Hydrogen Sulfide in Petroleum Production

A Technology Primer

Introduction

Hydrogen sulfide (H_2S) is a naturally occurring gas, formed from the decomposition of underground deposits of organic matter, such as decaying plants. It can be found in both deep and shallow wells and may also enter surface water through springs, though it quickly escapes into the atmosphere. Wells drilled in shale or sandstone often contain hydrogen sulfide.

The primary producers of large quantities of hydrogen sulfide are sulfur-reducing bacteria, which use sulfur as an energy source. These bacteria convert natural sulfates in water into hydrogen sulfide and thrive in oxygen-deficient environments such as deep wells, piping systems, and water treatment facilities.

Hydrogen sulfide is colorless and has a characteristic odor of rotten eggs. It can also be produced whenever sulfur-containing waste or oil is broken down by bacteria, releasing the gas into the surrounding environment.

General Information

Hydrogen sulfide gas has a strong odor, even at very low levels. It can be detected by smell at approximately 10 parts per billion (ppb), roughly equivalent to a thimbleful of hydrogen sulfide in a theater full of air. Some individuals can detect it at even lower concentrations.

Exposure to higher levels of hydrogen sulfide can irritate the eyes, nose and lungs. Although the gas has a strong odor, prolonged exposure can dull the sense of smell. At concentrations of 50 to 100 parts per million (ppm), about the same as two soda cans of hydrogen sulfide in a typical house, the ability to smell hydrogen sulfide begins to deteriorate. At this level, it is unsafe to rely on sense of smell to detect the gas; a proper monitoring instrument should be used.

At even high concentrations, the sense of smell can be completely overwhelmed. Increasing levels of hydrogen sulfide can cause eye irritation, dizziness, coughing, and headaches. Concentrations above 250 ppm begin to impair the ability to breathe, and levels exceeding 600 ppm can be fatal. Fatalities have occurred in poorly ventilated spaces such as sewer systems, deep wells, and underground manure tanks.

Because hydrogen sulfide is heavier than air, it tends to accumulate near the bottom of these spaces, posing a particularly high risk. At these dangerous levels, hydrogen sulfide can make a person gravely ill and, in extreme cases, cause death.

Hydrogen Sulfide and Sulfate Reducing Bacteria in the Oil Field

In addition to its health and safety hazards, hydrogen sulfide impacts the operation of oilfield systems. It is a primary cause of sour corrosion, largely driven by sulfate-reducing bacteria (SRB). The bacteria colonize pipe walls, producing polysaccharides that help them adhere. As layers of bacteria accumulate, the inner layers become oxygen-depleted, creating an anaerobic environment ideal for hydrogen sulfide production, initiating sour corrosion.

If uncontrolled, SRB feed on organic material, converting sulfate to sulfide and producing hydrogen sulfide. This leads back to iron sulfide forming on vessel walls, blocking flow lines and filters, while introducing serious health hazards for personnel. SRB are present in most produced waters in an encysted, inactive form due to the heat of oil formations. However, once these waters enter separators and residence tanks, the bacteria become active and can cause corrosion problems.

Sulfate-reducing bacteria are also present in seawater used for injections. While anaerobic and inactive in oxygenated seawater, deoxygenation during water conditioning creates ideal conditions for their growth. This can lead to sour corrosion in injection lines, tubing, and low points of deoxygenation towers, and may eventually cause iron sulfide plugging in the injection zone.

Over the long term, as large volumes of water cool the formation, SRBs can multiply under anaerobic conditions, leading to hydrogen sulfide production in crude oil and further sour corrosion issues.

Plugging

Hydrogen sulfide reacts with iron to form iron sulfide, a black sludge that can accumulate in equipment, pipelines, and tanks. This buildup reduces flow capacity, clogs systems, and decreases process efficiency. In injection wells, it can reduce permeability, while in producing wells, it can block perforations and lower oil production. Managing these deposits increases operational and maintenance costs for both injection and production systems.

Corrosion

Hydrogen sulfide can cause sour corrosion in pipelines and equipment, compromising system integrity. Sulfate-reducing bacteria, which are anaerobic, are responsible for most hydrogen sulfide production. They produce polysaccharides to adhere to surfaces, forming layers. As inner layers become oxygen-depleted, the anaerobic SRBs become active, producing hydrogen sulfide, and initiating sour corrosion.

High concentrations of hydrogen sulfide can also lead to sulfide stress cracking, further reducing system reliability.

Hydrogen Sulfide Solution

Revive Production's custom hydrogen sulfide control solution combines triazine with a proprietary additive that enhances the chemical's effectiveness and keeps reaction products in solution, preventing precipitation of solids.

When used alone, triazine does not fully react with hydrogen sulfide, leaving unreacted triazine that can cause reaction products, mainly elemental sulfur bonded with triazine, to precipitate as solids. Our additive improves reaction efficiency and keeps the resulting compounds dissolved and suspended.

This prevents solid buildup, extends the treatment's useful life, and reduces product usage and maintenance frequency, resulting in overall cost savings.