Oily Wastewater Treatment

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2014
Green Chemical Solution for Oil and Remediation Industries

ETHICALCHEM BACKGROUND
EthicalChem Background

- Recently acquired the intellectual property assets of VeruTEK Technologies Inc.
- Provides plant-based, green chemical solutions for the oilfield and remediation industries

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<thead>
<tr>
<th>Oilfield Technologies</th>
<th>Remediation Technologies</th>
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<tr>
<td>• Viscosity reduction</td>
<td>• SEPR (Surfactant Enhanced Product Recovery)</td>
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<td>• Demulsification</td>
<td>• S-ISCO (Surfactant-enhanced In Situ Chemical Oxidation)</td>
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<td>• Drilling muds removal</td>
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<td>• Wellbore cleaning</td>
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<td>• Oily wastewater separation</td>
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Green Chemical Solution for Separation of Oily Wastewater

HOUSTON AREA CASE STUDY
Oilfield service company

Large tanks of oily wastewater

Exceeds local TX discharge limits for multiple parameters

Primary goal of reducing hydrocarbons in water

Sent samples to EthicalChem lab
Lab Testing

- Bench scale tests were conducted to determine treatment conditions
- EthicalChem’s Green-synthesized Nano-iron Activator (GnA) was evaluated with hydrogen peroxide
- Excellent separation achieved
- Tests conducted in duplicate
Houston Area Case Study

Oily Wastewater Treatment
Aqueous Phase TPH Concentrations

Notes:
1. Post treated sample had 2 phases, TPH analysis represents the aqueous phase
2. Results represent average of 2 duplicates
• Successful results led to full scale trial at facility
• 15,000 gallons treated
• GnA and peroxide were pumped simultaneously into tank
• Dosing and recirculation lasted 2.5 hrs
  – 1.6 GPM GnA dosing
  – 4 GPM peroxide dosing
  – 120 GPM recirculation
• Tank was left to settle overnight
Results

Oily wastewater separated overnight following treatment

Oil and water phases were analyzed

- 2,000 gallons (of 15,000) was usable oil
  - Oil was 96% pure

- Water met discharge limits and is reused in other cleaning applications at the facility
Green-synthesized Nano-Iron Activator

GNA TECHNOLOGY
Synthesis of GnA

- Developed in collaboration with US EPA
- Nano-iron synthesized through a non-hazardous process
- Metal salt + polyphenols = metal nano-particle
- Nano size creates increased surface area of iron resulting in enhanced activation of peroxide
Synthesis of GnA

TEM image of GnA Synthesized Using FeCl₃ and Polyphenols

Particle Size = 10-200 nm
GnA Activation of Peroxide

Early study was conducted by EthicalChem to compare GnA against two conventional chelated iron activators.

- GnA was tested against chelated iron activators – FeEDTA and FeEDDS for activation of peroxide
- All activators were tested at 1.33 mM (concentration as iron)
- Initial concentrations of hydrogen peroxide were 5% in each reaction
- Hydrogen peroxide concentration was measured over time
GnA Activation of Peroxide

![Graph showing comparison of hydrogen peroxide catalysts.]

- GnA activates peroxide significantly faster than the chelated iron.
A third-party study was conducted to compare GnA vs FeEDTA activation of sodium persulfate on VOC destruction.

- Effectiveness measured on rate of contaminant destruction (BTEX, TCE, PCE)
- Test Conditions:
  - 5 g/L sodium persulfate used
  - Lower Fe doses in GnA than FeEDTA:
    - GnA at 1.33 mM Fe
    - FeEDTA at 9.0 mM Fe
  - Reaction Times:
    - Control = 360 min
    - FeEDTA = 360 min
    - GnA = 60 min
GnA Activation of Persulfate

**GnA activates the persulfate more rapidly for effective contaminant destruction**
- After 60 minutes, GnA activated persulfate destroyed 100% of TCE, benzene, toluene, ethyl-benzene and total xylenes relative to the control.
GnA Treatment of Extracted MGP Fluid

- Treatment of wastewater tanks after implementation of SEPR
- Left Jar – 4% Hydrogen peroxide only
- Right Jar – 4% Hydrogen peroxide with 1.33 mM GnA

TPH Concentrations:
- Initial = 1,302 ppm
- Day 5:
  - 4% HP = 348 ppm
  - 4% HP with 1.33 mM GnA = 22.1 ppm
Thank you.

EthicalChem
USA

www.ethicalchem.com