TIMILON
TECHNOLOGY ACQUISITIONS LLC

Hydrogen Sulfide (H_2S) Technical Information

Timilon's Products for H_2S Removal

Timilon is the leader in synthesis, testing and production of innovative nanochemistry products. These high performance materials have high surface areas and unique morphologies which make them uniquely different from conventional counterparts. This high chemical reactivity led to development of several formulations that are very effective at treating a broad range of chemical hazards, including hydrogen sulfide.

Background on Hydrogen Sulfide

Hydrogen sulfide (H_2S) is a colorless, poisonous, flammable gas with the characteristic foul odor of rotten eggs at concentrations up to 100 parts per million. It is usually the result of anerobic digestion of organic matter by bacteria (swamps, sewers, etc.). Additional sources include volcanic gases, natural gas, and some well waters. H_2S is produced in small amounts by the human body to be used as a signaling molecule. It is most commonly acquired by separating it from sour gas, natural gas with a high content of H_2S. Hydrogen sulfide is used to produce thioorganic compounds, metal sulfides, and alkali hydrosulfides, as well as being used in analytical chemistry for qualitative analysis of metal ions. It is also used to produce elemental sulfur which is one of the most commercially important elements.

Health Hazard

Hydrogen sulfide is a highly toxic and flammable gas (flammable range: 4.3 % - 46 %). It is easily recognized by characteristic "rotten egg" odor with the minimum perceptible odor being 0.13 ppm. Although very pungent at first, it quickly deadens the sense of smell. H_2S reacts with enzymes in the blood stream to inhibit cell respiration which results in pulmonary paralysis, sudden collapse, and death.

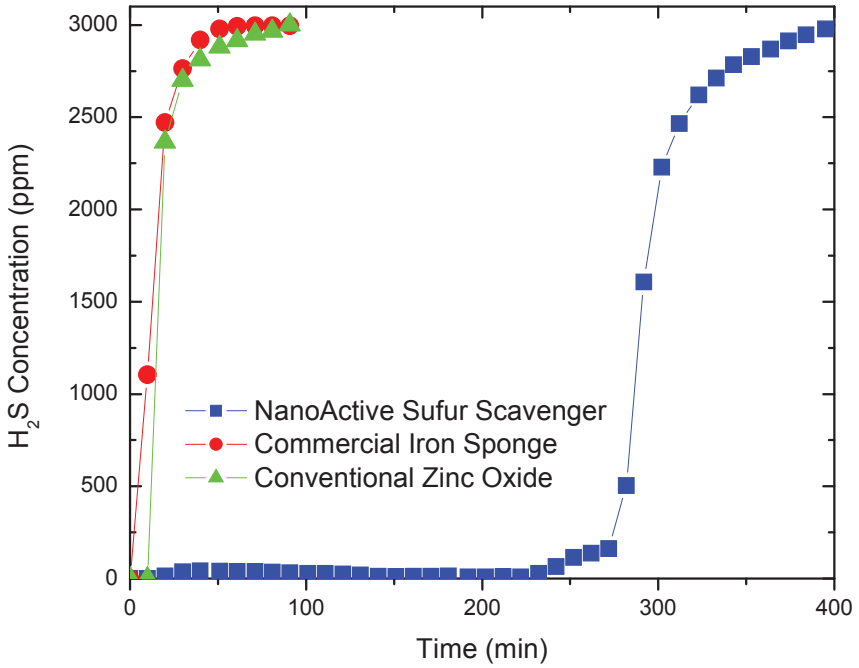
At concentrations of 20 ppm, hydrogen sulfide begins acting as an irritant on the mucous membranes of the eyes and respiratory tract and increases with concentration and exposure time. Prolonged exposure to moderate concentrations (250 ppm) may cause pulmonary edema. At concentrations over 500 ppm, drowsiness, dizziness, excitement, headache, unstable gait, and other systemic symptoms occur within a few minutes. Above 700 ppm, sudden loss of consciousness without premonition, anxiety, or sense of struggle can occur. At concentrations of 1000-2000 ppm, H_2S is rapidly absorbed through the lung into the blood. In this range a single inhalation may cause coma and may be rapidly fatal. At higher concentrations, hydrogen sulfide exerts an immediate paralyzing effect on the respiratory centers. When concentration reaches 5000 ppm, imminent death almost always results.

