

Review on Pipelines in Offshore Platform Processing System

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Abstract

Pipelines are essential for transporting energy utilities such as oil, natural gas and coal for the nation. Similarly, pipelines are the only medium installed at offshore region to convey oil, gas, chemicals and water. Currently, corrosion is being a major problem for offshore pipeline occurrences around the world. Hence, this paper discussed on the pipelines in offshore platform and the corrosion of corresponding pipeline materials.

Introduction

Everyone knows that water, fuel and gas are essential utilities needed for daily life. However, many people do not know that pipeline is the only carriage to transport fluid such as water, oil, gas and so on from one region to another. According to Canadian Energy Pipeline Association pipeline is imperative for energy transportation and also to sustain a country's economy [1]. Since pipelines play crucial role in transporting crude oil, oil products and gas to all over the places, transnational pipelines fabricated and installed in underground or subsea many years ago [2,3]. Concurrently pipelines are vital in offshore field to convey the fluid especially oil and gas.

Offshore Field Pipeline Systems

Pipelines play a vital role in connecting all the offshore field development systems. Pipelines used to link offshore facilities because it is safer, more reliable and environmental friendly. The offshore field includes subsea system, riser or flowline pipelines, offshore platforms and topside processing system shown in the following Figure 1.

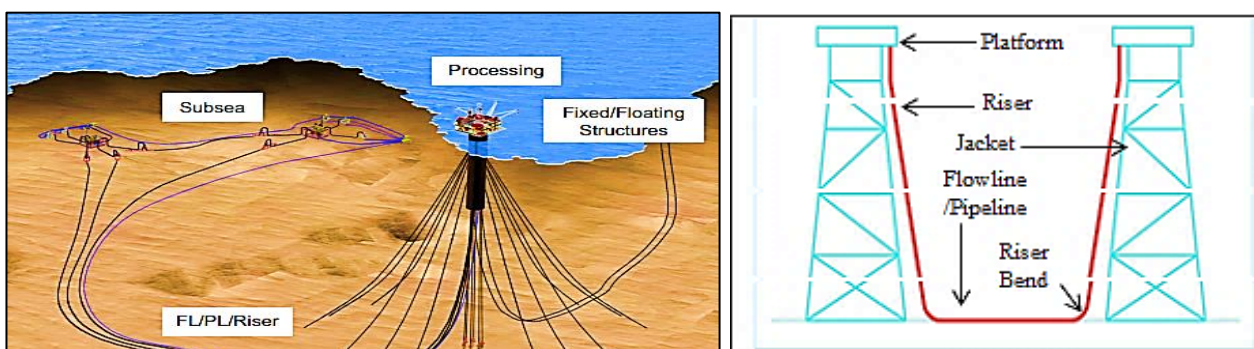


Figure 1: Offshore Field Development Components [5]

Subsea System can be divided into various components such as wellhead structure, manifold, subsea control system and connection system [4,5,6]. Well head structure is also known as Christmas tree; it is stationed at the ocean bed to control the extraction of hydrocarbon from wildcat, prevents leakage of oil or gas and prevents blowout due to high pressure during extraction process [7,11]. Meanwhile, manifold simplifies subsea system by linking to numerous wellheads to receive productions and channel them into smaller flowlines [6,9]. One of the subsea control system element is its retrievable components such as pumps, choke insert, and control modules. They are

attached to wellhead or manifold to regulate pressure, valve and position of sensing device. Umbilical pipeline is also a part of subsea control system to link all the subsea components [10]. Moreover, connection system pipeline end terminals (PLET) acts as termination network between the main pipeline and a rigid spool or flexible jumper [6].

Flowlines and Risers are important offshore field elements operate through pipeline system. Flowlines convey the crude oil or gas from subsea to riser which connected to offshore platforms [11]. Concurrently, riser is a pipeline transports the extracted oil and gas from flowlines to offshore processing platform [12]. Hence, pipeline is the only agent to carry the hydrocarbon from oil well to the offshore processing platform via wellhead, manifold, flowlines and riser.

Fixed/Floating Offshore Platform is an advanced deepwater technology to extract hydrocarbon produced at reservoir and convey them to onshore receiving facilities for refinery such as semisubmersible, tension leg platform and spar platforms [13,14,15]. Those offshore platforms are connected to the riser or flowlines/pipelines for crude oil transportation. Forth element of offshore field is topside processing systems, a primary section of offshore production platform. Entire topside processing systems are built of various pipelines.

