Arctic Offshore Materials and Platform Winterisation

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ABSTRACT

Materials for fixed and floating structures in arctic environment must be designed for low ambient temperature. The offshore operating environment is also including sea ice, marine ice accretion and snow. The materials strength, ductility and wear resistance are challenged. Structural steels and steel for piping and pressure vessels for operating temperatures down to -60°C are needed, and the steel industry has a challenge to meet such requirements. At the same time the testing and qualification procedures should be improved to open for utilisation of new materials and welding procedures.

As operation in many cases is located in remote areas, the cost of maintenance and repair is more expensive, and the need for replacements, repair and maintenance should be minimised. Of particular importance is the corrosion protection by painting and cathodic protection.

The integrity and performance of the process system depends upon a good control of the temperature in the production and utility fluids. Therefore, insulation and electrical heat tracing of piping and process equipment is essential. The material selection must therefore take into account that large temperature variations can take place and that the maximum temperature associated with localised heating can be higher than normal process temperature.

Operation of gas production systems includes strict requirements to ventilation. Natural ventilation is not compatible with enclosed process systems unless very large ventilation systems are installed. Material selection for advanced heating, ventilation and air conditioning (HVAC) systems and combinations of natural and mechanical ventilation systems need to be developed for systems operating in arctic marine environment where sea spray, ice accretion and snow can cause problems. Ice repellent materials are attractive, but the long term performance of the materials is questioned.

The lecture will review the state-of art on these items and propose some ideas on the way forward.

KEY WORDS: Arctic; Materials; Winterisation; Steel; Welding

INTRODUCTION

The offshore industry is moving north. The operating environment becomes colder and the distance to civilisation and infrastructure is increasing. Activity is increasing in Alaska, North Canada, Greenland, the Norwegian and Russian part of the Barents Sea as well as eastern parts of Russia.

Offshore experience has been gained from Production in Alaska, Canada Barents Sea and Eastern Russia. Experience from onshore and shallow water developments in arctic areas is also of great value, but there are still technology gaps to be closed before many of the fields can be developed in a cost-efficient way. One problem is that much of the resources are gas. The cost of the field development is challenged.

With respect to material selection, the main strategy to keep costs down has been to stretch the limits for current offshore solutions. Very little R&D has been directed to develop new materials or new applications.

In the following, the main technical challenges are explained, the state of art regarding solutions is described and some ideas for alternative material solutions are proposed.

TECHNICAL CHALLENGES

Low ambient temperature

The most obvious challenge for materials is the low ambient temperature. All structural steels will suffer from reduced fracture toughness at low temperatures due to the ductile-to-brittle transition behaviour that is characteristic for all ferritic steel grades. This behaviour can be mitigated by Nickel alloying and cryogenic grades are readily available, but they are not competitive in price.

So far the solutions have been to stretch existing technology by fine-tuning the chemical composition by reducing carbon content and by advanced thermo-mechanical treatment. Dillinger Hütte developed an improved grade of their S450 grade steel to the Sakhalin II project with a minimum design temperature in the range of -30 – 35°C. Other steel suppliers claim to have steel for similar temperature conditions, but it is challenging to make materials for lower temperatures. The main problem is to maintain good toughness in the weld heat affected zone.