Performance and Cost of Treating Flowback and Produced Water to Surface Discharge Standards

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Growing Volumes of Produced & Flowback Water (Produced Water)
Restricted Salt Water Disposal (SWD) Usage
We need more CREATIVE disposal options – while cost is still the primary driver!
Common Problem: Lack of data in the industry, particularly with regard to effectiveness and costs of individual unit operations
Imagine having much needed data to expand treatment for surface discharge and reduce the use of SWDS (particularly in applicable basins!)
Performance and cost of a range of water treatment technologies to meet surface discharge standards from test program driven by the push to reduce SWDs.
Community & public acceptance

Reuse in Fracking Operations or Discharge to water cycle

Produced Water & Flowback Treatment: Mobile, Semi-Fixed, Fixed

Sourcing - Operator sharing, Surface water, Recycled

Operations - Exploration & Production: Hydraulic Fracturing and well completion

H2O SPECTRUM®
The goal was to develop the most cost-effective combination of unit ops that meet the water spec to pass the Whole Effluent Toxicity (WET) Test for the state of Colorado.
Targeted Treatment Scheme

Constituents:
- TSS
- Ammonia
- Bacteria
- BTEX
- Radio-nuclides
- Inorganic Salts
- Free Oil
- Oxidant/Flocculant Combinations
- Iron and Metals
- NSF, GAC, AOP, MBR, RO
- Oxidant, Flocculant, DAF, NSF
- MBR, RO, AOP

AOP  Advanced Oxidation Process
DAF  Dissolved Air Flotation
GAC  Granulated Activated Carbon
MBR  Membrane Bioreactor
NSF  Nutshell Filter
RO   Reverse Osmosis
Oxidant/Flocculant Combinations
The pilot program was required to permit fixed facility due to state regulatory requirements and stringent discharge water quality coupled with complex and varying feed water quality.
Drastically changing quality in feed water from multiple production and frac/flowback sites during harsh Colorado winter conditions, meant JAR TESTS on JAR TESTS!

Fixed facility expected to be less variable due to blending of feedwaters.
Monarch DAF design and Alginate Flocculant chemistry were able to reduce turbidities from greater than 650 NTU to 1 NTU and oil removal to less than 2 mg/L, and Iron & Manganese to less than 1 mg/L.

- “Green” flocculant extracted from seaweed reduces environmental impact
- Expands recycle uses for produced and flowback water
- Fast acting chemical providing robust and shear-resistant flocs
- Demonstrated to achieve below 2 ppm Oil in Water
To pass WET testing requirements for discharge into local river, desalination was required for final polishing.

- Treating iron from 35 mg/L to less than 1 mg/L
- Alginate flocculant dosing of 5-7 mg/L for produced water at a cost of less than $0.04/bbl treated water
- Ability to take sidestream after primary treatment for recycle back to frac operations
- 100% BTEX and TOC removal in MBR
- 99+% salt removal in RO and 100% ammonia removal in MBR/RO
- Pass WET tests for surface discharge!!!
- Overall treatment cost << $1/bbl for 24,000 bpd (outlet capacity) facility
Wrap it up!

- Challenges grow and we need to be prepared
- Cost-effective treatment schemes are available
  - We have validated proposed technologies and ability to cost effectively treat produced water
- Sharing data is important
Thank you!

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