Tackling Flow Assurance Problems in Multi-kilometre Subsea Pipelines

As the search for oil and gas is extended, hydrocarbon products are being discovered in more difficult to access locations, sometimes at great distances from land and at significant depths in the oceans.

Michael Dicker, *Heat Trace*

Recovering that oil and gas now brings greater challenges. As a result, technology is developing quickly to provide more effective and economical methods to bring these hydrocarbons ashore for processing at an economical cost.

One of the challenges facing operators is the fact that oil and gas from the reservoirs needs to be maintained at elevated temperatures to prevent wax and hydrates from causing blockages in the flowline. Many crude oils contain dissolved waxes that can precipitate and deposit under the appropriate environmental conditions, whereas natural-gas hydrates are ice-like solids that form when free water and natural gas combine at high pressure and low temperature. This can occur in gas and gas condensate wells, as well as in oil wells. These problems are particularly relevant during a prolonged system shutdown of long tie-backs, when no-flow conditions exist and the flowline from the well cools to that of the surrounding sea temperature, usually around 4˚C.

One method used to overcome this problem has been to inject chemicals into the flowline to mitigate hydrate and wax formation. These chemical injection points can be at each end of the flowline, as well as one or more places along the flowline, depending on the seabed topography. However, in addition to the cost of designing and supplying the equipment capable of injecting these chemicals into the flowline, there is a significant cost attached downstream as a result of having to clean out these chemicals prior to refining.

A more efficient and lower cost option is to apply heat to maintain the pipeline above the temperature at which wax and hydrates can form. This is usually around 30˚C and below. Several heating solutions have been used in the past, such as skin effect current tracing (usually referred to as *"skin trace"* heating) and direct electric heating (DEH) which both use the actual pipeline as part of the heating circuit. However, both of these systems have proven to be inefficient and not ideally suitable for most applications. For example, as the skin effect system is primarily an inductive heating system, efficiency can be a low as 75%.

Now, another heating solution has been developed, successfully trialled and installed in the North Sea and is an efficient active heating solution to meet the challenges resulting from both deep water and shallow water applications for long heated pipelines.

The World's first electrically trace heated, reeled, subsea pipe-in-pipe (ETH-PiP) system was recently installed in the North Sea by Technip UK for Total E&P.

The Islay Project consists of an ETH-PiP flowline carrying gas condensate from the Islay reservoir wellhead, located approximately 6km North East of the existing Forvie Manifold. It is to this manifold that the Islay pipeline is connected.

The pipeline comprises a 6" flowline inside a 12" carrier pipe. The flowline is made from Super Duplex Stainless Steel, a material best suited for aggressive environments due to its resistance to erosion, corrosion and corrosion fatigue. When completed, the 6km of ETH-PIP was reeled onto the Apache II pipe lay vessel and subsequently laid on the seabed at approximately 100m water depth.

This World first electrically trace heated, reeled, subsea pipe-in-pipe system uses a specially modified Longline series resistance heating cable. However, the Longline system is one that has been successfully used onshore for heating multi-kilometre pipelines for over 30 years. This particular cable features 3 individually insulated metal conductors encased within a metal braid and then an outer insulating jacket. The three conductors are designed to have a specific resistance that, together with the applied 3 phase voltage, permits each of the four heating cables which are spiralled onto the flowline, to each operate from a single supply point, producing sufficient power/heat along the entire length to maintain the pipeline at optimum flow temperatures in excess of 30˚C.

ETH PIP Configuration