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Intelligent Coiled Tubing (ICT) for Completions and Flowlines

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Abstract

The primary objective of the system is that it enables the use of reeled technology to deploy highly sophisticated intelligent completions without any requirement for externally bundled control, telemetry and power lines.

The properties of the external tube and internal tube can be selected for the environment in which it will operate. I.e. it can be steel, duplex stainless, and beryllium copper, composite or even polyurethane. The sandwich layer may contain insulated copper cables for power transmission, or include fibre optics and embedded sensors for more sophisticated applications.

In an ICT completion, all electrical, hydraulic and telemetry lines would be isolated from the aggressive well bore environment at all times, being immersed in dielectric oil or a similarly inert fluid. This should provide significant reliability benefits over the lifecycle of the well.

Initially, the benefits of this technology will be realised through the development of intelligent pumping applications. If proven, the dual skin umbilical can be utilised to test and run such relatively simple electrically operated completions. However, in the longer term, significant benefits of this technology will gradually emerge as it brings down the capital costs of intelligent completions and and also subsea flowlines and riser systems.

Financial**,** as a direct comparison with coiled tubing deployed ESPs it has been estimated to be 32-35% cheaper to manufacture, therefore for an existing proven system it is more cost effective and offer additional benefits. If compared with externally strapped conduits for SMART wells, cost savings in the order of 49-58% can be demonstrated.

Introduction

The basic concept is simple.

Sandwich electrical, hydraulic and optical conductors into the annular space between two concentric coiled tubing strings and then swage, or pressure expand the diameter of the inner coil to lock these conductors in place in the annular gap.

There are some key technical considerations that will be investigated within the project to determine if the dual skin coil can be successfully implemented in the field. These include, material specification, spatial configuration, bore requirement, dual skin coil fatigue profile, differential expansion, connectors and splicing, technoeconomic analysis and weight constraints.

The size range being considered includes the options for both annular and internal production paths. Figure 1 illustrates the range of sizes which will be considered for manufacture, and which are possible to produce using commercially available equipment.

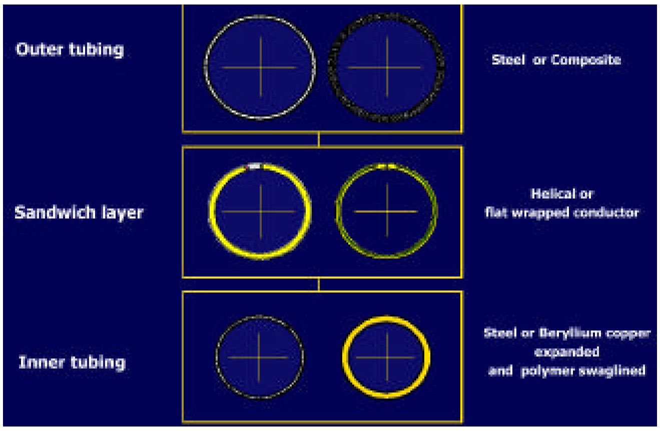

Figure 1

The manufacturing process is quite straight forward. Figure 2 illustrates this and the resulting sandwich of electrical conductors between inner and outer CT members.

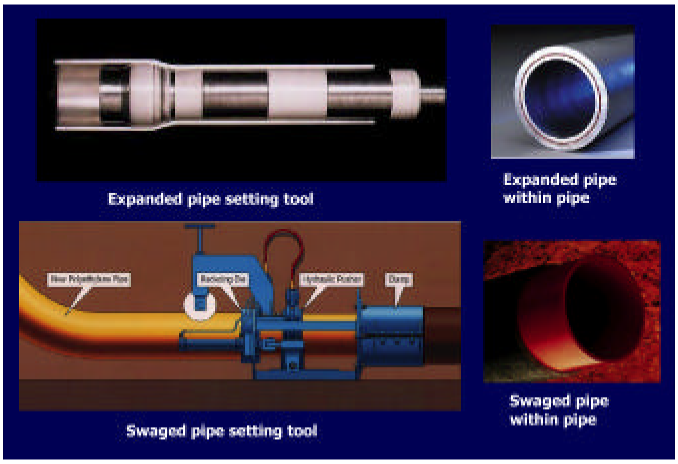

Figure 2

Figure 3 illustrates some of the conductor configurations that are being considered. These are based upon a layer of conductive material being sandwiched between insulating material. The 'sandwich' may also contain fibre optic and hydraulic control lines as well as copper, or other, conductors. Clearly, there are alternative configurations which will be considered.

Figure 3

The need is clear for a simple, reliable, rapidly installed connector to join sections of the dual skin umbilical together. Mechanically the same strength as the virgin pipe is essential, with matching electrical and communications ability. Several possible solutions are currently under evaluation. Figure 4. is shown by way of example.

