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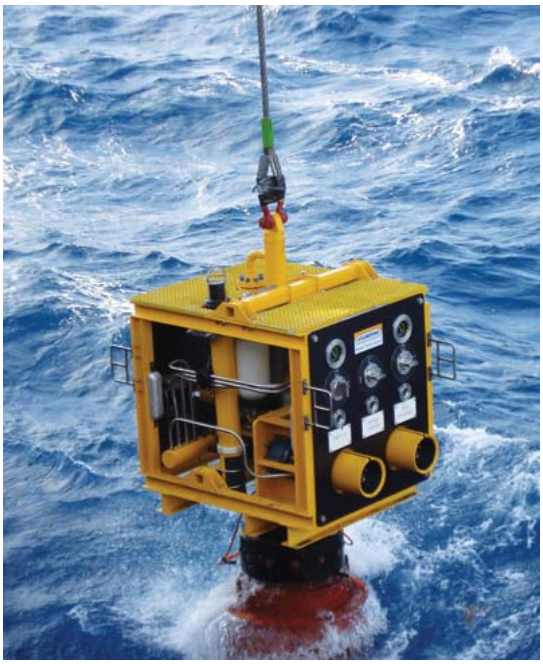
Intervention is necessary to maintain production levels, but when workover rig and vessel day rates are high, the costs can sometimes outweigh the benefits.



The acid injection tool being deployed in this photograph measures 85 in. high by 54 in. wide and weighs 6,500 pounds in air. It can be deployed by virtually any MSV davit crane in most operable sea states. (Images courtesy of Oceaneering)

The economics of well intervention are straight forward. A well requires stimulation, either scheduled or not, when daily production begins to drop. As with all offshore activity, rig availability is a key cost factor. If a workover rig has to be brought on site to drop and connect a riser system so that intervention can begin, the cost of the operation goes up. Even when the barrel price for oil is high, cost is a major consideration.

The deepwater technical solutions group at Oceaneering was enlisted by a major operator to devise an alternative method for injection stimulation in deep water so that large, expensive, and scarce surface assets could be replaced with smaller, less expensive, and more readily available multiservice vessels (MSVs).

The solution evolved in the form of a subsea acid injection tool deployed from a relatively small vessel. An MSV can carry out the process in lieu of a rig and riser. The MSV is outfitted with 13?4-in. dual coiled tubing units, 150-ft (45.7-m) flying leads with attached “cobra head” connectors, the acid injection tool with attached subsea tree running tool, and sufficient chemical capacity to complete the reservoir stimulation.

Technology makes the difference

The ability to quickly address stimulation needs benefits any operator’s production model. The faster the intervention work can take place, the faster production can be returned to peak levels. If an MSV inclusive of a remotely operated vehicle (ROV) system and specialized tooling can perform a well intervention in a timely manner, the operator has the additional choice of taking advantage of available vessel schedules to reduce project costs. Fluctuating oil prices could even be factored into planning, and rig availability would no longer control intervention schedules.

When this novel MSV-based system was initially deployed, rigs were scarce, and

availability came at a steep price. Day rates for suitable MSVs, which were also in high demand at the time, were much more favorable, and highly capable vessels inclusive of the ROV systems were accessible.

The system at work

The novel intervention system runs from the vessel to the wellhead. The ends of the coiled tubing units are ballasted with clump weights to assure proper descent and stabilization over the working area. Before deployment over the side of the vessel, the flexible flying leads are attached to the coil, and the “cobra head” connectors are checked. The flying leads are long enough to accommodate vessel heave and position deviation while allowing ample room for the ROV to access the front panel on the injection tool. During the actual project, a 150-ft (45-m) length of hose functioned without incident.

Dual coil tubing units addressed safety concerns and the need for increased chemical volume. Dual 13?4-in. coiled tubing units provided ample flow while maintaining a lower deck profile. It would have been impractical to use a single large-bore coil unit because of its larger footprint on deck and higher center of gravity, which is prohibitive on smaller vessels. Using the larger unit would have limited the operator once again to large, costly surface assets. Using dual units also has the advantage of allowing for fast and easy chemical purging from the tubing once the stimulation is complete. It is unadvisable to retrieve coil onto the deck while it still contains stimulating chemicals.

Using two units allows the operator to bullhead water through one unit and up through the other unit, which purges both units of chemical at the same time.

The acid injection tool used in this operation measures 85 in. high by 54 in. wide and weighs 6,500 pounds in air. The relatively compact size allows virtually any MSV davit crane to deploy the tool in most operable sea states.

Once the tool is lowered to within range of the subsea tree, the ROV guides the tool into place and locks it. Designed for flexibility, the acid injection tool is capable of operating with virtually any tree running tool on the market. The panel on the front of the tool is used to operate the tool. Full wellbore access is available once the tool is locked onto the tree using ROV hydraulics (5,000 psi required).

Once the tool is in place, the ROV locates the ends of the suspended coil tubing and grasps the cobra head connectors. Both connectors are flown to the tool and connected. Once the connections are pressure tested and verified, stimulation chemicals can be pumped into the well bore at up to 10,000 psi.

With safety a concern throughout the tool design process, system disconnects and shutdowns were built for maximum reliability and redundancy. If an unforeseen emergency necessitates disconnecting the leads from the tool, two API PSL level 3 compliance valves are available. The first valve is manually actuated from the front panel by the ROV. If for any reason it malfunctions, cannot be actuated, or cannot be reached by the ROV in time, the second valve can be remotely actuated via acoustic controller.

Either method causes the two nitrogen filled accumulator bottles onboard the tool to discharge and shut the valves. A unique feature of the tool is that the accumulators can be refilled subsea so that the system can be reconnected and work restarted.

Once the valves are closed, the well bore is completely and safely shut in.

It is important to note that closing the emergency valve causes the flying lead connectors to be jettisoned from the tool. Poppet valves in the connectors eliminate fluid leakage from the connectors should an emergency occur. The features of this system allow a vessel to completely disconnect from the tool and leave the area should the vessel encounter rough sea states, mechanical failure, or loss of dynamic positioning. These incidents, although rare on any vessel, occur more frequently with smaller vessels than

large rigs. Because the system was designed with smaller vessels in mind, the system was designed to address this point. Upon returning to the work site, the vessel can reconnect without difficulty. No trips to surface are required.

In the case of this particular project, the tool succeeded without any major problems or delays. A total of 40,000 gal of chemical was injected through the tool with an average flow rate of 5.2 bbl/min. Production increases were on par with that of a conventional stimulation job. Oil production increased from 2,500 b/d to 4,000 b/d, and produced gas increased by 3 MMcf/d.

Necessity sparks creativity

This system typifies the results of thinking outside the box on standard industry subsea intervention practices. Pressed with the issue of reducing the time and money involved in using the large surface assets previously required to conduct stimulation operations, engineers conceived an innovative tooling package for an ROV-equipped MSV.

The future of deepwater oil and gas production holds the potential for accomplishing many subsea tasks with similar methods and tooling. Other intervention tasks using ROV systems deployed from MSVs have been explored and exist today. Successful hydrates remediation, remote workover control systems, and testing of subsea assets have all been accomplished with MSV and ROV deployed deepwater systems. And many more advances in technology will no doubt be discovered as the industry's needs change and demands for creative innovation continue.

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