Effectiveness

H_2S Removal of Natural Gas

In sulfur scrubbing applications, research has indicated that the capacity of hydrogen sulfide (H_2S) removal for NanoActive Sulfur Scavenger in a natural gas or syn-gas stream was at least ten times greater than that of a commercial iron sponge sorbent and other commercial sulfur scavengers based on zinc oxide. The NanoActive Sulfur Scavenger is available as a powder, granule and as a suspension. A variety of carrier fluids are available for the suspensions.

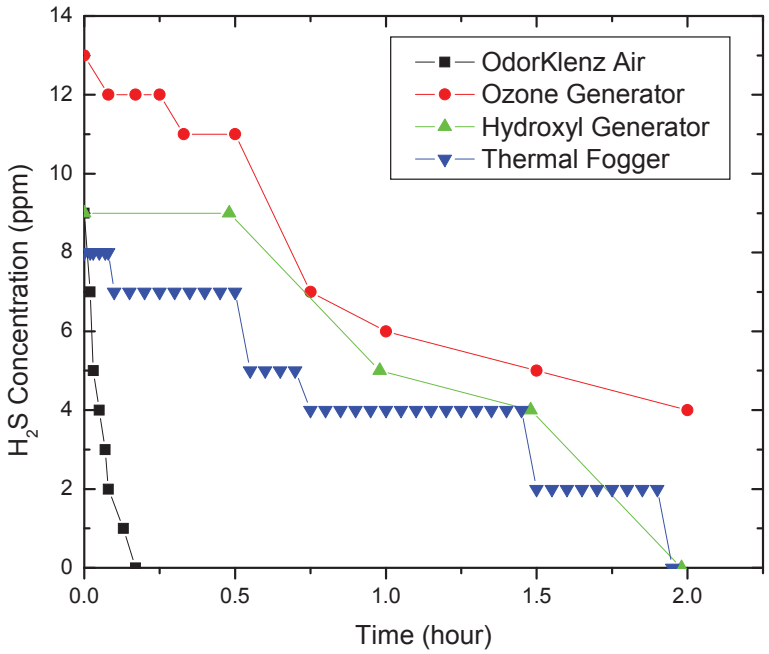
Evaluation of a gas stream containing 3000 ppm hydrogen sulfide indicated that the same amount of NanoActive Sulfur Scavenger was capable of treating a significantly larger volume of gas when compared to iron sponge or conventional zinc oxide scavenger. For comparison purpose, the hydrogen sulfide capacity of the NanoActive scavenger was ten times greater than that of commercial iron sponge and conventional zinc oxide.



Breakthrough Curves for H_2S Removal from Natural Gas

H_2S Removal from Air

Timilon has developed a product capable of removing airborne H_2S. Timilon's OdorKlenz-Air Cartridge, along with three other techniques for odor removal were compared: ozone (oxidation), chemical thermal fogging (chemical paring), and hydroxyl generation (free radicals). The enclosed chamber was contaminated with H_2S at a target of 10 ppm. The gas was allowed to equilibrate and then the odor control mechanisms were remotely turned on. As illustrated in the following graph, the OdorKlenz-Air Cartridge removed the H_2S from the environment faster than the other processes.



