Meeting the Latest Materials and Corrosion Challenges of Hydrocarbon Transportation

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ABSTRACT

Construction and operation of the infrastructure for hydrocarbon transport are of fundamental importance to the success of oil and gas developments. A number of materials and corrosion challenges for projects are reviewed. The first materials challenge is the commercialization of remote arctic gas reserves by the potential use of new higher strength pipeline materials. The second challenge is that arctic or seismic areas may require pipelines using a strain-based design. This requires confirmation that the pipeline can accommodate the additional strain capacity requirements created by soil movement. The third challenge reviewed is the qualification of subsea cryogenic lines for the transfer of liquefied natural gas (LNG) to shore. This design permits significant savings. Finally, a corrosion control challenge is the transport of wet sour corrosive gas. This requires qualification of effective corrosion control. This approach also enables substantial savings, compared to the alternates using either carbon steel internally clad with corrosion resistant alloy or offshore dehydration.

KEY WORDS: oil; gas; production; pipeline; materials; corrosion; welding

INTRODUCTION

Upstream developments are capital intensive construction projects. A large proportion of expenditures is either direct material costs or fabrication. The hydrocarbon transport systems represent a major project investment and can include flow lines, loading lines and long distance pipelines. This emphasizes the importance of early application of materials and corrosion technology to optimize capital and operational expenditures, and to maintain integrity throughout the design life.

Crude oil was originally transported from the field in wooden barrels carried by horse and cart (Giddens, 1948). However, this method was expensive and unreliable. The answer to this problem was first, the use of wooden stave and subsequently cast iron pipelines for transport. However, both the wooden and cast iron lines experienced frequent leakage. This led to the use of more reliable wrought iron, and later carbon steel lines.

Continued developments in steel manufacturing, welding, inspection and corrosion control have enabled a wide variety of commercial line pipe products that are suitable for the majority of today's applications. However, project requirements continually evolve, creating materials and corrosion challenges that require the development and specification of materials with improved properties to meet continually higher performance demands.

The above is illustrated by evaluation of improved materials for higher strength pipeline steels for long distance gas transportation, strain-based pipeline applications and subsea cryogenic lines for transfer of LNG. There is a need to optimize the use of carbon steel via corrosion control to enable full well stream production verses carbon steel internally clad with corrosion resistant alloy or offshore dehydration.

Successful technology implementation requires rigorous qualification program that addresses all technical aspects of the target application. These include installation, commissioning and feasible upset conditions. Effective technology transfer to both project construction and to production operations is also essential to communicate the technology limits and the required operating practices.

HIGHER STRENGTH PIPELINE STEELS

Anticipating increased regional demand for gas by 2010, in 1993, ExxonMobil identified the commercial leverage offered by lower cost pipelines to increase the reach of gas transmission pipelines from remote regions. In 1994, ExxonMobil began research on higher strength line pipe steel and welding methods to reduce the cost of gas transmission pipelines.

The concept was that future commercialization opportunities can be made economic by fully capturing the benefits of high-pressure transmission for large volumes of gas. The higher strength steel provides an opportunity to reduce pipeline costs and enable development of remote resources currently considered non-commercial.

Achieving the noted economic benefits requires that the steel (1) is stronger and yet less expensive than current line pipe steel on a