Industry takes steps
to monitor, control subsea processing

Milton Korn of ABS explains how industry is monitoring well conditions and fluids for efficient and safe production.

The task of monitoring and controlling operations is difficult onshore, and when subsea drilling and production are taking place in ultra-deep water, the complexity and magnitude of this task is compounded several-fold. Monitoring and control concerns are moving to the forefront now that previously unreachable reserves are being recovered and particularly when the percentage of recovery is increasing toward 50%.

Expanding needs

With the discovery of deepwater reservoirs, operators are expending great effort planning the development of their fields to do more with less, to maximize the amount of oil recovered from each field as well as the rate of recovery from individual reservoirs. Fields can include multiple reservoirs that can be spaced over an area as large as 100sq km or more with multiple production wells and additional wells for stimulation and re-injection.

Production wells are connected to a subsea collection network that spans the field. Operation of valves and pumps, etc., controls the movement and manipulation of well fluids as they are processed as necessary to facilitate transport to the surface or tieback to shore. Each of these wells while in production requires monitoring for effective control. Some wells include electric submersible pumps to help lift well fluids to the sea floor level, and stimulation and re-injection wells have their own subsea piping network.

The extensive geographic coverage of modern ultra-deepwater fields and the large number of systems and equipment being deployed to the sea floor is increasing the volume of monitoring and control information that must be exchanged. Monitored information can include temperatures, pressures, flow rates, well fluid viscosity, etc. both down hole as well as at various points in the subsea collection network, risers, tie backs and processing equipment. Control information and signals might extend to the position of valves to shut in a particular well, valve position control to direct flow, valve position modulation to control flow rates, the starting/stopping and speed control of pumps and compressors, pipeline heating, and the control of subsea processing and separation equipment.

The proliferation of subsea monitoring and control information manifests itself in several ways. The repetitive sample rate of select individual channels is increasing along with the overall bandwidth requirement as the number of individual channels of information dramatically grows. The ability to reliably exchange information and transmit and receive control commands without corruption over the great distances envisioned in fields with tiebacks extending hundreds of kilometers is of paramount importance; safety and shutdown systems including BOPs and HIPPS (high-integrity pressure protection systems) are critical.

Wired vs. Wireless

Choosing between wired and wireless subsea communication is a matter of great importance, but the decision is not straightforward.

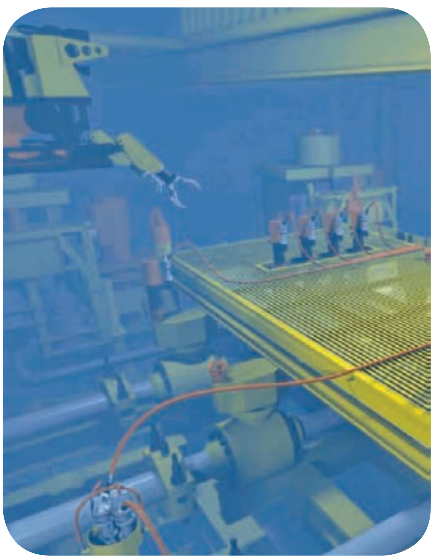
Long-distance "ocean bottom cable systems" are wired solutions that can be pneumatic or hydraulic. The challenge with these technologies is that they can be limited by the great distances and depths. Other wired solutions include copper and fiber-optic systems, which use proven technologies that are firmly established in the scientific community and are likely better choices.

The great bandwidth, immunity to interference and noise, and the ability to carry information over long distances with minimal attenuation make fiber optics a preferred choice for communications. One of the challenges to the full deployment of fiber-optic communication in the production environment is the development of wet-mate, fiber-optic connectors for use at depth that can be readily manipulated by an ROV. Allied technology is regularly covered at the bi-annual IEEE Symposium on the Scientific Use of Submarine Cables and Related Technologies. Manufacturers that have established solutions for scientific applications are transferring the technologies to the offshore production environment.

Long-distance copper-based electrical communication is possible; however, it is susceptible to more interference and noise and exhibits greater signal attenuation than is encountered with fiber-optic communication. Copper-based electrical systems possibly could require additional repeaters (amplifiers) along the length of the communications line than would be needed in a fiber-optic system and consequently would be more power intensive. In many cases, the communication line can be included as part of a subsea power cable from shore, integrated into a flow tieback or umbilical.

The International Cable Protection Committee (www.iscpc.org/) provides many resources on long-line submarine cables. The wet-mate connectors used for copper communications are not envisioned to be covered by the draft standard for wet-mate power connectors being developed by the Subsea Electrical Power Standardization (SEPS) Joint Industry Project (JIP). At present, the operating voltage is envisioned to range from 3.6kV to 36 kV.

Wireless communication is an option for certain applications that may apply diverse technologies: acoustic, radio frequency, and free space optical. The Subsea Wireless Group JIP is building on the efforts of many early pioneers and contributors to transform the concept of subsea wireless into reality. Various wireless technologies exhibit different capabilities with regard to effective range, data rate, immunity from noise and electro-magnetic interference (EMI), and power requirements.



Some wells include electric submersible pumps to help lift well fluids to the sea floor level.

Acoustic communication is well established within the subsea control field and often is considered as a backup technology for communication and control of BOPs and other similar devices. It also can be used for low-data-rate telemetry. The effective range of acoustic communication and control system could be on the order of 10km; however, as mentioned, the data rate is very low. With "spread spectrum" encoding techniques, acoustic signals are quite immune to interference and with low energy at any one particular frequency are not likely to be harmful to marine mammals and other marine life. Radio frequency communication is effective at much shorter ranges and within the effective communication range offers much higher data rates than acoustic communication schemes. Free-space optics offer the highest bandwidth and are immune to EMI, but are susceptible to interference from turbidity and require more accurate alignment of the sender and receiver.

The use of "hybrid" systems for communications, monitoring, and control allows for placement of technologies in their "sweet spot," allowing hardware and communication strategies to be optimized for maximum communication life, and reliable and repeatable communication system performance. Some wireless techniques envision piggybacking communication and control signals between devices to achieve the data rates and ranges required to effectively communicate with a central "hub" that would collect/distribute information to and from an FPSO and the shore. Wired techniques would be used for long-haul communications to an FPSO or to shore.

R&D targets subsea

The push for subsea development options has led to R&D efforts across the industry aimed at finding technical solutions for the challenges of subsea applications.

Engineers at ABS are among those looking for innovative solutions. In-house investigations are examining the characteristics of electrical insulation systems for electric submersible pumps and other subsea pumping and compression applications where the insulation system is in communion with high-temperature, high-pressure corrosive well fluids. Other subjects of interest include thermal management of permanent magnet machines, and simulation and analysis techniques for subsea power transmission, distribution, utilization, and control networks.

ABS has organized recent discussions on the topic of subsea electrification (subsea_electrification@eagle.org) and is interested in expanding R&D efforts through industry partnerships that address additional areas of subsea research.

Looking ahead

A major challenge for wireless communications is providing for and managing the energy and power required. In some instances, it may be possible to connect a device directly to a wired subsea communication and control power network – networks such as this are likely to operate at voltages below that of the electrical networks used for subsea electrification.

A more attractive option is for wireless energy and power transfer between the subsea communication and control power network, using inductive coupling. For short-term deployment, it could be possible to use a battery attached to the device. For longer-term deployments, energy and power consumption need to be managed carefully.

The industry is working to move subsea communication forward with considerable R&D investment. These systems, when mature, will help move oil and gas development into even more remote and harsh environments.

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