Jetstring sub designed to improve cleaning for downhole equipment

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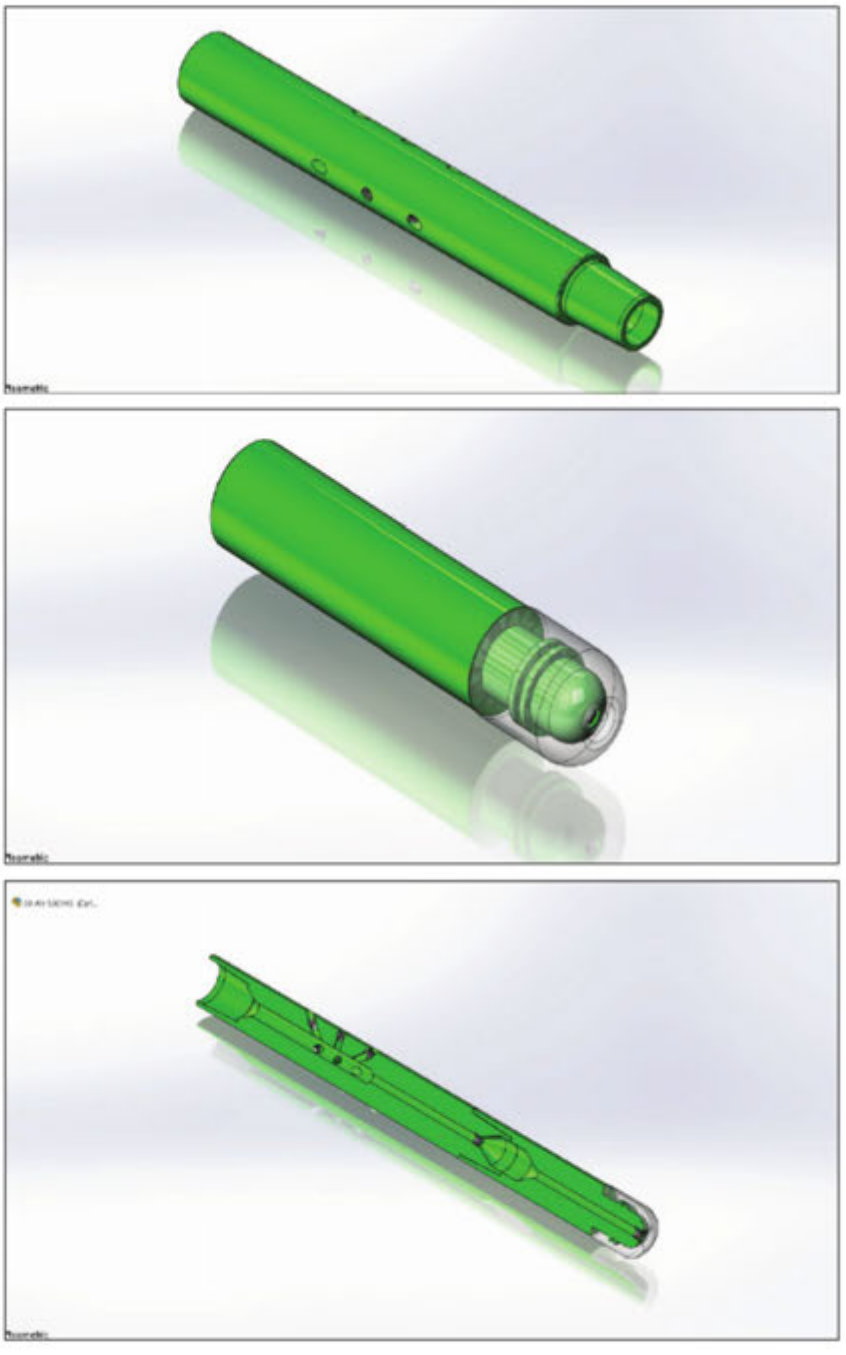
OPERATORS FREQUENTLY GRAPPLE with the problem of how to clean debris from their subsea equipment, including blowout preventers (BOPs), wellheads and subsea tree cavities. When circulating a wellbore with mud, the annular flow rate drops when it reaches the wellhead and BOPs due to the larger internal diameter (ID), thereby allowing particles to settle in that area.

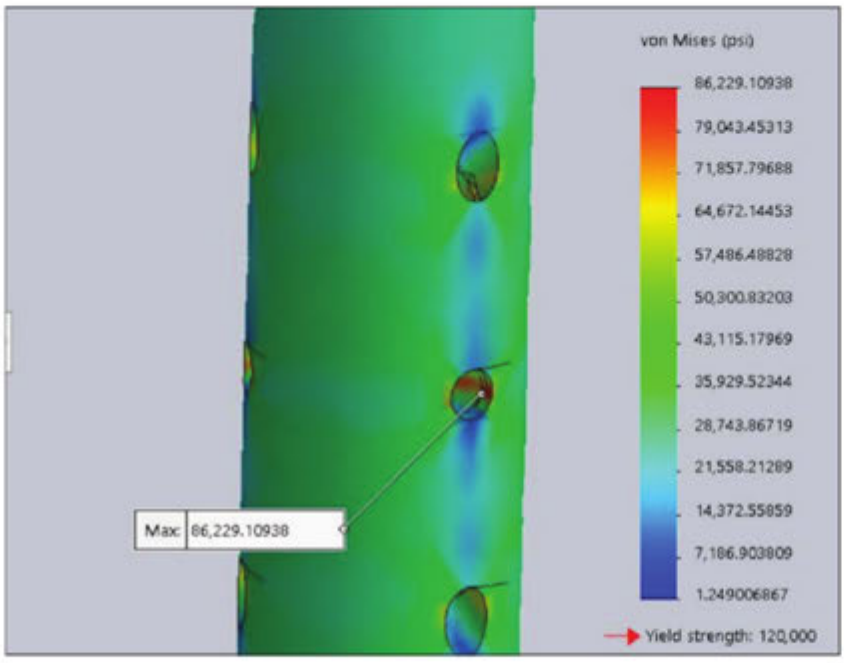
During the lifecycle of a well, there are several times when BOP cleaning is required. One critical time is the transition from drilling to completion mode, as it is vitally important for completion fluid to remain uncontaminated from solid particles. Of note, when operators test BOPs, the sealing elements are designed to close around the pipe to make sure that it is holding pressure. If there is a high level of debris present, it may not seal correctly.

