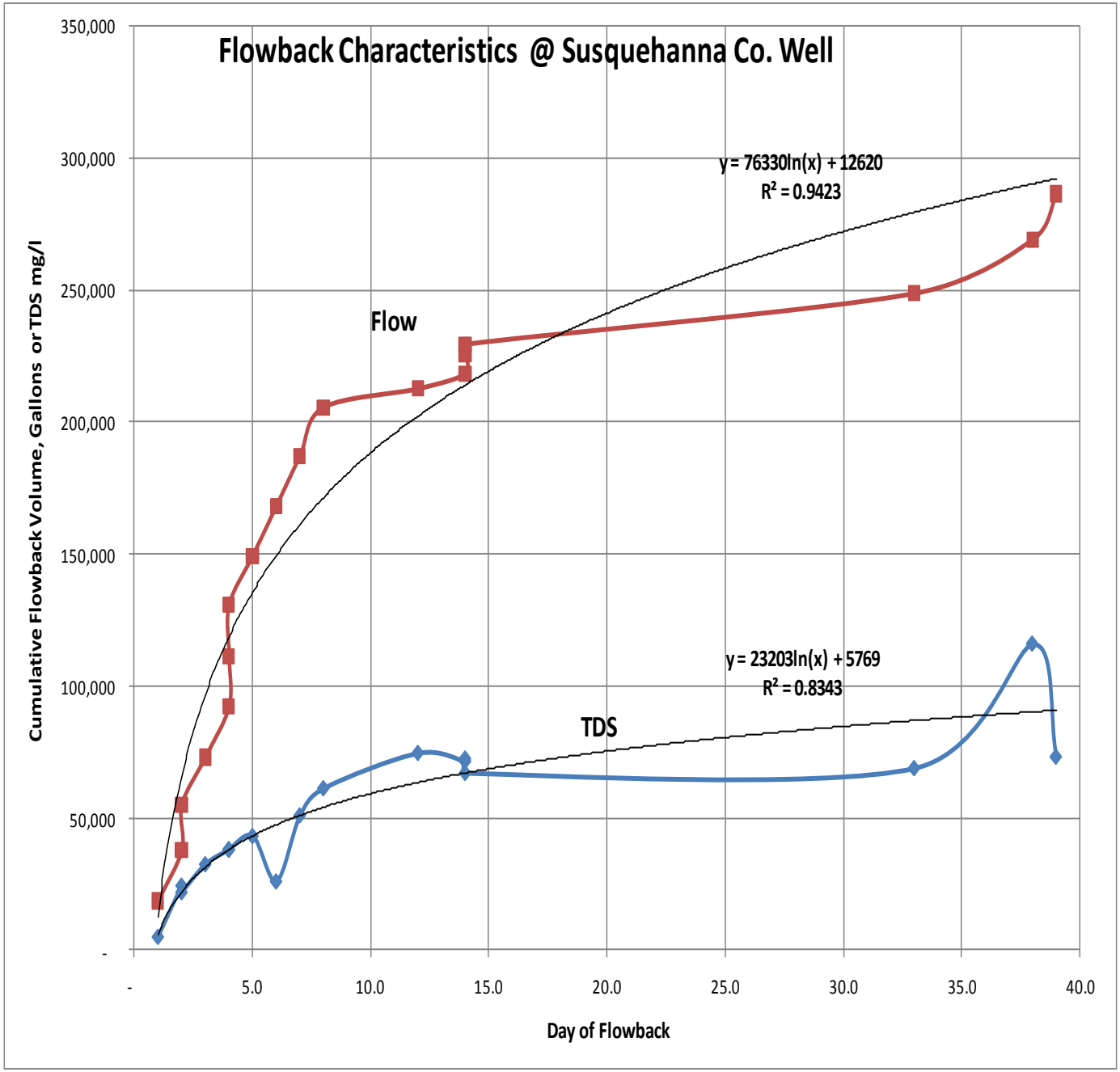
About 80% of flowback returned in 14 days

