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Problems Associated with Sour Gas in the Oilfield Industry and Their Solutions

Melissa J. Goodwin,[†] Osama M. Musa,[‡] and Jonathan W. Steed*[,†]

[†]Department of Chemistry, Durham University, South Road, Durham DH1 3LE, United Kingdom
[‡]Ashland Speciality Ingredients, 1005 Route 202/206, Bridgewater, New Jersey 08807, United States

ABSTRACT: Fossil fuels are still a necessary and important part of modern living, keeping cars running and houses heated for example. As demands have risen and reservoirs of oil and natural gas have depleted, it has become increasingly more important to tap into fields that were once classified as undesirable. Sour fields, fields high in acidic gases, such as hydrogen sulfide and carbon dioxide, are one such option. There are many difficulties and dangers associated with working sour fields, such as toxicity of the sour gases, hydrate formation, and corrosion of equipment, that have prevented these resources from being used in the past. Many varied methods of overcoming these problems have been developed, from removing the sour components to inhibiting their effects. This review highlights the major issues raised by sour fields as well as a wide range of solutions in use today.

1. NATURAL GASES: SWEET AND SOUR

Natural gas is an important fuel used in a range of applications. There is an increasing demand for natural gas, with consumption predicted to almost double between 2004 and 2030.[1] Many other fossil fuel stocks are waning, and a desire for cleaner burning, low carbon fuels has also played a large part in the increased demand for natural gas.[1,2] Natural gas reserves can be generalized into two categories: sweet and sour. Sour gases contain a significant amount of acid gas components. The acid gases are most commonly CO_2 and H_2S, although other sulfur-containing compounds (mercaptans) can also be present. A gas may be referred to as sweet when the acidic components are below a certain threshold. This threshold varies depending upon the company or country of origin, with pipeline transport specifications being between 3 and 15 ppm[3] and sales specifications at less than 4 ppm of H_2S.[4,5] The act of removing acid gases is called sweetening.

Gas is used in its sweetened state, for safety and efficiency reasons. When gas fields were in abundance, fields containing sour gas were sealed off for later use, because the cost of sweetening the gas before use was not worth the smaller profits. Because of the increase in demand for natural gas and depletion of many sweet gas fields, use of sour fields are now a more economically viable undertaking, with the use of sour fields rising from 16% of all natural gas produced in 1971 to 21% in 2004, with a prediction that 26% of all gas will be from sour reserves in 2030.[1]

In this review, the dangers and problems associated with sour gas stores will be covered as well as the methods employed to overcome them.

2. DANGERS AND PROBLEMS

2.1. Toxicity. Beyond the risk of asphyxiation associated with a majority of gases, there are no particular health risks associated with CO_2. Unfortunately, the health risks from H_2S are more than adequate to make sour gas production a hazardous undertaking. Humans do have proteins capable of safely oxidizing or methylating H_2S into excretable, safe compounds by use of sulfite oxidase and *S*-methyltransferase.[6] These proteins metabolize the small amounts of H_2S that are produced by the anaerobic processes of bacteria found in the intestines and liver. These proteins are not found in significant concentrations in the lungs and are not designed to cope with relatively large quantities of gas, greatly reducing their efficiency when dealing with toxicity from inhaled hydrogen sulfide.

The distinctive rotting egg smell of H_2S is detectable at around 0.05 ppm. The smell would be a good indication of its presence if not for at concentrations after 100 ppm it paralyzes the olfactory nerve, killing the sense of smell and, thus, the awareness of danger. After 50 ppm, the effects of sub-acute poisoning start to become apparent, gradually becoming more severe until 700 ppm when acute poisoning occurs.[6] Sub-acute poisoning has a range of symptoms.[6,7] In the 1930s, "gas eyes" or conjunctivitis was usually taken as a routine hazard of the trade when working sour gas fields.[8] Symptoms often include sore eyes, swelling of the eyes, blurred vision, light sensitivity, and the feeling that the eyelids are rough. Similar inflammations can occur in the nose and throat, such as rhinitis, pharyngitis, laryngitis, and bronchitis. Mild exposure causes dryness of the nose, painful cough, and the feeling of something being stuck in the throat. Moderate exposure can give a feeling of tightness and rawness in the chest, along with the buildup of mucous in the bronchia. More severe exposure results in a buildup of liquid in the airways and irregular bleeding or pus deposits.

Acute poisoning results very quickly in death. It is generally taken that only two breaths over 1000 ppm of H_2S result in a loss of consciousness and the heart stops beating after 5−10 min.[6,7] Within these few minutes, rescue and treatment can be successful, although lasting neurological damage is possible. The extremely short time between exposure and collapse is referred to as a "knockdown" effect.

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