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Well testing has been cited as one way to ensure that the investment of a company’s time and capital has been justified and is sustainable in the future. With accurate test data, acquired through an appropriately designed testing program, the critical information necessary to characterize a reservoir and establish well deliverability is presented. But even the best information in the world can be useless unless it can be presented to key decision-makers in time and in the correct format. Time is the keyword. The principle of well testing is to produce a pressure disturbance in the reservoir, then analyze its transient response. Many times a test that is an operational success – everything worked as intended – can turn out to be a practical failure, simply because the dynamic pressure transient measurement was terminated prematurely or prolonged unnecessarily. Test data, if supplied in a timely fashion to reservoir engineers, can allow them to recognize problems in the test procedure or results in time to take remedial action to recover from what would eventually be described as a "successful failure."

**North Sea scenario illustrates the point**

Centrica Resources Ltd. operates the Grove gas field in the UK North Sea approximately 133 km (83 miles) east of Great Yarmouth. Discovered in 1971, Grove has been producing up to 50 MMcf/d of natural gas from two wells since 2007. Because of increasing demand, an extension of the field was initiated in 2008 with a four-well drilling program that targeted previously untapped reservoir volumes. A concurrent well testing campaign was designed with the objectives of cleaning up all the wells and determining the reservoir deliverability as well as its extent.

Centrica and Schlumberger recognized that the biggest risk to achieving the test objectives was inconclusive data. Even if tests were designed with the best intentions, only evaluating actual reservoir dynamics while testing could provide the necessary confidence in the results. Among the challenges were to improve production handling capabilities and separation efficiencies, enable real-time data monitoring and evaluation 24/7, and provide the ability to change acquisition and test programs on the fly to ensure that test objectives were achieved. In essence, the company wanted zero inconclusive tests.

The scenario presented both technical and logistical challenges. A clear benefit of real-time data acquisition and transmission is the opportunity to concentrate expertise at a single point to facilitate analysis and the decision-making process. With the advantages of global connectivity, the single point could be real or virtual as long as seamless collaboration of critical expertise was achieved.
Technology played a key role as well. The ability to deploy the latest measurement technology allowed experts to visualize the acquired data along with the manual readings, which provided enhanced understanding of actual well operation conditions. This allowed adjustment of the test program to the actual well or reservoir performance instead of blindly following a pre-established program.

This approach does not de-emphasize the importance of a well thought-out test plan, however. It provides a way to detect and evaluate any deviation from the original design or expectations, allowing users to facilitate intelligent contingencies or take corrective action.

**Real time is not a ‘buzz’ word**

The concept of providing data in real time, or near-real time, had its origins in the early 1970s, driven largely by the mounting costs of offshore rig time. Some of the first users benefited from radio communication of well log data direct from offshore rigs to offices onshore. While moderately successful, the growing popularity of the practice highlighted several challenges:

- Software tools were not available to make efficient use of streaming data;
- Users experienced excessive time in manual data preparation and difficulties in synchronizing transmission with interpretation – changing data into actionable information;
- Conventional well test interpretation used static test data and could not handle dynamic data;
- It was not possible to efficiently integrate streaming test data into conventional reservoir engineering software programs; and
- There was a general lack of communication between operations personnel and reservoir engineering groups that seriously impeded timely decision-making.

It could be seen that merely providing real-time data streams from the well site would not solve the problem. There is an engineering approach to real-time operations that transcends data transmission.

**Customizing practical workflows**

Schlumberger presented to Centrica engineers a testing infrastructure that was developed to handle, store, and render all relevant data, including data from third-party sensors.

High-speed secure Internet connectivity was supplied by deploying satellite communications terminals to well sites. The ability to deliver quickly the massive datasets was provided by Schlumberger’s global network connectivity and collaboration system with more than 37,000 users around the world. This latter capability secured virtual collaboration of experts from their individual locations in real time.

Special processes for handling the data were developed. These included integrated workflows to eliminate the need to wait for final data, some of which are only available after the test string is pulled out of the well. Often there are indicators that a process needs changing before all the data are in, and bringing real-time monitoring into play allows changes to be made “on the fly” as requirements change.

In the test environment, early indicators derived from real-time data can suggest the need to change choke sizes or sampling times. Flow simulations across the surface test spread can predict hydrate formation issues and safety effects like erosion of pipework; hence, remedial actions can be taken. In instances where real-time bottomhole pressure and temperature are unavailable, these parameters can be estimated using well-known engineering software and streamed into the workflow. This allows the test to be evaluated in real time. Later, when actual data becomes available, it also can be integrated into the models, allowing final interpretation to be performed.
Monitoring hydrate potential with remedial methanol injection solutions allowed engineers to be prepared to deal with hydrates should they appear.

Where required, Schlumberger can provide real-time operation support centers (OSC) linked by secure satellite communications to support the concentration of expertise. In certain cases, portable OSCs can be set up in client offices to provide temporary capabilities. Knowledge management is the key to successful real-time well testing. Defined as the totality of relevant knowledge on a subject, coupled with global connectivity, knowledge management takes the guesswork out of complex processes and allows parallel solutions to be implemented.

**Testing campaign on the Grove field reservoir**

Hydrate formation is always a major concern in a gas and gas-condensate environment because potential risks can lead to significant operational delays. Even though well temperatures were generally above the hydrate formation threshold, it was deemed prudent to monitor temperature continuously and provide the capability to inject methanol if needed. Required methanol injection rates were determined on the spot to eliminate hydrate formation problems.

While flowing the second well on a fixed 60⁄64-in. choke, unstable production behavior was observed. This failed to meet the stable flow criteria specified in the test program. Without delay, the separator flow-rate measurements were cross-checked using choke performance correlations for dry gas. Following the recommendations from the experts onshore, several base sediment and water (BSW) manual readings were performed to confirm the measurements at 20% to 30%.

Additionally, the water vapor content of the natural gas and the expected condensed water rates were calculated using various correlations. With all these data, the flow production regime was simulated. The results indicated a high-frequency slug flow condition existed. Experts agreed that wellhead pressure and temperature could not be stabilized to the level specified in the test design. A collective decision was made to start surface sampling immediately. By multitasking while pressures stabilized, valuable rig time was saved that would have been lost had operations been performed sequentially.

Obtaining real-time bottomhole flowing pressure was another concern on this campaign. Sometimes the downhole data cannot be accessed in real time, so provisions can be made to compute bottomhole pressure with reasonable accuracy using surface measurements. This can be used to allow engineers to perform a quick-look well test evaluation necessary to continue the test without surprises.

On another well test, once the well was cleaned up, it was shut in for buildup while the progress of the calculated bottomhole pressure was monitored and interpreted in real time. This allowed Centrica engineers to optimize the test duration long enough to provide conclusive results but not so long as to waste valuable time.

The initial buildup interpretation was carried out, and the results of forward modeling were compared with the actual well performance during the three-step-rate test. The good match added confidence in the initial interpretation results. In light of the test results, the final buildup period, which was planned to be 12 hours long, was cancelled and the rig moved to its next location.

The ability to make rapid critical decisions is essential in today’s dynamic oilfield environment. These are facilitated by flexible workflows, real-time data acquisition with backup procedures, and global connectivity. Establishment of a collaborative environment is crucial – a post-script to the “successful success.”

This article is based on paper SPE 127909, Remote Real Time Well Testing – Experience in the Grove Gas Field in the North Sea. Data courtesy of Centrica Resources Ltd.