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TurkStream Technological Advancements

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The TurkStream offshore pipeline has been one of the most challenging projects in the offshore oil and gas industry in the last decade. It is a major gas-transmission system that is pivotal to the transport of natural gas from the large Siberian reservoirs to the Turkish and European markets. The system consists of two subsea pipeline strings of more than 900 km each that cross the Black Sea through water depths of up to 2,200 m. Its large outer diameter of 32 inches makes it possible to transport a massive amount—31.5 billion cubic metres—of natural gas per year from the Russian to the Turkish shore. A very thick wall of 39 mm is needed to ensure structural integrity. The sheer size of the system and the conditions in which it operates come with many challenges. Several are discussed in this paper, which focuses on the work carried out between 2010 and 2019, before the pipeline commenced operations. Available technologies had to be advanced to the next level on many fronts to ensure the success of this project.

INTRODUCTION

The TurkStream Offshore Pipeline is a major gas-transmission system that is currently in operation and comprises two pipeline strings in up to 2,200 m deep water. It connects large gas reservoirs in Russia to the Turkish gas-transportation network via the Black Sea, as shown in Fig. 1. The system currently has an annual capacity to transport 31.5 billion cubic metres (bcm) of natural gas over approximately 940 km. The line pipe is longitudinally welded with a nominal outer diameter (D) of 813.0 mm (i.e., 32 inches) and a wall thickness (t) of 39.0 mm. The material grade is DNV SAWL 450 with supplementary requirements F, D, U, and (light) S, according to DNV-OS-F101 (Det Norske Veritas (DNV), 2010), plus project specifications.

The line pipe is externally coated using a three-layer polypropylene (3LPP) anticorrosion coating. A liquid-epoxy flow coating has been applied on the inside to reduce the frictional pressure loss during operation and, more importantly, ease pre-commissioning and commissioning. Concrete weight coating is applied merely in shallow water to ensure on-bottom stability.

This project has been a challenge on many fronts, including issues related to commercial, political, regulatory, logistic, and technical complexities. However, this paper focuses merely on the technical issues encountered between 2010 and 2019, before the pipeline commenced operations. The combination of ultra-deep water and a large diameter resulted in the need for a heavy wall, one at the limit of what present-day tier-one pipe mills can manufacture in large quantities. Dedicated testing programmes were launched, and project-specific manufacturing requirements were developed to ensure that the line pipe was fit to resist the tremendous external pressure acting in ultra-deep water.

It was not economical nor practicable to design the pipeline to resist buckle propagation in the route portions with the deepest water. Consequently, buckle arrestors (BAs) were needed to halt a propagating buckle and to limit the maximum length of pipe lost during such an event. These are in-line sections of very thick pipe. The installation was conducted using the S-lay method. This means that the BAs needed to travel over a long stinger on which they are cyclically loaded because of the individual rollers. The manufacturing and installation of the BAs came with their own challenges.

The routes selected for the two pipeline strings cross steep slopes and areas in which geohazards could threaten the system. The robustness of the on-bottom design of the pipeline on the steep slopes has been a specific point of attention. TurkStream is

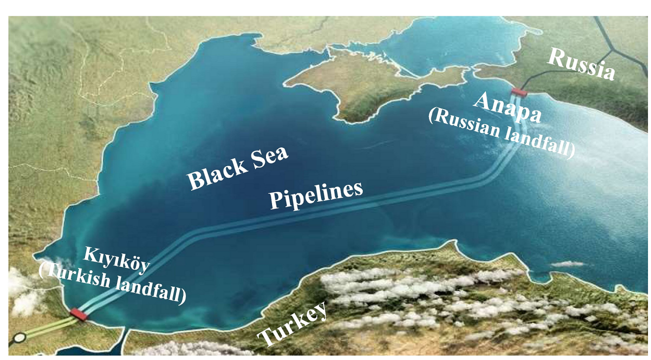

Fig. 1 Routing of the TurkStream pipelines

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