

PRACTICE MAKES PERFECT

Claire Kennedy Platt and Michael Rossing, NOV, USA, report on the testing of customised solutions aids in milling and intervention operations.

The unique, sporadic nature and high costs of intervention operations have increased operator demand for technology validation before deployment. Unlike the repetitive nature of drilling rock formations, interventions require varied tasks and more customised solutions. The ability to respond to operational needs and test in simulated conditions before deployment opens new opportunities for the development

of fit-for-purpose intervention products. In response to milling and intervention needs, National Oilwell Varco (NOV) has invested in a horizontal milling machine (HMM), which aids in the performance evaluation of milling assemblies and other intervention tools. Testing in simulated environments has enabled the creation of tailored solutions, lowering intervention risks and costs and increasing the success of intervention operations.



Horizontal milling machine

Located in Houston, Texas, the Horizontal Milling Machine (HMM) pushes and rotates a bottomhole assembly (BHA) consisting of tools such as mills, drilling motors, and friction reduction technology into simulated environments while quantitatively measuring the performance of the tools. An adjustable BHA guide provides stabilisation similar to high-angle and horizontal wellbores and casing in common hole sizes. Capable of milling processes for a short distance into a simulated formation or other target of interest, the HMM is 90° from vertical, mimicking the horizontal wellbore common in most oilfields. A standalone power pack provides pressurised hydraulic fluid needed to drive rotary and thrust functions on the HMM, as well as the make and break vices and pipe cradles for ease and safety while assembly and disassembly take place.

During testing, the target designed and constructed for the specific tool or tool string being tested is positioned in the HMM. High-strength cement targets, cemented and uncemented casing, or blocks of actual formation are securely positioned and prevented from movement and vibration to provide accurate rates of penetration (ROP), mill advancement, and measurement of other test parameters. With individual target lengths limited to 40 ft with a maximum usable diameter of 36 in., the device is modularly configurable to provide a total test length of up to 80 ft. Uncemented casing used as a target holder for internal milling tests can measure up to 40 ft long.

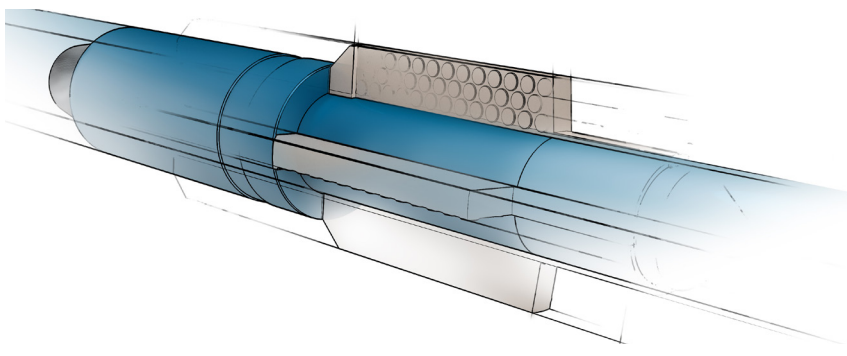


Figure 1. Modern engineering and modelling techniques have aided in more precise design of mills.



Figure 2. The Horizontal Milling Machine (HMM) from NOV aids in the simulation of well environments while quantitatively measuring tool performance.

The HMM provides accurate data generation during operation. The BHA guide positions the BHA and bit/mill to the target without needing to drill into it to bury and stabilise the BHA.

Pumps, tanks, and solids-handling equipment provide a range of working fluid types, including freshwater and water-based mud. A control cabin positioned near the HMM and target enables operation of the HMM. The data acquisition system may be installed to monitor the test operation and collect performance data. An overhead crane, forklift, guide rails, or mechanical positioners aid in positioning the BHA and target.

Companies wishing to test equipment can deliver a made-up BHA to the HMM, or NOV can design, manufacture, and assemble a custom solution. The BHA is then attached to the drillpipe to be used for thrust or rotation. Capable of handling a torque capacity of 30 000 ft-lb, the HMM can test ROP up to 200 ft/hr and a maximum rotary speed of 140 rpm. The machine has aided in the testing and development of milling solutions.

