

Intelligent completions: Potential, but some hurdles

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INTELLIGENT COMPLETION (IC) is the term used to encompass the use of products and technologies for monitoring and controlling reservoir performance, without having to deploy a rig or mast to alter the physical configuration of the well.

A strategy of minimum intervention can reduce the economic and HSE risk associated with oil and gas production.

The key driver of the development of intelligent completions is economics. Easily recoverable reserves are becoming harder to find. To replace depleting reserves and meet future demand, operators must explore deeper formations. And deep-water plays, many in geographically remote locations, have relatively small reservoirs.

For these plays to be economic, the way the reservoir is managed must change.

The industry has always known how to optimize economic value through active management of the reservoir, but has never been really pushed to implement it. Technology is seen as a driver, but this technology has been driven by the need to clear new economic hurdles; hence the impetus to develop the intelligent completion concept.

Operators are focused on two main areas: maximizing and accelerating production and minimizing and eliminating intervention. Current technology tends to result in delayed production and hence lower Net Present Value (NPV). Operators want to accelerate production to realize the economic benefits as soon as possible.

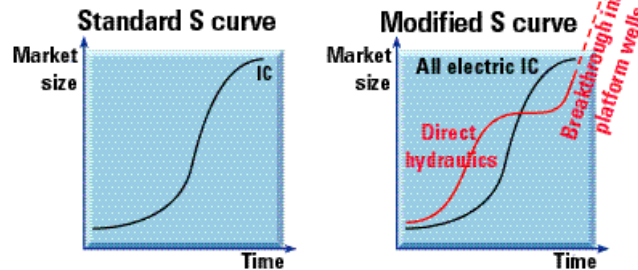
As the well life cycle progresses, the well will also require numerous interventions to collect data (reservoir characteristics) and subsequently to close out or open up new zones. These interventions can be the single biggest cost over the life of a well.

They are expensive enough on normal completions, but on the new remote sub-sea plays, intervention needs can make the field uneconomic.

With operators seeing the economic advantage of the IC well, the industry soon got excited about the opportunities for a step change in completion philosophy and well/reservoir management. The geographical areas of Brazil, Norway, West Africa and the Gulf of Mexico have been identified as hot spots for IC.

The market for intelligent completions has been estimated at \$800 million to \$1 billion over a 5-year period.

Figure 1: IC development



Ultimately, operators will be looking for uninterrupted online data that can be used for analysis of the well and reservoir performance. From this, operators will be able to make very quick decisions on what should be done to optimize well performance.

Some of the specific reservoir applications involve control of zonal drawdown and production rates; optimization of stacked or commingled production; re-injection for artificial lift; and the ability to prevent cross flow in multilateral and horizontal sections.

The analysis could provide, on demand, pressure build up analysis, and related inter-zone, or inter-well, interference testing.

Operators have some specifics they expect from IC technology, including:

- Data reliability of at least 90% over a 5-year period;
- The ability to segregate and regulate flow at each zone;
- Variable flow valves and delta pressure and temperature measurement at each zone;
- Easy integration into existing completion technologies;
- Minimal impact on packer, wellheads, tubing hangers, and Christmas trees.

THE MARKET PLAYERS

The market size figures being discussed and the “game changing” nature of the IC business has attracted a number of players from the various original technology suppliers.

Some of the early work was done by **PES** in developing their sleeve technology. This, in turn, was strengthened on the completions side by the marriage with **Halliburton**.

Schlumberger has used the Camco sleeve completions technology, wedded to their existing permanent monitoring experience to develop their system. **Baker Hughes** has used its completion expertise and married it with our sleeve technology.

TECHNOLOGY & BENEFITS

The basic technology features required by the market can be broken down into completion equipment (including flow control devices), power monitoring and communications.

These all exist in some form, but needed to be modified and packaged appropriately to create an IC.

In some areas, any well with data monitoring is termed smart or intelligent; however the new IC philosophy goes further. The real measure of an IC is its ability to facilitate both downhole control and measurement.

The benefits of IC are focused on the delivery of production management flexibility. The IC should allow operators to fine-tune well production so that they achieve optimal depletion of the reservoir. The accompanying reduction in interventions should have a positive impact on cost and NPV.

Reduced interventions can also reduce well risks by removing difficult well operations which could compromise well integrity, and increasing safety performance by removing personnel from these operations.