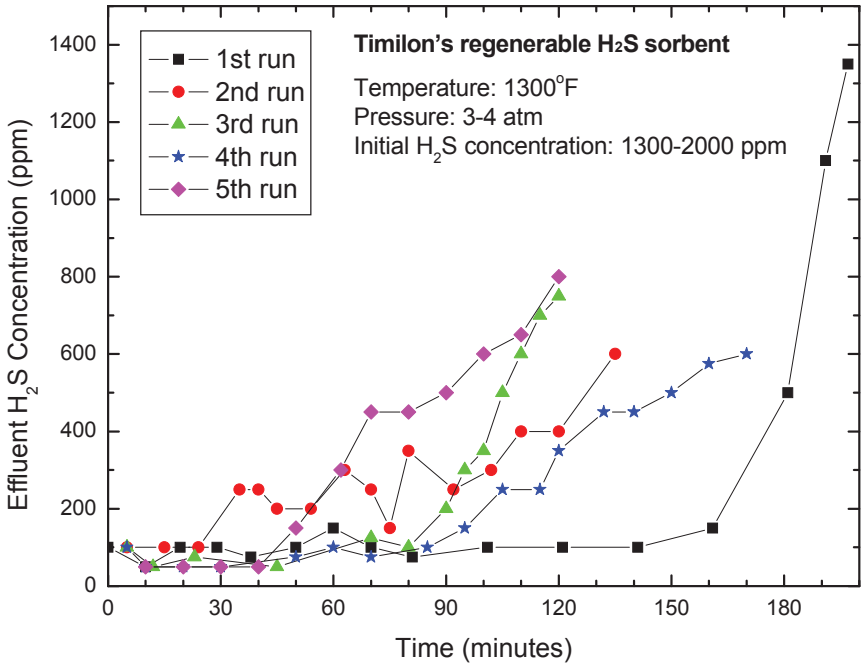
Comparison of H_2S Removal by Various Technologies

H_2S Removal from Fuel gas

Integrated Gasification Combined Cycle (IGCC) systems are one of the most promising technologies to meet the challenge of generating electricity from coal in an environmentally sustainable way. The IGCC technology uses a gasifier to convert coal to fuel gas, and then uses a combined cycle power block to generate electricity. IGCC has many advantages over traditional technologies including: higher efficiency, lower pollutant emissions, and a possibility of carbon capture and sequestration. One of the remaining challenges for the IGCC is the need to develop a cleanup technology to remove reduced sulfur (H_2S and COS) and nitrogen (NH_3 and HCN) compounds.

Timilon has developed a nanocrystalline sorbent for the removal of reduced sulfur and nitrogen pollutants from coal-generated fuel gases at gasification operating temperatures in. Benefits offered by nanocrystalline sorbents include enhanced chemical kinetics and increased removal capacities. Equally important, the approach developed by NanoScale utilizes manufacturing methods that are easily scalable, cost efficient, and environmentally friendly. The sorbent was tailored to selectively react with reduced sulfur and nitrogen compounds present in fuel gas but also to be immune to other components of the fuel gas.

Performance testing was done at pilot-scale in real fuel gas conditions at Western Research Institute (WRI) in Laramie, Wyoming. At this scale, the regenerable, high-temperature H_2S sorbent demonstrated excellent absorption of H_2S and COS pollutants in the 400-700 C range. This performance was confirmed at real synthesis gas condition at WRI. The sorbent was used 5 times with regeneration cycles applied in between each run. The figure below shows the breakthrough performance for all runs conducted. The tested sorbent demonstrated a clear ability to effectively remove hydrogen sulfide from the synthesis gas stream and an ability to be regenerated multiple times.



Breakthrough Performance of Timilon's Regenerable H_2S Sorbent

Summary

To summarize, Timilon has the technology to remove H_2S in a variety of applications:

- Natural gas sweetening
- Syn-gas treatment
- Vent gas treatment
- Agricultural and animal waste runoff related odor removal
- Power plant operations

NanoScale material offers several advantages:

- No ancillary equipment required; NanoActive material can be readily applied in existing facilities.
- NanoActive material can be utilized to scrub H_2S in the presence of CO or CO_2.
- When tested under comparable conditions, NanoActive material removes at least ten times more hydrogen sulfide than a typical iron sponge or commercial ZnO. This translates into fewer change-outs and reduces operating costs.
- Non-corrosive and non-flammable byproducts.
- Possibility to recycle spent sorbent and minimize hazardous waste disposal cost.

For more information, please contact a Timilon Customer Support Representative at 785-537-0179