DEEPWATER PIPELINE INSTALLATION METHODS. THEIR POTENTIAL APPLICATION IN THE ARCTIC. MODERN TECHNOLOGY AND FEATURES

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One of the most crucial challenges modern petroleum industry faces is the depletion of light hydrocarbon reserves. There are two possible ways to deal with this problem: the first is to significantly develop technologies such as hydraulic fracturing to produce heavy scavenger oil and the second is to go offshore, where oil and gas fields still contain much of light oil. This article is focused on the second way of dealing with an issue, particularly on construction of subsea pipelines. The most common methods of deepwater pipelines installation are mentioned in the article focusing on the S-Lay method as the most preferable for the Arctic offshore area.

Installation methods are divided by three main factors: water depth, pipeline outside diameter and type of the pipeline or cable. Modern technologies allow installing rigid steel pipelines, flexible pipelines and umbilical cables. Rigid steel pipelines are commonly installed by four methods called S-Lay, J-Lay and Reel-Lay (Fig. 1) [1]. By far the most common method is S-Lay. This can be used for all water depths and for flowlines and export lines. However, it is the only method suitable for rigid pipelines installation in shallow water. J-Lay is used in deeper water. This method is slightly slower and it provides less pipeline stress near touchdown [2]. With Reel-Lay method, pipes are manufactured and assembled together onshore and either loaded onto a reel or towed to the destination by trailer vessels. These methods provide a faster laying process, however they are limited to the smaller diameters or lengths of pipelines. Another disadvantage is yielding of the pipeline as it is loaded onto the reel and once again when it is straightened while installing. However, when it leaves the pipeline installation vessel, it is installed in a similar manner to the J-Lay method with minimum stress at touchdown [2]. As for the flexible pipelines and umbilical cables, they are installed in a similar manner, but they face a lower stress because of the relatively non-robust nature [3]. Since Russian Arctic offshore area is mostly shallow (up to 75-100 m in depth) S-Lay method of pipeline installation is the most preferable among all of the mentioned ones.

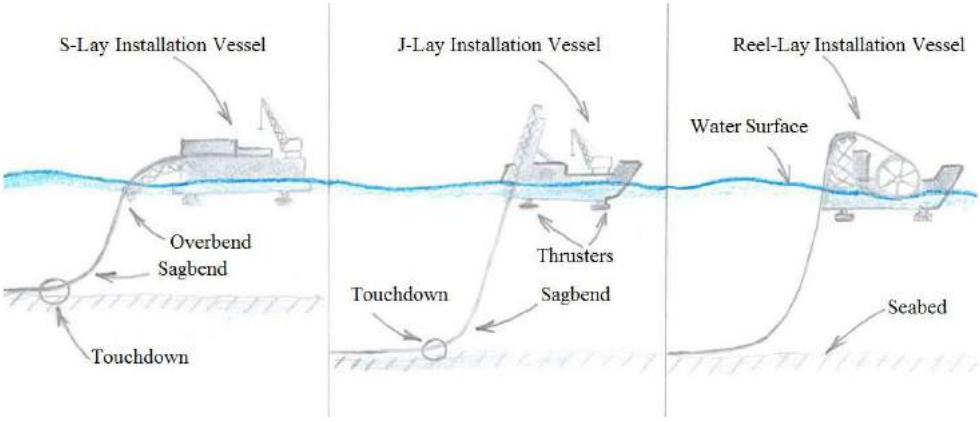

Fig. 1. Schematic illustration of three most common subsea pipelines installation methods

S-Lay method of installation takes its name from the shape of the suspended pipeline at the end of the installation vessel which lays from the stinger to the seabed. Stinger is a solid frame structure supporting the pipeline as it lowers into the water to avoid excessive bending stress by creating a curve shape. The most important feature of this method is that the vessel must provide great tension for the pipeline to hold its shape. The pipes are usually about 12 m long and manufactured onshore. Then they are transported to the installation barge where welded together at a firing line and coated (if needed) while running through the centre of the vessel out of the stern, down the stinger into the water. As the pipeline is welded up, the barge is moving forward on an anchor system or by its own dynamic positioning thrusters.

