CASE STUDY

Emergency Response for Industrial Wastewater Treatment

Rapid Response using Environmentally Friendly Water Treatment Solution

Streamline®

MAKING HEAVY INDUSTRY CLEANER,
SUSTAINABLE, MORE PROFITABLE.

SCENARIO: Refinery Fire

A lightning strike ignited a major above-ground storage tank at a petroleum refinery, causing a destructive explosion and subsequent fire. Around 8 million gallons of water and firefighting foam were used to suppress the flames, and these volumes were recovered and stored in three above-ground storage tanks at the facility. The water, contaminated with petrochemicals, was stored while a treatment and discharge plan were developed.

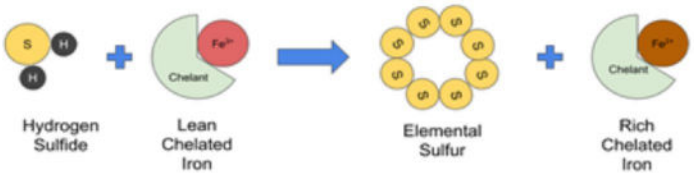
During the several months it took to evaluate and choose a treatment plan, levels of hydrogen sulfide (H_2S) and Benzene increased in the holding tanks, with H_2S reaching 20,000-40,000 mg/liter (ppm) in solution and Benzene reaching 4-8 mg/liter (ppm). Due to the contamination's severity, discharge into local waterways was deemed unviable, necessitating on-site treatment.

The operator reached out to several companies, including Streamline Innovations, to propose a swift and cost-eXective solution for treating and disposing the contaminated water.

SOLUTION: Rapid Response, Green Solution

The customer opted for the Streamline ThunderOx Sulfide Elimination System (TSES) to remove the sulfide and Benzene contamination in its water.

The illustration below describes the three-steps of how the Streamline TSES process works to transform sulfides and H_2S into non-toxic byproducts (elemental sulfur and water) using a regenerative process.

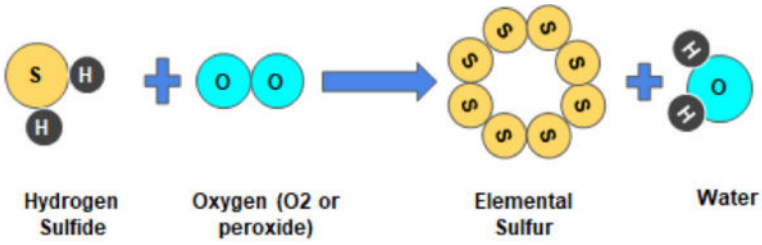


Step 1: RED

$$H_2S\uparrow + 2Fe^{III+} \rightarrow 2H^+ + S\downarrow + 2Fe^{II+}$$

Step 2: OX

$$\tfrac{1}{2}O_2\uparrow + H^+ + 2Fe^{II+} \rightarrow OH^- + 2Fe^{III+}$$



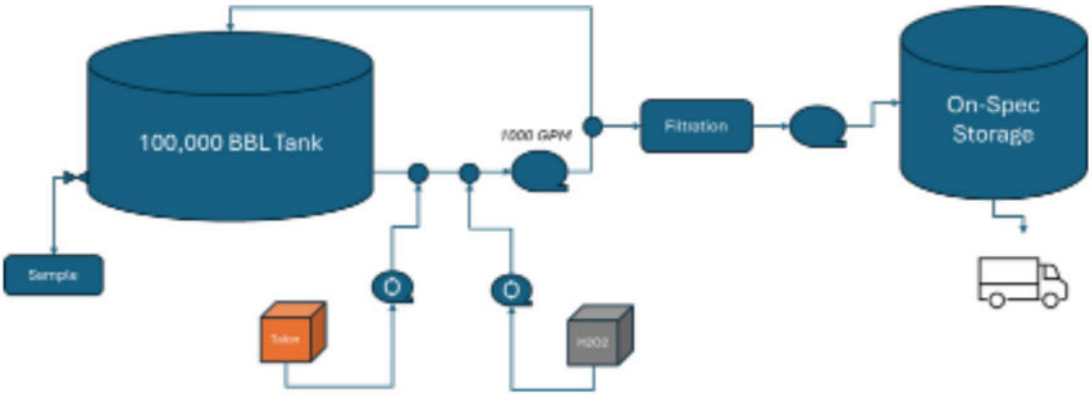
Overall: REDOX

$$H_2S\uparrow + \tfrac{1}{2}\,O_2\uparrow \rightarrow H_2O + S\downarrow$$

Compared to the alternatives, such as traditional iron salts, magnesium hydroxide, deep well injection or carbon beds, Streamline's TSES provided several advantages that drove the customer to its decision:

- Rapid emergency response and ability to stand up a treatment solution quickly.
- Demonstrated project management expertise.
- Very strong safety record.
- Capability to simultaneously treat H_2S and bio-organics.
- Exceptional Sulfide treatment capabilities
- Environmentally friendly treating technology.
- No negative byproducts or adverse impacts on operations.
- No physical media disposal requirements.

