WALL THICKNESS OPTIMIZATION FOR ULTRA-DEEPWATER PIPELINE SYSTEM

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INTRODUCTION

Recent advances in pipe manufacturing techniques and pipeline construction have enabled the installation of larger diameter pipelines in ultra-deepwater locations (water depths greater than 1,500 meter). Results of recent work have demonstrated the beneficial effect of a modified UOE (U bending, O forming, expansion E) manufacturing approach on linepipe collapse resistance (Kashani 2008). Through the modified UOE fabrication process, in combination with low heat treatment process significant improvements in collapse resistance is obtained. The use of modified forming parameters and heat treatment during pipe manufacture may enable to increase the collapse reduction factor given by the offshore codes. The enhanced fabrication parameters however are not considered in the present work but have only been identified as additional controlling parameters in ultra-deepwater pipeline sizing.

A comparatively new method of pipeline construction in ultra-deepwater, is the J-lay method. In the J-lay method the lengths of line pipe are welded to each other whilst supported in an almost vertical position by the tower. The near-vertical configuration of the pipe at water level results in relatively small horizontal and vertical reaction load on the stinger. The method is attractive as the pipe overbend strains are low and the horizontal force required for stationkeeping is often within the capability of dynamic positioning systems.

The tension capacity for most present J-lay vessels is limited to 550 tonne and the pipelay rate is shown to be inherently slower than the conventional S-lay method. For this reason, in addition to hydrostatic collapse and local buckling considerations, the designer must make sure that the vessel tension capacity is not exceeded. A careful consideration must also be given to the barge thrust in reducing the installation cost.

The design methodology adopted for ultra-deepwater pipeline systems is often based on the wall thickness and material grade selection that meet the maximum allowable bending strain, usually provided by the pipeline operators. The strain limit is normally based on the material strength and is usually set to a value in the range of 0.15% to 0.2%. For this reason the strain limit used for ultra-deepwater systems is often similar to the strain limit utilized in intermediate and deepwater depths, with seemingly no consideration to water depth effect on the installation load. The above design method is essentially based on the intermediate and deepwater experience, where in most cases the barge thrust is insensitive to wall thickness selection, and tension requirements are often within the vessel capabilities. For a selected pipeline examples however, results presented in this paper show that installation loads are sensitive to wall thickness solution when laying in water depths greater than 1,500 meters. The strain limit combined with the material strength is also shown to control the economy of the line pipe and installation cost. It is therefore, difficult to see how the above design methodology with no reference to installation loads can result in an economical solution.

This paper, seeks to combine pipe strength and stiffness characteristics with pipelay installation parameters to develop wall thickness selection charts that can be routinely adopted at the design stage.