About 60% of TDS returned in 14 days

TDS about 70,000 mg/l @ 14 days

Average combined TDS = 48,000 mg/l

Log function provides good fit for data



Typical Batch Run

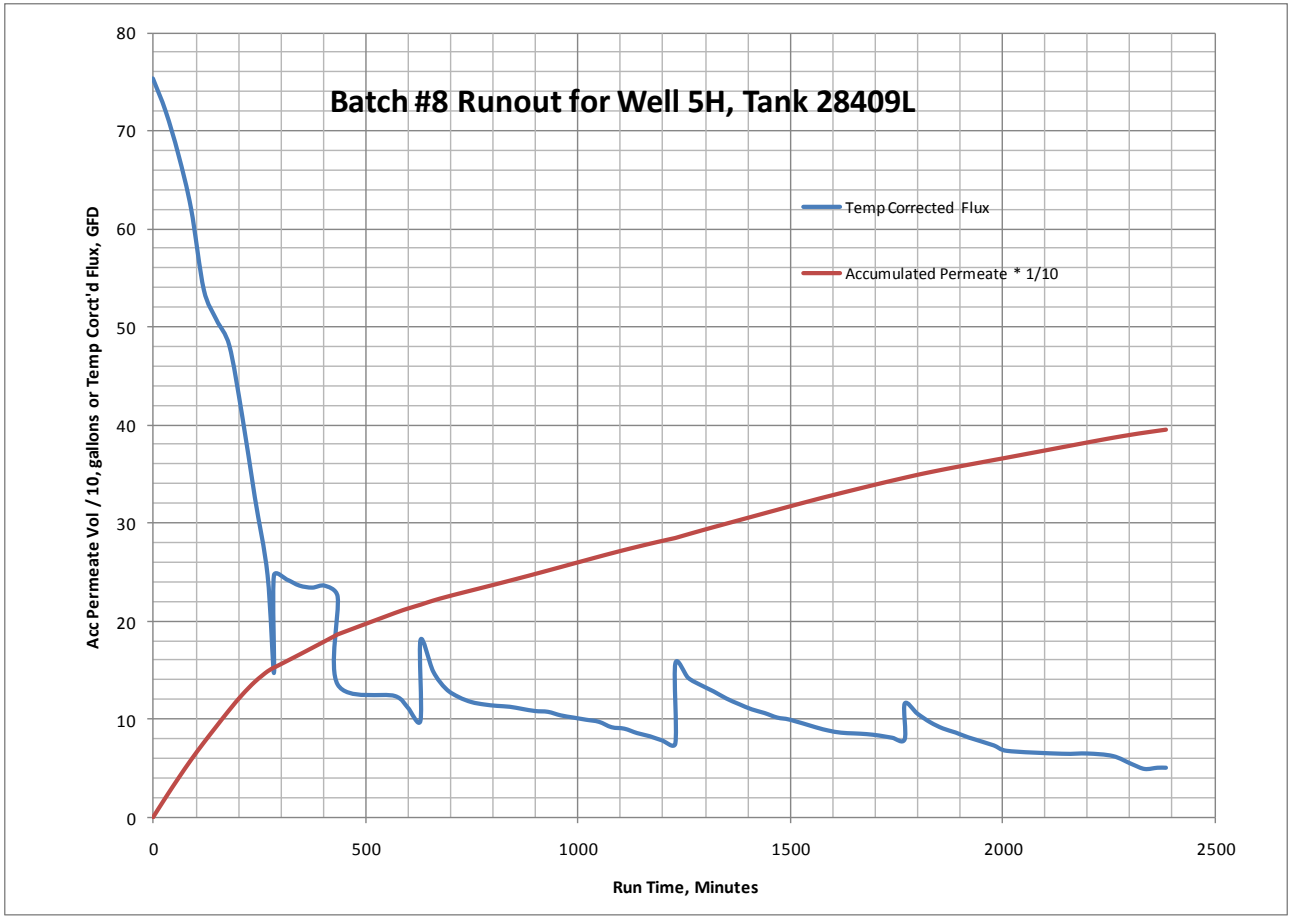
Focus on Flux Rate the blue line: Initial conductivity = 34.5 mS/cm

High flux at start

Clean water flushes where periodic peaks occur

Red line shows the accumulation of permeate

Information from many batches used to estimate design flux rate



Flowback Sample, Permeate, & Concentrate

Pit Water Sample, Permeate, & Concentrate

Re-use Evaluation

One well service company described the Vsep permeate as “good quality”

Langelier Index implying moderate scaling potential

Microbial Activity Indicator (ATP) – Shows no evidence of biological growth

Scale and Iron control chemistries need to be applied during the fracturing process

