**H₂S Implications on Transmission Systems:**

It is possible that hydrogen sulphide (H₂S) may be present in the transmission systems. The presence of H₂S can present additional considerations for material choice. Of primary concern is the occurrence of sulphide stress cracking (SSC) as well as hydrogen induced cracking (HIC).

Corrosion under wet conditions with the presence of H₂S leads to the generation of atomic hydrogen as simply expressed by the following equation:

$$\text{H}_2\text{S} + \text{Fe} \rightarrow \text{FeS}_x + 2\text{H}^+$$

(Note that H⁺ can migrate through conventional steel.)

The degree of SSC attack on steel can vary, mainly because the mechanism of sour corrosion depends upon numerous factors such as:

- pH level
- Chloride ion concentration (if present in the water)
- Oxygen, CO₂, and H₂S in the solution
- Composition, microstructure, and hardness of the steel
- Level of applied stress
- Temperature (carbon steel has a maximum sensitivity to SSC at around 25°C)
- Pressure
- Flow rate of the solution present

Standards define sour gas systems having an H₂S partial pressure of 0.0034 bara (0.05 psia).

The differences between SSC and HIC and a comparison of the major features of each of these forms of attack are given in the table below:

<table>
<thead>
<tr>
<th>Sulphide Stress Cracking</th>
<th>Hydrogen Induced Cracking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application of external stress is normally necessary</td>
<td>No external stress is required</td>
</tr>
<tr>
<td>Cracking is generally orientated perpendicular to the direction of the applied stress</td>
<td>Cracking always has significant components in the rolling direction but may propagate in a stepwise fashion</td>
</tr>
<tr>
<td>Generally occurs in higher strength materials and largely controlled in practice by limitation of the steel hardness</td>
<td>Cracking occurs in both high and low strength and this cannot be avoided by control of hardness</td>
</tr>
<tr>
<td>Can take place in the presence of very small levels of H₂S.</td>
<td>In all probability to a significant extent only in severe environments</td>
</tr>
<tr>
<td>Not normally associated with non-metallic</td>
<td>Generally associated with non-metallic</td>
</tr>
</tbody>
</table>

---

1 Compiled from: IEA “Pipeline Transmission of CO₂ and Energy” Report PH4/6
inclusions but requires a susceptible microstructure.  
inclusions such as manganese and calcium sulphides. Cracking can occur at bands of hard transformation products in macroscopically lower strength materials.

Health Effects of H₂S:²

Hydrogen Sulfide (H₂S) is a colorless gas that smells like rotten eggs (from the sulphur). Often referred to as "sewer gas," hydrogen sulfide is highly poisonous. Usually, the poisoning caused by hydrogen sulfide is though inhalation and has a toxicity similar to cyanide. It is found in petroleum and natural gas and is sometimes present in ground water. Natural gas can contain up to 28% hydrogen sulfide gas and may be considered an air pollutant when found near a natural gas production area or refinery.

Low Levels of H₂S
The odor or hydrogen sulfide gas can be perceived at levels as low as 10 ppb (parts per billion). At levels of 50-100 ppm (parts per million), it may cause the human sense of smell to fail. Low levels can cause eye irritation, dizziness, coughing, and headache.

High levels of H₂S
At high exposures (usually greater than 300 ppm), H₂S has the amazing effect of causing the nose to stop perceiving its smell after a few inhalations, which may lead to the inhalation of a toxic or fatal dose (which can occur at 600 ppm). At high levels, hydrogen sulfide gas may paralyze the lungs, meaning that the victim may then be unable to escape from the toxic gas without assistance.

Deaths are not uncommon when people enter poorly ventilated spaces such as deep wells, underground tanks or sewer systems. Since H₂S gas is heavier than air, its concentration is highest near the bottom of enclosed spaces.

² Copied from: http://www.h2ssafety.com/hydrogen_sulfide.htm