



FENTON'S REAGENT TREATMENT PROCESS References

Fenton's Reagent Iron-catalyzed Hydrogen Peroxide

Many metals have special oxygen transfer properties that improve the utility of hydrogen peroxide. By far, the most common of these is iron (e.g. Fe²⁺) which, when used in the prescribed manner, results in the generation of highly reactive hydroxyl radicals ($\cdot\text{OH}$).

Fenton's Reagent is used to treat a variety of industrial wastes containing a range of toxic organic compounds (phenols, formaldehyde, BTEX, and complex wastes derived from pesticides, petroleum refining, wood preservatives, plastics additives, and rubber chemicals). The process may be applied to wastewaters, sludge, or contaminated soils, with the effects being:

- 💧 Organic pollutant destruction
- 💧 Toxicity reduction
- 💧 Biodegradability improvement
- 💧 BOD / COD removal
- 💧 Odor and color removal



US Peroxide, LLC
500 Bishop St. NW, Suite C-3
Atlanta, GA 30318
www.h2o2.com

Inquiries call 877-346-4262
or email at: info@h2o2.com

Specialty Chemical Manufacturer ■ Louisiana

Problem: Discharge violations (phenols, bio-toxicity) resulting from ineffective treatment with the existing processes - physical-chemical treatment (DAF unit, coagulation/precipitation) followed by aerated lagoon.

Treatment Goal: Effectively pre-treat a specific 40 GPM wastewater stream containing 400-600 mg/L phenol compounds and 4000-500 mg/L COD to reduce phenols by 90% prior to mixing with higher flow waste streams.

Fenton's Process Description: The iron catalyst is added to the wastewater stream in-line (static mixer), with the hydrogen peroxide injected (with mixing) into the first cell of a baffled reaction vessel. The baffled reaction vessel helps eliminate short-circuiting and provides sufficient reaction time. The hydrogen peroxide and iron catalyst dosing modules are interlocked with the wastewater pumps to ensure chemical feed stops with an interruption in wastewater flow.

Treatment Results (6 years operating): Fenton's process has consistently achieved >90% removal of phenols from this stream and eliminated bio-toxicity violations and public relations issues.

US Peroxide Contributions: USP personnel worked with a major environmental consulting firm and the manufacturer on lab scale "treatability" tests as well as design of the full-scale process. USP conducted successful 6-month full-scale demonstration of the technology resulting in optimization of chemical dose requirements. Fenton's process is now a permanent part of the overall facility wastewater treatment process.

US Peroxide supplies the iron catalyst, hydrogen peroxide, and turnkey storage and dosing systems for both chemicals. Supply scope includes ongoing equipment maintenance, remote tank monitoring/inventory management, and applications services.

Refinery ■ Southeast US

Problem: The existing treatment process system (ozone) required significant maintenance and was not providing effective treatment of COD, phenols and other organic compounds in a 15 GPM scrubber blowdown stream.

Treatment Goal: Effectively pre-treat the stream prior to discharge to on-site biological treatment.

Fenton's Process Description: Catalyst is added to the wastewater stream in-line (static mixer) with the hydrogen peroxide injected into the wastewater stream in-line (static mixer) just prior to entry into the reaction vessel. The hydrogen peroxide and catalyst dosing modules are interlocked with the wastewater pumps to ensure chemical feed stops in the event of an interruption in scrubber blowdown flow.

Treatment Results (5 years operating): This process has consistently achieved effective pre-treatment, eliminating upsets to the biological system.

US Peroxide Contributions: USP conducted successful 6-month full-scale demonstration of the technology resulting in optimization of chemical dose requirements and it is now a permanent part of the overall facility wastewater treatment process.

US Peroxide supplies the catalyst, hydrogen peroxide, and turnkey storage and dosing systems for both chemicals. Supply scope includes ongoing equipment maintenance, remote tank monitoring/inventory management, and applications services.



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Wood Treating Facility ■ Western US

Problem: Discharge violations (NPDES) to a municipal collection and treatment system caused by phenols, naphthols and cresols.

Treatment Goal: Pre-treat this 20 GPM wastewater stream to reduce these compounds by >95%.