ID #:	072209_001
Sample ID:	Milnes Engineering
Sample Date:	
Anions	
P Alkalinity (mg/L as $CaCO_3$)	0
M Alkalinity (mg/L as $CaCO_3$)	124
Chloride (mg/L as Cl^-)	10,480
Sulfate (mg/L as SO_4^{2-})	0
Cations	
Calcium (mg/L as Ca^{2+})	522
Magnesium (mg/L as Mg^{2+})	15
Total Hardness (mg/L as $CaCO_3$)	1,364
Iron, Ferrous (mg/L as Fe)	0.0
Iron, Total (mg/L as Fe)	0.2
Miscellaneous	
pH	7.78
Total Suspended Solids (mg/L)	13
Specific Gravity (g/ml)	1.009
Conductivity (micromhos)	29,100
ATP (rlu) – Microbiological Content	0
Microbiological Content	Low
Langelier Saturation Index (LSI)	1.15
Langelier Potential	Scaling
Calcium Sulfate Scaling Potential	Negative
Barium (mg/L as Ba^{2+})	172
Strontium (mg/L as Sr^{2+})	128

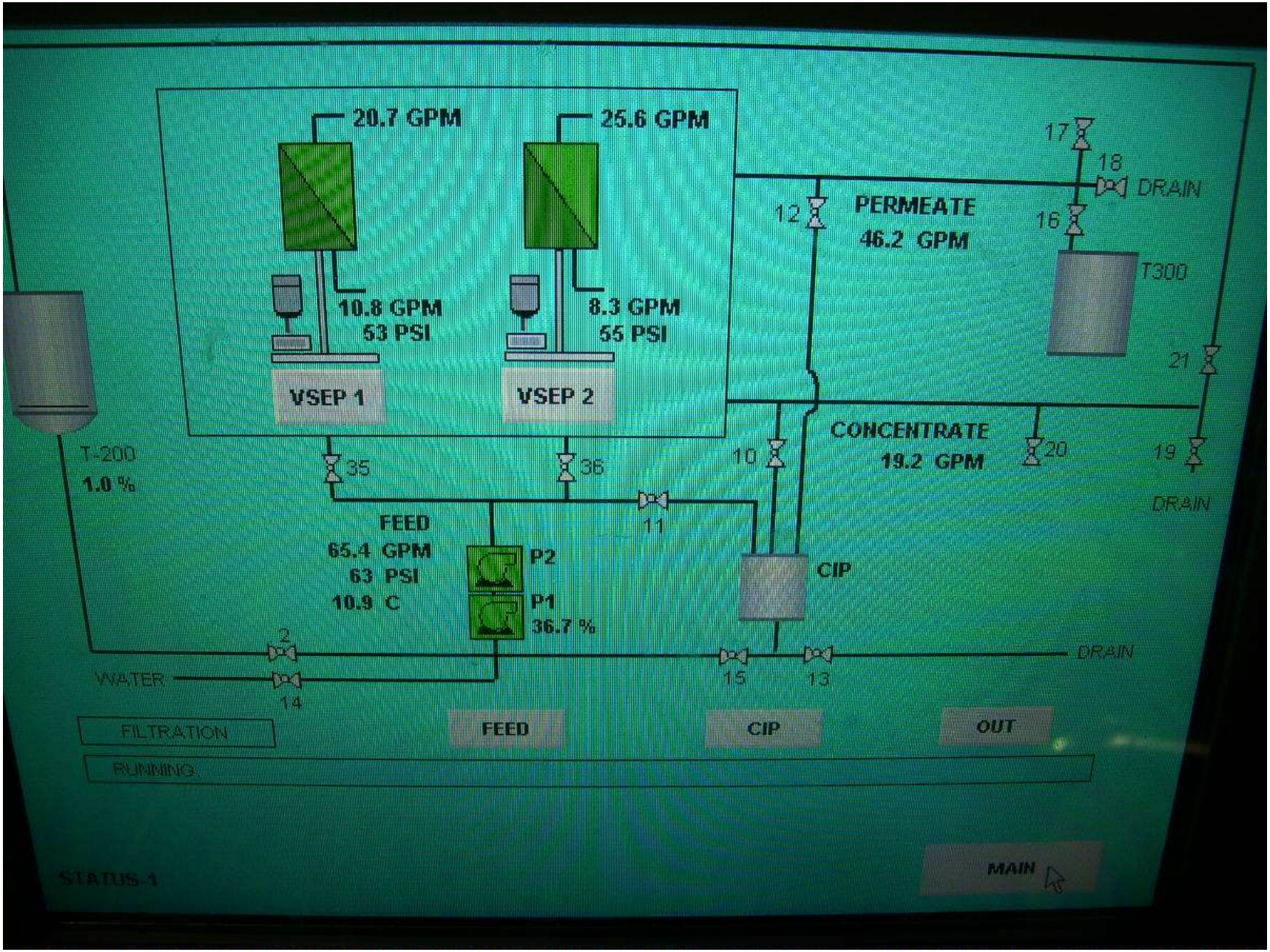

ARM-FEED
ARM-PES5/TYVEK PERMEATE
ARM-PVDF-100 PERMEATE
ARM-PVDF-200 PERMEATE
ARM-0.05UM PERMEATE
1.0um
ARM-1.0UM PERMEA

Space Requirement @ Well Pad for a 1,000 BPD Treatment Facility

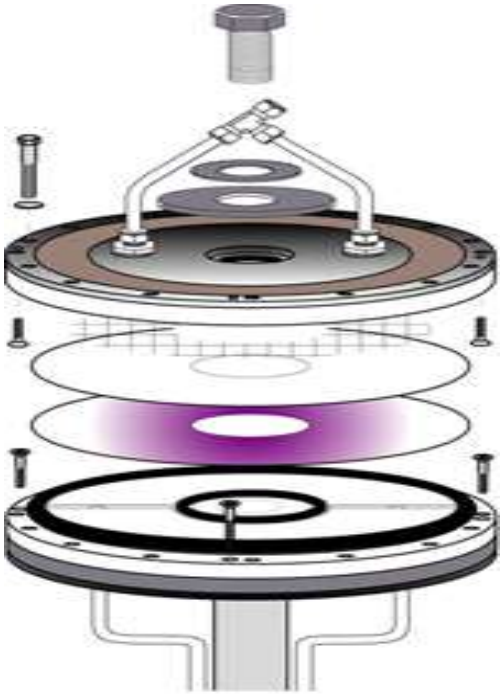
- 60’ x 80’ bermed area with membrane liner to contain the following
  - Diesel powered electric generator
  - 40’ trailer with two nanofiltration units and control skid
  - 40’ trailer with feed tanks,
  - 20,000 gal feed storage tank?
  - 20,000 gal concentrate storage tank
  - 20,000 gal permeate storage tank


AUTO CRANE


WHP 3182


20.7 GPM
25.6 GPM
10.8 GPM
53 PSI
8.3 GPM
55 PSI
VSEP 1
VSEP 2
PERMEATE
46.2 GPM
CONCENTRATE
19.2 GPM
T300
T-200
1.0 %
FEED
65.4 GPM
