PENFLEX

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Sour Gas Transfer: Considerations Around Metal Hose Alloy Selection

NATURAL GAS MARKET

As demand for natural gas increases, effective extraction and efficient processing of sour gas is top of mind for many in the industry. The acidic gases contained within are toxic, flammable and highly corrosive.

The main driver of increasing demand, which jumped 4.6 percent in 2018 according to the International Energy Agency, is the switch from coal to gas. As countries like the United States and China look to reduce air pollution from coal to gas switching, other regions like the Middle East expect power generation to be a key driver of industry growth in the coming years.

The industrial sector also presents a ready market for natural gas where it is used as energy for processes and feedstock for chemicals. Continued growth in global demand is expected.

SWEET AND SOUR NATURAL GAS

Like crude, there are different kinds of natural gas, namely sweet and sour. Sour gas is natural gas that contains significant amounts of acidic gases, namely hydrogen sulfide (H2S). It may also contain other acidic gases like carbon dioxide (CO2)—and can thus be termed an ‘acid gas’—but it’s important to recognize that an acid gas is not always a sour gas. Without the presence of H2S, an acid gas is not technically a sour gas. Sweet gas, which does not contain concentrations of acidic gases, is preferable.

While definitions defer between states and countries, natural gas is typically considered sour if hydrogen sulfide content exceeds 5.7 milligrams of H2S per cubic meter of natural gas, or about 4ppm.

H2S is extremely corrosive and can be lethal to breathe. Often in combination with water, which leads to sulfide stress cracking, hydrogen sulfide damages drilling equipment and corrodes piping during extraction, transportation and processing of natural gas.

Highly poisonous, the toxicity of H2S is comparable to carbon monoxide and several instances of death have been reported due to short-term, high-level exposure.

High concentrations of CO2 decrease the amount of energy produced when burning natural gas and also present challenges when liquifying natural gas. CO2 will freeze before the gas is liquified causing blockages in flow lines and other operational problems.

Thus, before sour natural gas can be consumed it must be “sweetened” to remove H2S and CO2. The removal of hydrogen sulfide is typically done through an amine gas treatment process while the removal of carbon dioxide can be done using solvent systems, absorption towers, membrane separators or various cryogenic processes.

ALLOY SELECTION IN SOUR GAS APPLICATIONS

Given the highly corrosive nature of H2S, careful consideration is needed when designing metal hose assemblies for sour gas. At concentrations up to about 25 percent, H2S is a reducing agent while at higher concentrations it becomes an oxidizing agent. H2S concentrations in natural gas vary but can be as high as 90 percent.

316 SS is resistant to both reducing and oxidizing acids due to its molybdenum (Mo) content and can be used in sour gas applications. It even "fares" better than some exotic alloys like Monel 400 (NiCu 400).

However, if price is a secondary concern, then using AL-6XN which has twice as much Mo than 316 SS or one of the exotic alloys such as Inconel 625 or Hastelloy C-276—with significantly greater amounts of Mo (as much as four to eight times the amount compared with 316 SS)—is preferable. Hose assemblies made from these alloys will demonstrate greater corrosion resistance in sour gas applications.

To summarize, the above-mentioned alloys are listed below in descending order based on molybdenum content, one of the indicators of resistance to corrosion caused by H2S.

- Hastelloy C-276
- Inconel 625
- AL-6XN
- 316 Stainless Steel
- Monel 400

Beyond Mo, the greater the nickel (Ni) and chromium (Cr) content of the alloy, the better suited a hose will be for such environments. Of those alloys listed above, Hastelloy C-276 and Inconel 625 are the only high nickel alloys with nearly 60% Ni composition.

As the elemental composition of media following through piping systems varies and there are other factors to consider—such as movement, temperature and pressure—it’s important to keep in mind that the information shared here is general in nature. Ultimately, piping system designers should be deciding which alloy is best for a particular application given their familiarity with these various inputs.

Any questions, please contact us.

Sources: “Gas 2019: Analysis and forecasts to 2024,” International Energy Agency, https://www.iea.org/gas2019/.