Frequently asked Questions

I have a well that has 8 ppm of H_2S, what is the maximum ppm that we can run a standard line in?

September 2013

Minimum threshold to use an alloy wireline in sour wells

As oil and gas fields age, the presence of partial pressures of hydrogen sulfide (H_2S) and carbon dioxide (CO_2) becomes more prevalent. This has increased the incidence of wireline companies encountering trace amounts of these corrosive elements in day to day operations, especially when operating in established oil and gas basins. While specialized greases have been formulated to help protect wireline from the corrosive effects of CO_2 and $H2_S$, these products are not always available or effective in protecting a wireline. This is why the critical question of how to choose between carbon steel or alloy steel wireline for down hole operations, given the higher cost of the latter, continues to be a topic for discussion. While it is widely understood that the severity of a well's condition is determined by the combination of temperature and partial pressure of these corrosive agents, including chloride ion concentrations (See Technical Bulletin #13), a safe working limit for carbon steel wireline is still up for debate.

The National Association of Corrosion Engineers (NACE International) is considered a global leader in developing corrosion prevention and control standards, certification and education. NACE MR0175/ISO 15156-2:2009 suggests guidelines in determining the critical value of pressure of H2S beyond which the use of alloy steel wireline is recommended[1]. For partial pressure of H_2S (pH_2S) < 0.05 psi (0.3 kPa) the guideline suggests no precautions are required for the selection of steels. However, the steel's physical and metallurgical properties affecting its inherent resistance to hydrogen stress cracking (HSC) and sulfide stress cracking (SSC) need to be considered for use in these conditions. For pH_2S of 0.05 psi (0.3 kPa) and above, the guideline suggests the use of alloy wireline.

Partial pressure of H_2S (pH_2S)is calculated as:

pH_2S = Total bottom hole pressure x fraction of H_2S present

For example: For a bottom hole pressure of 10,000 psi, containing H_2S in a concentration of 8 ppm, the partial pressure is,

$pH_2S=10{,}000\times8/1{,}000{,}000=0.08$ psi

Similarly, industrial practices suggest varying thresholds for partial pressure of CO_2 (pCO_2) between 10 to 32 psi, above which alloy wireline is considered a safe option[2]. Partial pressure of CO_2 is its mole fraction times the total pressure. For example, if the CO_2 mole concentration is 2% and the well pressure is 3,000 psi then:
$pCO_2=2/100\times3000=60$ psi

In the case of carbon steels, the microstructure seems to have a major effect on how it is affected by CO_2 corrosion. Alloy steels have a shape and distribution of ferrite and cementite microstructure resulting from different heat treatments, making them beneficial for wet CO_2 service[3]. Also, the corrosive effect of CO_2 depends on aqueous presence and its solubility.

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Given the potential of SSC and HSC affecting high strength carbon steels even below the recommended levels for pH_2S and variation in recommended partial pressure of CO_2, it may be considered safer to rely on alloy steel for wireline operations even at low partial pressures. From a scientific standpoint, these recommended levels seem to be relevant and have been adopted all this while. However, there has been some debate[4] and studies which show that fugacity along with reduced solubility of H_2S due to methane influences must be used to evaluate SSC potential. This would involve performance revaluation of any high tensile steel wireline under these conditions if they have to be considered safe.

While Camesa continues to recommend the use of alloy wirelines for safe sour well operations at any concentration level to achieve longer life of the line, the NACE guideline gives a general baseline for industry accepted concentrations of H_2S for steel wireline operations. Additionally, the copper in a wireline's conductor is also susceptible to the corrosive elements in sour well which is why all Camesa alloy wirelines have nickel plated copper conductors for corrosion resistance. It should be noted that exposure time and temperatures also need to be considered in these well conditions as they can affect the severity of the corrosive well environment. Operators should always follow their company's recommended practices when determining the safe operation of non-alloy wireline in corrosive environments.

References

1. NACE Standard MR0175: 2009. "Petroleum and natural gas industries — Materials for use in H_2S-containing environments in oil and gas production — Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons".
2. Hunting PLC. "Wireline Operation: Slickline Calculations." http://www.huntingplc.com/
3. Shiladitya Paul, Richard Shepherd and Paul Woollin. "Selection of materials for high pressure CO_2 transport." TWI. http://www.twi.co.uk/
4. Bruce Craig. "Is NACE MR0175/ISO 15156 becoming irrelevant?" E&P Magazine. 2009. http://www.epmag.com/

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