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## **Subsea Deployment of Instrumented Sand Screens in High-Rate Gas Wells**

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### **Abstract**

Arrays of miniaturized temperature sensors were deployed in the lower completion of six subsea wells in Southeast Asia. The novel system allowed the operator to perform batch completion of the wells. A mechanical fluid loss control device included in the lower completion and a temporary plug set above the lower completion after gravel packing enabled the operator to return later with the upper completion. Upon deploying the upper completion, acquisition was activated and cleanup data were transmitted, allowing the operator to monitor flow from individual reservoir zones. Subsequently, production data have been transmitted in real time to the operator headquarters from an offshore production platform, allowing continuous reservoir modeling.

Key to the communication success was the use of mating inductive couplers, with the female coupler just below the gravel-pack packer and the mating male coupler at the bottom of the upper completion. This coupler has been proven reliable in the presence of standard field operations. In some cases, there were multiple activations of the coupler, and all were successful.

Success of the overall system required that each interconnecting component and interface work as designed. For example, each temperature sensor was designed to land on a blank section of the sand-screen joint above the coupling. A special coupling clamp secured each sensor. The intersensor spacing was designed to be slightly longer than the longest anticipated sand screen. At each joint, a rig device applied a small S-shaped bend to the cable between the sensors. As the bend was formed, this shortened the intersensor spacing for precise onsite depth adjustment.

Similar attention to detail was expended on cables and rig handling. The cable allowed inline splices using a welded seal technique adapted to this specific deployment, the first field deployment of this technique. Significant effort was expended in weld development and testing, but nonetheless there were opportunities to continuously improve on process components such as cable handling and splice preparation.

The proven robustness of the system has led to alternative completion configurations such as monitoring the sandface of wells using electric submersible pumps for enhanced recovery.

### **Introduction**

There are significant challenges to deploying sandface measurement hardware in a subsea environment. These require specific attention to the overall system design, especially when the well includes a dual-stage completion. At the heart of all sandface measurement systems is a requirement for robust and reliable communication to power the reservoir-monitoring hardware in the lower completion. Such a communication method has been deployed in six subsea wells. The use of inductive coupling technology provided a hermetically sealed, wet-mate connection with bidirectional communication and efficient power transfer. The coupler design was integrated into the overall completion and allowed a batch deployment operation, wherein the lower completions were gravel-packed, and the wells were subsequently suspended with a mechanical fluid loss control device and a temporary plug. The coil of the outer inductive coupler (female) was deployed with the lower completion, just below the gravel-pack packer. The upper completions were landed later, deploying the production string jewelry, which included the coil of the male inductive coupler. No orientation was required for correct engagement. After engagement, a contraction joint in the upper completion was activated and the tubing hanger landed into a horizontal tree. Once the penetrator was extended successfully, data were transmitted for well cleanup and subsequently transmitted during gas production. Some of the wells in the field used sandface measurement; others used a more traditional monitoring setup with downhole quartz gauges. The sandface data are amenable to standard temperature interpretation techniques (e.g., Curtis and Witterholt, 1973) to monitor flow contributions from major producing zones. No modifications were required at the tree level to support the temperature array. The coupler and temperature array system have been described elsewhere (e.g.,