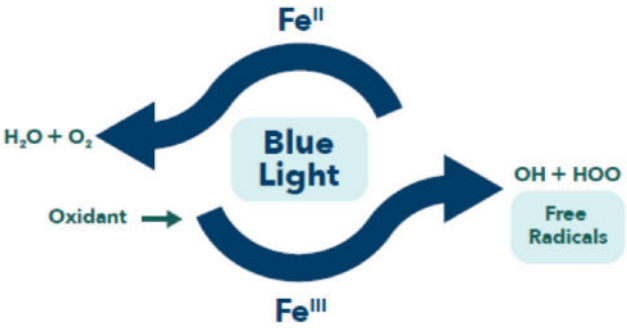
Over the course of several months following the incident, rainwater steadily accumulated in the tank farm, swelling the total volume of water requiring treatment to 11 million gallons before Streamline Innovations was selected. Working closely with the operator, we devised a treatment process that designated one tank as the reaction vessel and then the operator installed low-pressure lines to transport the contaminated water from the holding tanks to the reaction vessel.



In operation, the contaminated water was transferred in batches ranging from 250,000 to 500,000 gallons at a time to the reaction vessel. Equipped with a pump system, water was drawn from the tank's bottom and reinjected it at the top, ensuring a continuous flow and thorough mixing for optimal contact with the ThunderOx chemistry.

The ThunderOx Sulfide Elimination System is a cost-effective solution for treating H_2S in water and wastewater. It can be used for odor control for small H_2S concentrations (eliminating the source of foul odors), or for much higher H_2S concentrations (as was the case for this project), providing rapid elimination of H_2S without the corrosion and cross reactions with other chemical processes.

TSES utilizes our ThunderOx Redox catalyst combined with an oxygen source, creating a process that breaks apart H_2S and converts it to elemental sulfur. In addition to the traditional Redox reaction for H_2S, ThunderOx can be tailored for a second oxidative pathway, which creates an advanced oxidization reaction that targets other contaminants including dissolved organic matter, semi-volatiles, volatile organic compounds, and metals along with sludge solids.



Pollutants Eliminated:
Class I (Sulfonated Compounds) – Sulfide (H2S), Sulfite, Thiosulfate
Class II (Other Aromatics) – Phenol, Cyanide, Amines
Class III (VOC's) – BTEX, MtBE, Mercaptan, PCE, TCE, and Oil & Grease

Relative Oxidant Power

Oxidant	Symbol	Oxidation (Potential Voltage)	Relative Oxidation*
Flourine Gas	F_2	2.87	2.11
Hydroxyl Radical	OH	2.80	2.05
Atomic Oxygen	O	2.42	1.78
Ozone	O_3	2.07	1.52
Hydrogen Peroxide	H_2O_2	1.77	1.30
Permanganate	MnO_4	1.67	1.23
Chlorine Dioxide	ClO_2	1.50	1.10
Chlorine Gas	Cl_2	1.36	1.00
Oxygen	O_2	1.20	0.90

* Normalized to Chlorine Gas

RESULTS: Fast, Safe, and Cost-Effective Remediation

In operation, the contaminated water was transferred in batches ranging from 250,000 to 500,000 gallons at a time to the reaction vessel. Equipped with a pump system, water was drawn from the tank's bottom and reinjected it at the top, ensuring a continuous flow and thorough mixing for optimal contact with the ThunderOx chemistry.

Testing confirmed swift results, with H_2S levels reaching non-detectable status within 24-48 hours and benzene down to less than 0.5 ppm (the limit) within 72 hours. Subsequent batches exhibited higher contamination levels compared to earlier ones. The treated water was then safely reintroduced into the environment.

