Magnetization/AC effects on Hydrogen Induced Corrosion of Pipelines

The need for highly reliable and accurate inspection techniques for pipelines has led to the widespread adoption of magnetic flux leakage pigging tools. Magnetic flux leakage applies a saturating magnetic field and measures the induced magnetic field for areas of higher magnetic field that reveal defects and anomalies in the pipeline. A very significant effect has been measured in the laboratory on the hydrogen content in steel after electrochemical hydrogen charging with and without a two Tesla applied magnetic field, as well as a strong increase in hydrogen-induced cracking and pitting. Cold work combines with the effect of applied magnetic field to further increase hydrogen content.

An alternating current (AC) is applied to the steel pipelines to heat the pipe and contained oil in an effort to prevent gelling of oil hydrates and clogging of pipes where oil is transported through underwater pipelines. Investigation has been undertaken to provide an accurate and thorough understanding of the mechanisms and severity of corrosion of 13 Cr super-martensitic stainless steels in seawater. Pitting and environmental cracking, including hydrogen assisted cracking, are being analyzed by considering various models for AC-induced corrosion.

CO_2/Sour Corrosion Mechanisms and Materials Development

Corrosion of pipeline steels in brine solutions containing carbon dioxide gas and sour environments containing hydrogen sulfide gas is a severe problem in oil and natural gas production. The mechanism and characteristics of iron carbonate scale formation on line-pipe steels under different heat treatment conditions in a CO_2- brine solution is reviewed. An attempt has been made to correlate the observed corrosion rates conducted under various conditions of temperature, carbon dioxide partial pressure and pH. The pertinent factors that affect the corrosion rate have also been discussed. The stability diagram controlling this system has been developed showing the possibility of iron carbonate formation. A comprehensive corrosion rate expression which introduced both chemical and physical variables is suggested. It has been determined that iron carbonate is the main end product of corrosion reaction of steel in CO_2-containing solutions and is not a very protective film below 60^0C.

Similar work is underway for studying pipelines steels in sour environment at higher pressures and temperatures in an autoclave system. Results from ambient pressure studies in H_2S environment will be discussed.

A new grade of high strength, high Nitrogen and Carbon bearing austenitic stainless steel has been developed for the sour gas conditions in oil exploration material needs. Corrosion behavior of this new steel as well as its mechanical properties and processing requirements will be presented.

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