Reducing Risk and Mitigating Cost by Understanding the Source of H_2S. Examples from Texas

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No operator wants to have a sour gas problem in their well. Even worse, "Surprise, we detected 10, 1000 or > 10,000 ppm H_2S in your well!"

The presence of H_2S in the production stream is a well-known problem from a safety and commercial perspective. Understanding the H_2S source is critical to estimating potential production quantities over time as well as identification of H_2S trends. Source identification allows critical cost and associated risk reduction decisions such as evaluating chemical treatment vs sour facility to be made early in the life of the field.

Sulfur is incorporated into organic matter shortly after deposition, generally within the first few meters of the subsurface, via reduction of seawater sulfate by bacteria. If there are abundant metals available, the sulfur will preferentially form metal sulfides. There are three main sources of H_2S in petroleum

Bacterial reduction of sulfate to H_2S through dissimilatory reactions. The biological creation of H_2S requires conditions in the subsurface compatible with bacterial growth, the most important of which is reservoir temperatures <80°C.

Thermochemical sulfate reduction = TSR. TSR is a reaction of sulfate minerals (primarily anhydrite) and petroleum to form H_2S and carbonates. This reaction is thought to begin only a subsurface temperatures > 120°C or more.

Thermal decomposition of sulfides in kerogen in clay-poor sulfur rich source rocks. The reactions are high temperature at the late stages of thermal maturation in carbonate dominated source rocks. Associated oils are high in sulfur and can provide a source for the H_2S in addition to the primary kerogen.

Determining the origin of H_2S found in any particular accumulation requires analysis of the H_2S itself, as well as the other components of the natural gas, the water, and possibly

any produced liquids. Examples from Texas will include thermochemical H_2S that migrated from deep reservoirs, biological H_2S generated *in situ* and a combination of both types.

Once the source has been identified informed economic decisions with respect to treatment, facility types and even where to market (sour or sweet) can be made early in field development.