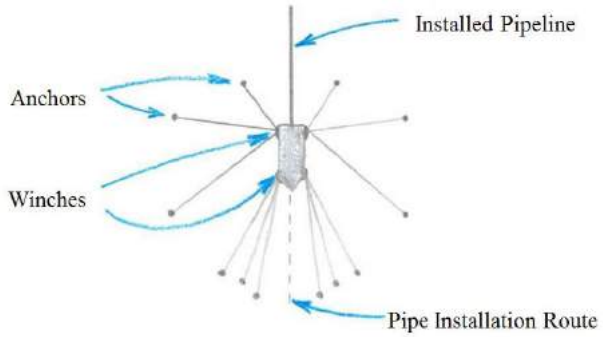

Fig. 2. Installation Vessel Anchor System

One of the most famous S-lay installation vessels called 'Saipem Castoro 7' has 12 anchors (Fig. 2), and two anchor tugs moving one anchor at a time as the main vessel moves forward. The thrusters provide more precise control of the vessel which makes it easier to maneuver close to offshore structures than for anchored laybarges, which have to carefully position their anchor cables to avoid clashes [4]. Lay rate in this method mostly depends on how fast pipes can be assembled together, which in its turn depends on the efficiency of firing stations onboard and their number. For instance, S-lay vessel 'Solitaire' has seven workstations and all welding and coating processes are divided equally among them. Pipeline installation is a continuous (24 hour) process, which is fully explained, considering its cost it is important to complete the construction including line-pipe leaving the pipe-coating facility, double-joint length production, passage through the firing line and barge movement in a shortest period possible. Another limitation is treacherous weather, which is why pipelaying companies must use the advantageous calm periods of time in the most efficient way. Schematically the S-Lay process of installation is shown in Figure 3.

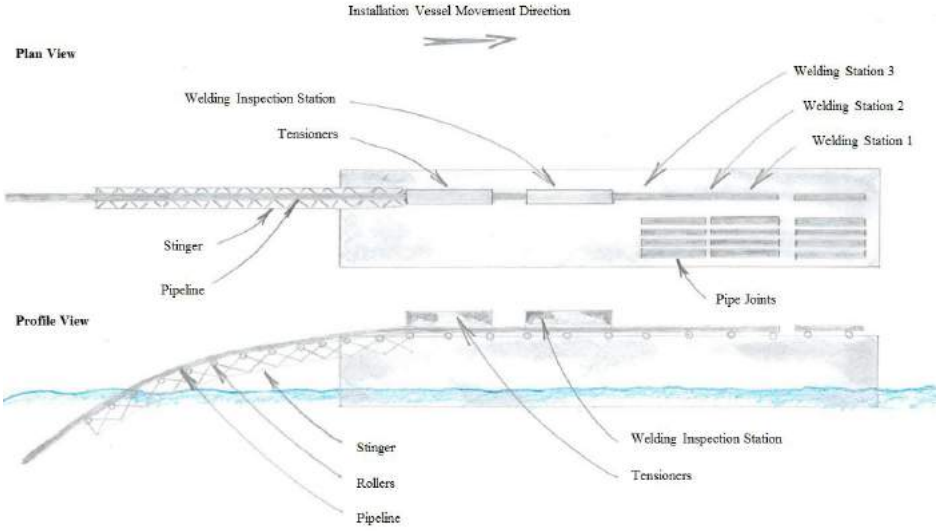

Fig. 3. Detailed schematic illustration of S-Lay installation vessel in a Plan (upper part) and Profile (lower part) views

Pipe-laying is a complex process, which requires many engineers and much equipment to be involved. Apart from the lay-barges a fleet of support vessels is used including pipe carriers, supply vessels, anchor handling tugs, guard vessels and survey vessels [1]. As for the Arctic, there is another crucial issue which is ice. There are not that many ways to overtake this problem. For example, in some areas it is possible to wait for a warmer period when ice disappears and start the installation. However, many areas are covered with the ice throughout the year that means the use of icebreakers is needed as the supporting operation. This makes the entire process much more expensive, but in such areas it is the only way, because currently there is no any pipeline installation vessel able to withstand and work independently in frozen water areas. All of vessels work together as team, constantly communicating one another, sharing data and current information about weather conditions, water behaviour and seabed state. The purpose of installation engineering is to calculate and find a way how a particular vessel will install a pipeline without or with a minimum damage applied [4].

In the article it is described how pipelines are installed in offshore areas. Focusing on the Arctic offshore area the most suitable option of installation is S-Lay method suitable to work in shallow water. However, there is a big issue with ice covered water long time every year. In order to resolve this issue might be either chosen short periods when water is free from ice (where possible) or used icebreakers as the supporting operation vessels, which makes the entire operation even more complex and expensive. However, it is worth doing considering the amount of hydrocarbons stored in the Arctic reserves and to be transported to the customers.

References

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