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Challenging Material and Fabrication Solutions for Deepwater Hydrocarbon Development

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ABSTRACT

Materials and chemical technology advancements related to materials selection, corrosion mitigation/management, welding engineering and non destructive evaluation have enabled harsher service environments to be developed including, ultra deepwater field developments, sour and arctic conditions, high pressure/temperature, and high fatigue loading related to pipelines and steel catenary risers (SCRs).

Reliable materials selection, fabrication and inspection techniques have the potential to save many millions of dollars on each project. Some of the reasons for this growing importance in materials engineering by the major operators include;

- More material failures have recently been reported and may be attributed to poor materials selection, quality control and fabrication practice resulting in much higher repair cost and lost production.

- Corrosion resistant alloys are being seen to give major long term benefits (OPEX), which are outweighing the short term higher capital costs (CAPEX) and an increasing awareness and concern for the environment and safety (HSE).

This paper discusses subsea developments which demand high performance materials and coatings with characteristics such as adequate strength, flow assurance, resistance to the initiation of brittle fracture and fatigue, excellent weldability and protection against corrosion. Reference will be made to some offshore material failures, to illustrate the importance of the above factors and recommendations shall be given to avoid their re-occurrence.

KEY WORDS: Materials Selection, Corrosion resistant alloys, Failures, Corrosion Mitigation, Pipelines, Inhibition.

INTRODUCTION

The response of materials to installation and operational conditions is of major importance for the quantification of safety and lifetime prediction as the unexpected incidents concerning subsea pipelines and flexible risers, clearly demonstrate the technology/knowledge gap between material properties and design parameters. Pipeline failures have not only exposed knowledge gaps on degradation mechanisms, but have indicated a need for improved interaction between global and local design.

Since the start of this century certification agencies in the North Sea have expressed concern over the number of gas leakages. These leakages have cost in excess of 5 billion dollars due to repair and replacement costs and lost production in the last decade alone. Fortunately the impact on the environment and human health and safety has not been significant. (Lange et Al, 2004). It is also estimated that direct corrosion costs in the USA are approximately three percent of gross domestic product.

Corrosion engineers continue to be challenged by new developments in oil and gas production systems. High reliability corrosion prevention, flow assurance in deep water and reservoir souring from sulfate reducing bacteria (SRB) are still major issues in hydrocarbon production and water injection systems. The composition of deepwater reservoirs may not be known during the design stage, hence, equipment material selection needs to be on the conservative side, as reliable performance in deep water is critical to the success of the field development, as repair and replacement of equipment in deep water, is cost prohibitive. In such circumstances nickel based corrosion resistant alloys (CRA's) for wetted parts in trees and chokes etc. should become mandatory rather than optional. It is paramount to know each CRA's operating limits such as pitting resistance, crevice corrosion and their ability to resist erosion-corrosion and also hydrogen embrittlement from cathodic protection and hydrogen sulfide. Other challenges include the selected elastomers ability to seal at both high and low temperatures in manifolds and subsea trees etc.