The three big players in IC come from a completions background and have leveraged their expertise to develop sleeve and communication technology in order to offer a complete service.

However this service cannot be considered complete in all cases. Outside of the big three, there are new entrants such as **Weatherford** and **ABB** who believe they have technology of value to IC operations.

There are also smaller players in the market who use sleeve design expertise to offer differentiation.

The Expro Group can also bring significant permanent monitoring experience to the IC industry. The Group's expertise is in providing state-of-the-art communication systems, which include a decade of experience in downhole electronic sensors, telemetry systems, data interrogation, and management systems.

The key differentiator for the Expro Group is the Harvest system which provides a fully addressable digital multi-channel architecture. This system will allow up to 256 nodes to record, interrogate, and control downhole processes on a single cable.

This is where some of the interesting questions in IC come into play. The market power appears to sit with the big service industry completions providers who want to offer total IC solutions.

However, the existing industry has proven players in communications, for example, who may have systems already in the market that can achieve the requirements of the operators' IC needs.

Although the big players want to offer a full service, it may not make sense to develop their own systems. They may instead prefer to ally with existing suppliers to fast-track proven systems to the market.

THE STORY SO FAR

The supposed golden era of IC is not yet with us.

The traditional 'S curve' (Figure 1) which should have heralded the UK £1 billion market over 5 years has not yet taken off. Nevertheless, the industry remains confident that the IC takeoff is just a matter of time.

The recent downturn in the industry

and the reduction in oil price had a major effect on IC. Although IC is heralded as a cost saving technology of the future, it requires strong oil and gas markets to facilitate introduction.

Most firms that hope to offer complete services have invested heavily, not only to upgrade their existing portfolio of products but also to enter what, in some cases, represents completely new business areas.

At the same time, various industry initiatives have focused on supply chain management which, in turn, leads to commoditization and standardization discussions. Where companies are investing in new technology, particularly aimed at the electric side of IC, then the parallel focus on supply chain management and cost reduction represents a dichotomy of views that the industry must confront.

This dichotomy can be highlighted by the efforts to standardize on hardware, power and communications protocols within IC.

The struggle at the moment appears to be between the major IC and control vendors. Both see the potential of the technology and both see the need to control all aspects and thus provide a total offering to clients.

The client on the other hand wants the total solution approach, but does not want to be tied to one particular supplier. This has driven the initiative to establish standards across IC which will, in effect, allow the mix and match of IC vendors' offerings.

While most IC players agree on the need to standardize to an extent, all are unwilling to lose their market differentiation and perceived competitive advantage. This is understandable given the investment to date in IC. It could be argued that full standardization would lead to commoditization of the IC market, which may in turn lead to a dearth of new investment and innovation.

The approach by the major IC vendors in having a number of standards would be more satisfactory for the industry rather than total commoditization. But this, too, may have its drawbacks in creating barriers to entry for new small-sized technology enterprises.

In the drive for continuous improvement, and ultimately lower finding

costs, the industry must create avenues for small and niche players to come forward with technology solutions.

THE IC FUTURE

The future for IC can be best described as uncertain. The economic rationale is clear, yet field application of the technology will depend on oil price.

Once this technology gets into the field it must deliver the benefits sold. If this can be achieved then even a drop in oil prices should not adversely affect the take up of the technology, as the cost/benefit will be apparent.

The shakeout of players in the industry will also prove to be interesting.

The major IC players may choose to focus on the all-electric high end of the market. The goal here will be an integrated system which allows operators to remotely control all aspects of the well.

The development of e-business technology will also have a significant impact on this area of the business, where data and its subsequent use will be critical.

The major players may well go it alone on the all-electric systems, but relationships with key technology suppliers may be more likely as the competition in the market drives them to fast-track through reliable solutions.

The industry will also probably see a different curve for the direct hydraulic ICs (Figure 1). The more basic architecture of these systems means it is easier for small players to club together and offer a low cost solution to a client.

This approach may ultimately result in the IC technologies being adopted, not only in remote subsea locations but also on more standard completions.

On the sensor side, the vast array of measurements will continue to grow. Expro is already offering pressure, temperature, flow, and water-cut using the Harvest architecture.

The system allows easy addition of further sensors on the same basic architecture and valve position, multiphase flow, corrosion monitoring, and sand detection sensors are all being developed.

Others are working on sensors such as water flood and seismic which will ultimately lead to the total reservoir monitoring concept operators envisage. ■