Totes of ThunderOx chemistry and oxidate on site at the refinery

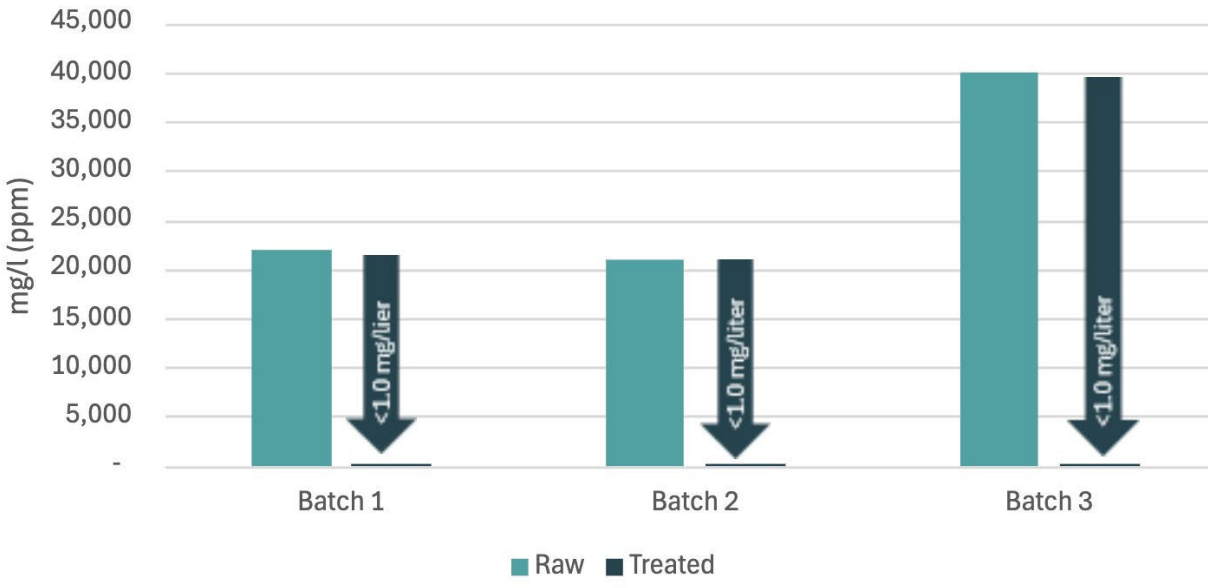
Isotainers holding oxidant

Oxidant Isotainers

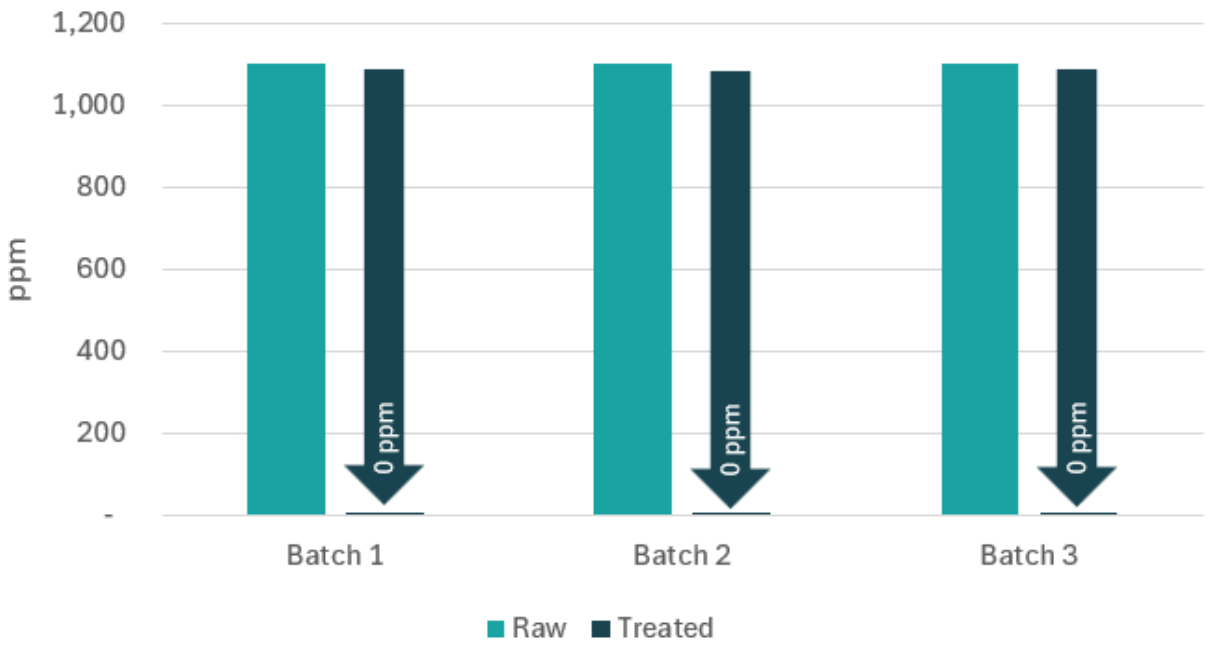
The table and chart below summarize the sulfide levels before and after treatment by the Streamline Innovations Solution.