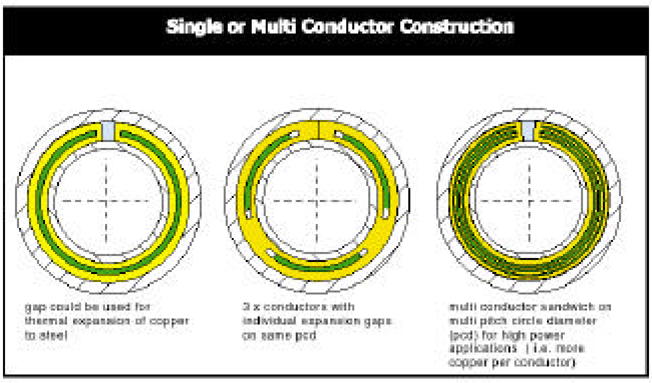

Figure 4

Current Activities

Two specific versions of ICT are currently in engineering.

Flowline / jumper system (figure 5 and 6)

This is an integrated flowline and umbilical for rapid development of subsea satellite developments. Both internal and ex-ternal tubes are seam welded coiled tubing, and incorporate many features unique to coiled tubing such as internal friction reducing coating, internal insulation coating, low cost and commodity availability.

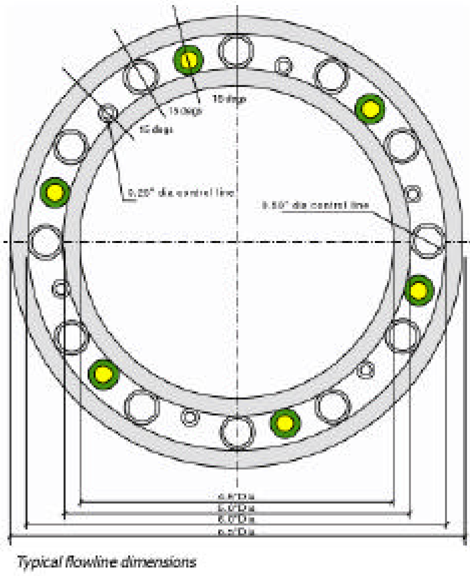

Figure 5

Figure 6

The product benefits from dual pressure barrier construction, increased mechanical protection from the external environment and embedded sensors to provide accurate deployment from the lay vessel and lifetime monitoring while on the sea-bed.

The embedded power cables can be powered up to heat the flowline on completion of pipelay, this pretensions the flowline and helps to avoid upheaval buckling problems, once production fluids enter and heat the line. Other hydraulic lines in the umbilical provide the option of metering additives, or supplying hydraulic control functions to the wellhead.

The following bullet points summarise the products main features;

- Dual skin, steel external and steel internal.
- Reduced overall lengths and optimised installation / burial costs
- Integrated heating, power transmission, additive metering & distribution and data transmission / acquistion.
- Integrated flowline monitoring options
- Internal ceramic coating provides insulation, reduced friction.
- External coating provides corrosion protection

This system may also have specific relevance to Steel Catenary Risers (SCR's) and Manifold wellhead jumpers.

Intelligent Well Umbilical (figure 7)
This version of ICT provides encapsulated electrical power cable and hydraulic control line into the production tubing which can be employed for deploying

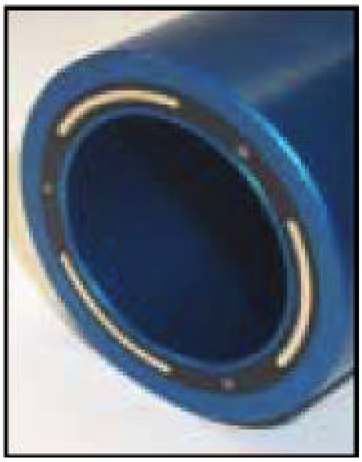

Figure 7

It combines, the flow means, a high power/voltage conduit, heating means, hydraulic functionality and the option to include fibre optics.

This provides the opportunity to lifetime monitoring, improve the placement and protection of sensors along the length of the tubing operate downhole sliding sleeves, chokes, etc.

In its hybrid form, it can be combined with composite materials, which will reduce the unit weight, provide additional buoyancy, while maintaining a steel pressure containment barrier.

The following bullet points summarise the products main features;

- Dual skin, steel external and steel internal.
- Simplifed hanger design.
- Integrated heating, power transmission, additive meter-ing & distribution.
- Integrated monitoring.
- Internal ceramic coating provides insulation, reduced friction.
- External coating provides corrosion protection.
- Few couplings or connections
- Reduced overall capex / optimised Opex

Summary
Intelligent Coiled Tubing, or ICT:

1. Represents an immediate, reelable solution for Intelligent Well Completions, flow lines, SCR's and operation of large band-width high electrical power devices.

2. Allows for live well deployment and retrieval of completions;

3. Reduces dependency on externally strapped power and hydraulic lines;

4. Increases reliability, flexibility and integrity of electrohydraulic conduit for lower cost (up to 55% material/installation savings) than comparable rig-deployed IWC infrastructure;

5. Increases functionality of reeled completions to same level as intelligent jointed completions;

6. Allows a wider variety of workover operations to be CT based, particularly with the advent of new generation well intervention vessels.

7. Dual skin coils can be produced for a fraction (estimated 60-80% savings) of the cost of embedded composites, and

7. Makes use of proven steel connector and cable splicing technology.

9. May also be applied to subsea pipelines, flowlines, SCR’s and manifold jumper systems.

References

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