Pipeline Systems in Offshore Processing Platform

Basic principle of an offshore production platform is to process extracted hydrocarbon into base elements such as oil, gas, water [16]. In common, oil and gas will undergo few processes and transported to onshore via pipelines. Separated water which is known as produced water will undergo various processes for several processing systems [7,17]. Major processing systems in topside and the pipeline configurations will be discussed further in this section.

The classification such as (1) *Produced Hydrocarbon Separation System* - Separation system is the major topside processing system that runs through pipelines. Inlet separator receives hydrocarbon from oil well then initiates separation operation into oil, gas and water [17,18]; (2) *Gas Compression & Dehydration System* - After hydrocarbon separated into oil, gas, water respectively gas will be undergo certain processes such as compression and dehydration before exported to onshore. Hence, pipeline network connects the system with sub-system; (3) *Produced Water Treatment System* - Water utilised effectively in an offshore platform for various operations such as ballast water, water injection and discharge to sea [19,20,21].

(4) *Sea Water Treatment (Water Injection System)* - Generally sea water treated for water injection to reservoir for pressure maintenance. Calcium nitrate, oxygen scavenger, biocide, corrosion inhibitor, scale inhibitor and antifoam are the chemical used in this system [22,23]; (5) *Water Utilities System* - Separated water is also processed into various sub-systems such as fresh water system, fire water system and cooling medium system. Pipelines are definitely required to supply water for those utilities and connect the sub-components [16,24]; (6) *Other Utilities Supply* - Pipelines are also essential for other processing systems which inter-related which the major ones; for instance diesel system, flare system, sand jetting and separation system, drainage system, instrument air and inert gases system and sewage system [7].

Corrosion in Offshore Platform Pipelines

In common corrosion is defined as destructive oxidation of metallic element [25]. In this globalisation era, corrosion is a threatening issue in any industry especially pipeline industry [26]. Corrosion is a major problem in pipelines which lead to uncountable worldwide pipeline failures [11,27]. Thus, further analysis of corrosion in 3 major pipeline material such as low carbon steel, low alloy steel and stainless steel have been done and the results are tabulated in Table 1.

Table 1: Corrosion analysis of three pipeline materials in offshore environment

| Material | Applications in Offshore Pipelines | Corrosive Environments | Corrosion Types (High Amount) | Reference |
|------------------|---|---|---|--|
| Low Carbon Steel | 1. Seawater system | <ul style="list-style-type: none"> • Natural Seawater • ASTM D11411 Synthetic seawater • MBL Synthetic Seawater • 3.5% NaCl Seawater • Aerated seawater • Above Seawater • Semi-submerged • Fully submerged | <ol style="list-style-type: none"> 1. General 2. Pitting 3. Galvanic 4. Erosion | [17] [25] [29] [30] [31] [32] [33] |
| | 2. Water injection system | | | |
| | 3. Produced water system | | | |
| | 4. Dry fuel and gas system | | | |
| | 5. Fire water system | | | |
| | 6. Glycol and methanol injection system | | | |
| | 7. Flare system | | | |
| Low Alloy Steel | 1. Water injection system | <ul style="list-style-type: none"> • Deep Ocean (>2000 feet's) • Deep Ocean (>6000 feet's) • Seawater Surface • Water Injection System (pH = 8.2) | <ol style="list-style-type: none"> 1. Pitting 2. Crevice | [17] [25] [33] [34] |
| Stainless Steel | 1. Seawater system | <ul style="list-style-type: none"> • Static Seawater • Deep Ocean (>2000 feet's) • Deep Ocean (>6000 feet's) • Fully Submerged • Semi- submerged • Seawater Surface • Above Seawater | <ol style="list-style-type: none"> 1. Crevice | [17] [29] [32] [33] [34] [35] |
| | 2. Water injection system | | | |
| | 3. Produced water system | | | |
| | 4. Portable water system | | | |
| | 5. Dry fuel and gas system | | | |
| | 6. Fire water system | | | |
| | 7. Chemical injection system | | | |

Summary

Thus, a precise review has been done on pipelines of offshore platform processing system and corrosion of the respective pipeline materials. In addition, this review paper can contribute for the research and development of offshore field by reducing corrosion rate of offshore pipelines.

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