Case studies

Milling

A company in Mexico had an objective to run packers in wells off the coast. A design flaw in the safety shear release mechanism required an intervention to enable retrieval. NOV combined a simplex packer retriever with an internal cutter, which was ready for testing within six weeks. The solution was tested and proved using the HMM. The hybrid solution helped solve the company's problems in one trip. The tool string latched packer made a cut and retrieved a packer in the same run, creating a solution for the company's challenges and a new milling product.

Lab testing

In addition to testing with the HMM, NOV has aided in recompletions, well cleanouts, and recovery and abandonment operations through lab testing. The modification of existing products has helped solve operation-specific challenges.

Recompletions/well cleanouts

In a quest for greater efficiencies during the completion phase of unconventional wells, service companies explore and innovate products and techniques. In these cases, service providers used a large bore plug and a dissolvable ball concept to eliminate the need for milling composite plugs. Unlike a composite plug, these mills consisted of cast iron or steel, requiring companies to re-access the well. This method led to considerable milling challenges and lengthened typical milling operations. This case study showed a project extend from 90 days to 350 days.

A service provider in the Western Canada Basin seeking improvements in the perf-and-plug process approached NOV for a solution. Through an engineered approach, Bowen™ products were combined with new milling technology. Insert placement, rake angle, and blade material are all key components that contribute to ROP and mill life; however, the most important component of this case study was debris management. In the first test, the V1 mill yielded suitable milling times at just under two hours and with acceptable cutting debris. Testing showed the inserts were not positioned properly, allowing the plug mandrel to go below the milling plane and cut the blade off while milling the second plug. In the second test, the insert positioning was modified and the blade thickness was increased. The V2 mill yielded similar mill times with extended range to include multiple plugs. The cutting debris size and shape lessened to aid in more effective hole cleaning (Figure 1).

Safe, efficient abandonment

A major producer in the UK requested NOV's involvement on a project with an objective to review current abandonment philosophies, and determine ways to safely and efficiently abandon wells without de-completing them. A challenge involved cementing tubulars when the tubular is static, as cementing in this manner can cause the creation of micro annulus flow paths to compromise the entire abandonment operation. A device was created that was similar to the Agitator™ system, installed in the suspended production tubing, and used to complete tests in as real life conditions as

possible by deploying in a test well with tubular and casing sizes that matched the actual well characteristics that would be commonly encountered. The device created pressure pulses, converting into vibration to generate significant movement of the tubing. The solution improved cement coverage and eliminated the possibility of microannulus occurrence. The displacement potential exceeded lateral restriction of a 9 5/8 in. casing drift. The lateral vibration magnitude accentuated from 1000 ft to 2000 ft, but it provided sufficient vibration of the tubing within maximum lateral restriction.

Recovery of evidence

A company working on a blowout well in California had objectives to ensure pieces of pipe recovered from the well were maintained and could be used to discover causes of well failure. Within a six-week timeframe, NOV designed, engineered, and built a solution consisting of modified existing finger-catcher technology to be used as a catching device and to ensure items recovered from the well were intact and safe. They conducted lab testing according to the specifications of the operation. Following lab testing, the company deployed the solution with NOV's assistance at the wellsite. After several attempts, the device recovered the evidence intact with no damage.

Conclusion

Lab testing and simulation using equipment such as the HMM prior to deployment leads to significant reduction in the application of technology and cost of milling operations. Testing for specific operations using simulated environments and matched well characteristics enables the creation of new designs through the slight modification of existing equipment, allowing operators to deploy fully tested, customised solutions. These modern engineering and modelling techniques assist engineers in creating a more precise design of mills, yielding cost improvements compared to older technology. The use of pre-proven solutions during operation reduces risks and costs, increasing the success rates of milling and intervention operations and leading to safer, more efficient evidence recovery, abandonment, and well cleanout. ■