Materials Integrity by Design

Eric John Wright*
ExxonMobil Production Company
Spring, Texas, USA

Maintaining asset integrity throughout the design life of oil and gas operations is key to the overall success of upstream projects. Specific locations, e.g., geographically remote or deepwater locations, create challenges to materials performance, logistics of installation, corrosion control and system inspection. Therefore, designing for sustained materials integrity requires an inclusive approach for materials selection, corrosion control, monitoring, and inspection that is needed throughout the asset life cycle. Furthermore, performance needs to continually increase because of more demanding designs requiring higher-strength, higher-temperature materials, long-life coatings, and highly effective corrosion inhibitors for carbon steel. For new materials or component applications, technology qualifications are conducted. For effective technology implementation, these should be integrated into the overall project design basis, the execution schedule and asset integrity management program.

INTRODUCTION

Materials integrity is a major contributor to the safety, environmental and economic success of oil and gas assets. Development of an asset integrity management program requires coordinated contributions of a broad range of disciplines (OGP, 2008). The focus of this paper is a review of selected materials integrity challenges related to the design, construction, and operation phases. To address these, a number of integrated processes are conducted to ensure that the materials integrity of the asset is maintained from startup through field decommissioning.

MATERIALS INTEGRITY SCOPE

Upstream project construction uses a range of materials that are exposed to a variety of environmental conditions, such as production well fluids, process fluids, and seawater. For example, Fig. 1 shows a floating storage and offloading (FSO) vessel with an offloading tower. The materials include structural steels, corrosion-resistant alloys, and flexible hoses. Corrosion control includes coatings, corrosion inhibitors, and cathodic protection.

Materials procurement and associated fabrication can represent a substantial proportion (approximately 65%–70%) of the capital expenditures for a project. In addition, corrosion control and inspection represent significant, ongoing operating expenses. The final design is based on life-cycle costs that include consideration of both capital and operational costs (ISO, 2000, 2001a, 2001b). In summary, selecting the optimal materials and associated corrosion control strategy can have significant impact on both the asset materials integrity and economic performance.

MATERIALS INTEGRITY THROUGHOUT THE LIFE CYCLE

The design, construction and operation of an oil and gas asset involve numerous activities by multiple organizations and interfaces potentially spanning decades. The typical life cycle of an asset consists of the following:

- conceptual design
- engineering design
- construction
- systems commissioning
- operations.

A number of factors may impact materials integrity during each of these stages; mitigation will include verification of the following:

- materials have been correctly specified for this design
- materials have been procured to specification
- materials have been fabricated and inspected to specification
- corrosion control strategy meets design requirements
- life-cycle environments are within the design envelopes

*ISOPE Member.

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Fig. 1 A floating storage and offloading (FSO) vessel and offloading tower includes a broad range of metallic and nonmetallic materials.