	Sulfide (mg/l, ppm)		*H_2S (ppm)*	
Batch	**Raw**	**Treated**	**Raw**	**Treated**
Batch 1	22,000	<1.0	1,100	0.0
Batch 2	21,000	<1.0	1,100	0.0
Batch 3	40,000	<1.0	1,100	0.0

Streamline Innovations: Sulfide Treatment Results



Streamline Innovations: H_2S Treatment Results

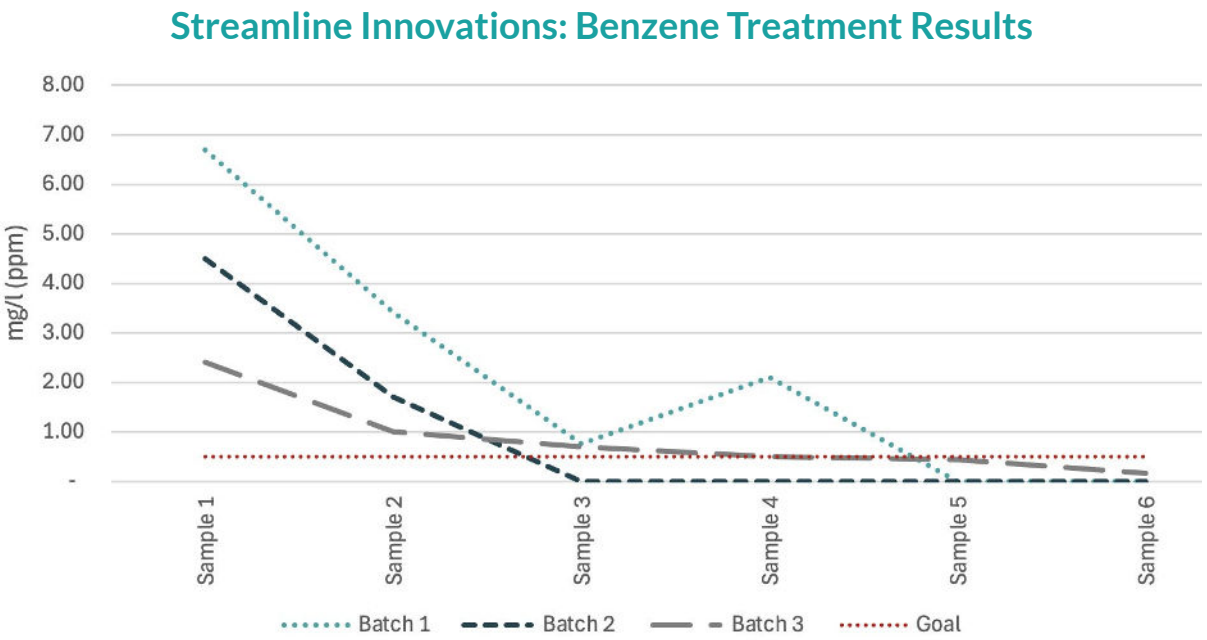


All batches were H_2S compliant in less than 40 hours.

Benzene Treatment Results

	Benzene (mg/l, ppm)		*Treatment*	
Batch	**Untreated**	**Treated**	**Goal**	**%Treated**
Batch 1	6.7	0.0	0.5	100%
Batch 2	4.5	0.0	0.5	100%
Batch 3	2.5	0.2	0.5	100%

The Streamline treatment solution reduced Benzene levels well below the goal of 0.5 mg/l (ppm) within days of treatment. The chart below illustrates the rapid reduction in Benzene for each batch.



The entire treatment process took approximately 10 months to complete, yielding harmless elemental sulfur. To decommission the reaction tank, the sulfur was flushed out, collected by vac trucks, and incinerated locally, with the tank going back into normal service.

BENEFITS

Streamline delivered these benefits to the operator:

- **Rapid response.** Streamline's assets were mobilized to the site within four days, and the operator installed circulation lines and pumps within two weeks of selection.
- **Expedited treatment.** Over 11 million gallons of contaminated water were treated and reclaimed in just a few months, outpacing alternative methods.
- **Environmentally forward.** ThunderOx's eco-friendly chemistry left no harmful byproducts, ensuring a green approach.
- **Convenient disposal.** The sole byproduct, elemental sulfur, was easily disposed of, simplifying waste management.
- **Minimal disruption.** The solution's implementation and treatment process had negligible impact on refinery operations.
- **Substantial cost savings.** The streamlined approach, coupled with its rapid deployment, resulted in multimillion-dollar savings for the operator compared to alternative methods.

While the ThunderOx Sulfide Elimination System excels in emergency water treatment scenarios, is equally valuable for routine municipal and industrial wastewater treatment. TSES effectively treats water for H_2S, other sulfur compounds, benzene, bio-organic compounds, phenols, and more.

Streamline's TSES solution is a great solution for both routine odor control and very elevated H_2S concentrations wastewater treatment plants, refineries, pulp plants, O&G produced water operations, and other industrial processes.

Contact us today to learn more about green, ecologically friendly wastewater treatment solutions from Streamline Innovations.

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