63 PSI
10.9 C
P2
P1
36.7 %
CIP
DRAIN
DRAIN
DRAIN
WATER
FILTRATION
RUNNING
FEED
CIP
OUT
STATUS-1
MAIN
17
18
12
16
21
10
20
19
35
36
11
2
14
15
13

New Application
From
March 15th



- The fluid is mostly water but it has a good amount of raw oil in it, together with suspended solids (I am approximating about 3-5% by volume of oil). It also seems to contain a good amount of cross-linked polymer of the guar gum variety, but I do not know that for sure and could not verify it- as usual, I received it as “mystery” fluid. One thing for sure it has a bit of viscosity going on at room temperature.


FBW
FEED
10-3-11
FBW
PERMEATE
10-3-11

Sulfate Removal

Sulfate Removal

- In general, with the NF-270 membrane, we stayed along the same path for sulfate reduction, when we do a "batch concentration", the feed has more sulfates then the permeate has more with the same rejection rate, thus, my subsequent tests were:
-
- Initial Feed = 1,776, 0 sulfates, then 12, then finally 40.
-
- Another Feed = 427, 10 sulfates, then finally 62.
-
- Another Feed = 956, 5 sulfates, then finally 30.

Sulfate Removal

Sulfate Removal

Sulfate Removal

Talking Points and Feedback

- What are gas industry water quality needs?
- Re-use Water Quality Requirements
- Environmental Concerns About Re-use
- Safety Concerns
- Economic Factors
  - Effect of Impending DEP Discharge Limits
  - Present & Future Costs for Flowback Disposal
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