Fenton's Process Description: The iron catalyst is added to the wastewater stream in-line (static mixer), with the hydrogen peroxide injected (with mixing) into the first cell of a baffled reaction vessel. The baffled reaction vessel helps eliminate short-circuiting and provides sufficient reaction time. The hydrogen peroxide and iron catalyst dosing modules are interlocked with the wastewater pumps to ensure chemical feed stops with an interruption in wastewater flow.

Treatment Results (4.5 years operating): Fenton's pre-treatment process has consistently achieved target compound removal efficiencies, and eliminated inhibition of biomass and discharge violations.

US Peroxide Contributions: USP conducted lab scale "treatability" tests, followed by a 6-month full-scale demonstration to optimize chemical dose requirements, as well as design of the full-scale process. The Fenton's process is now a permanent part of the overall facility wastewater treatment process.

US Peroxide supplies the iron catalyst, hydrogen peroxide, and turnkey storage and dosing systems for both chemicals. Supply scope includes ongoing equipment maintenance, remote tank monitoring/inventory management, and applications services.

Aircraft Painting Stripping and Maintenance Facility ■ Midwest US

Problem: Discharge violations for toxic organic compounds, e.g. methylene chloride, pentachlorophenol, nitrophenols resulting from ineffective treatment with the existing processes - physical-chemical treatment (chrome reduction followed by coagulation/precipitation)

Treatment Goal: Effectively pre-treat the paint stripping wastewater stream to reduce targeted toxic organics by >95% prior to discharge to the municipal wastewater collection system.

Fenton's Process Description: The prescribed amount of iron catalyst is added to the stirred batch reaction vessel over a period of about 5 minutes. The hydrogen peroxide is subsequently added to the stirred batch reaction vessel over a period of several hours. Peroxide addition is done over a longer period of time to optimize toxic compound oxidation. The hydrogen peroxide dosing module is interlocked with temperature probes in the reaction tank to ensure chemical feed stops if wastewater temperatures reach a predetermined level.

Treatment Results: Fenton's process consistently achieved >95% removal of toxic organics during the 6-month full-scale demonstration.

US Peroxide Contributions: USP personnel worked with a major environmental consulting firm and the manufacturer to conduct pilot "treatability" tests as well as design of the full-scale batch treatment process. USP conducted successful 6-month full-scale demonstration of the technology resulting in optimization of chemical dose requirements. Fenton's process is being designed into the permanent upgrade of the facility wastewater treatment process.

US Peroxide supplied the iron catalyst, hydrogen peroxide, and turnkey storage and dosing systems for both chemicals for the 6-month demonstration. Supply scope included ongoing equipment maintenance, remote tank monitoring/inventory management, and applications services.





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Emergency Treatment of Phenol Contaminated Wastewater at Chemical Plant ■ Alabama

Problem: In 2008, a large chemical manufacturing plant in Southern Alabama had over three million gallons of process wastewater contaminated with 200-300 mg/L of phenols. Due to the elevated phenol levels, the wastewater could not be directly pumped to the on-site activated sludge treatment system due to bio-toxicity concerns. The wastewater was diverted to several large storage tanks until a pretreatment solution could be implemented. Finding and implementing a temporary pretreatment solution quickly was critical, as the volume of contaminated wastewater nearly exhausted all of the plant's stormwater storage capacity.

Treatment Goal: Reduce phenol levels to the 0.2 mg/L plant mandated goal to allow discharge to the on-site biological treatment plant as soon as possible.

Fenton's Process Description: Addition of the ferric chloride catalyst and hydrogen peroxide was done sequentially over a 2-day period, using temporary peroxide and iron storage and dosing equipment supplied by USP. Chemicals were added using the mixing/recirculation system in the large stormwater (wastewater) storage tanks.

Treatment Results: After allowing the Fenton's reaction to proceed overnight (~12 hours), the plant laboratory confirmed that phenol levels had been reduced to below the 0.2 mg/l goal. The treated wastewater was subsequently pumped to the biological treatment plant with no treatment upsets or discharge violations. The entire emergency treatment process (equipment installation, chemical injection/oxidation, equipment demobilization) was completed in less than 5 days.

US Peroxide Contributions:

US Peroxide supplied the hydrogen peroxide; iron catalyst; temporary peroxide and ferric storage & dosing equipment; piping to the injection point; equipment system installation, start-up and operational oversight; equipment demobilization upon completion of the project; portable safety shower/eyewash; on-site applications support; and hydrogen peroxide and ferric chloride safety training for customer operations personnel.