BOP malfunctions or lack of a test on the sealing elements can require the equipment to be detached and the entire unit retrieved from the sea floor for maintenance to be completed at the surface. This contributes to a situation where debris can be brought to the surface with the BOPs, leading to longer cleaning time and potential environmental or safety concerns during the maintenance process.

Incremental maintenance or cleaning operations can correlate to substantial unplanned rig time, which, in turn, represents significant dollar expenditures for the operator or drilling contractor. Finally, at the end of the well, if a wellhead was not cleaned thoroughly, debris could fall onto downhole equipment, such as plugs or valves, that may fail to seal or operate correctly causing further time delay and cost.



The 2-in-1 sub was designed for use with a 5 7/8-in. XT57 drill string, including a row of nozzles pointing downwards. As part of the design process, a 3D engineering computer model was developed, including dimensions, sizes, port location and the specifics of the model.



TOP: The sub design was verified using a finite element analysis.

BOTTOM: The sub can be run in-line with the drill string, making it possible to perform short trips to jet the BOPs, wellhead or subsea tree cavities with directional ports and nozzles for appropriate flow area. The bullnose portion of the sub can be dressed as needed in an open or closed position

IDENTIFYING A FLEXIBLE, FAST CLEANING METHOD

In 2018, Workstrings International, a Superior Energy Services company, received a request from an operator that wanted to improve its BOP cleaning and reduce the rig time required to perform the operation. Workstrings' Canadian division subsequently designed with the engineering group the patent-pending 2-in-1 JetString Sub, with bullnose adding flexibility when run together as a conventional jet sub tool or in-line the drill string for a short trip. This tool would help the operator improve the cleaning of subsea equipment, such as the BOP, wellhead and subsea tree cavity and offer the versatility needed to save trip time.

Most traditional jet sub designs utilize fixed ports with no adjustability, thereby creating a tool with minimal flexibility. For example, the standard design offers a tool where the ports would only remain open and there was no possibility of reverting to smaller ports. These subs typically feature a "through bore" that would require a safety valve (TIW valve) placed below the jet sub that when closed would direct the flow out the side ports. This adjustment needed to be made at the surface. The traditional way of addressing the cleaning issue encompasses pulling the drill string out of the hole or hanging off with a BOP test plug in the wellhead and deploying a special wash tool. This, of course, required additional rig time.

The operator in Canada requested the jet sub and bull nose sub design be equipped with directional and adjustable ports that can be dressed to the specific nozzle size in order to obtain the desired total flow area (TFA) and maximize the coverage. The JetString Sub enabled the operator to perform short trips to pick up and install the sub. The bullnose portion of the sub could be run below the in-line jet sub portion with the port open or closed as a dedicated run. In addition, the bullnose is coated with urethane for ease of running in the hole and protecting wellhead equipment. This new design features removable standard size nozzles that are the same type used on drill bits. It allows the operator to either close off a port or redress and change the nozzle by simply removing the snap ring on the rig floor and dropping in any size nozzle as required.

The tool has regular pin and box connections so that it can be positioned in the middle of the drill string. One of the unique features of the in-line portion of the sub is that it has a nose port that can be set with an open or closed nozzle. This feature means that even though the rest of the drill string is positioned below it, nothing will pass below the in-line sub, directing flow out the side jets to maximize impact and optimize jetting force. This allows it to be run in the drill string, eliminating the need for a closed TIW valve, which historically had been required for standard jet sub design. The bullnose section of the sub also has a nose port that allows it to be dressed as needed to run open or closed compared with a traditional bullnose sub with a fixed open port. These features allow the operator flexibility to use the tool to best meet their operational requirements.

The result of the new design was an array of features that saved the operator time, money and equipment expenditure. Improved cleaning was delivered through the flexibility of the nozzles, which could now be changed out on the rig floor for the first time.

DEVELOPING A NEW SOLUTION

As with any collaboration, the ultimate goal is to seek benefits for all the parties. Through communication and teamwork, the process was developed:

a) The operator provided the basic idea specific to their requirements for the 2-in-1 sub for use with a 5 7/8-in. XT57 drill string, including a row of nozzles pointing downwards.

b) Once the port layout and the location of the nozzles was determined, a 3D engineering computer model was developed, inclusive of dimensions, sizes, port location and the specifics of the model.

c) The design was verified with a finite element analysis (FEA) to meet a tensile capacity of 1 million lb of tensile for the body of the sub. The end connections exceeded this tensile.

d) The most practical idea was to utilize standard off-the-shelf nozzles as they are interchangeable and readily available, such as standard drill bit nozzle sizes, $^{8}/_{32}$ in. to $^{28}/_{32}$ in.

e) After the final design was approved, a design process was implemented to calculate how much pressure the snap ring could bear. It was determined that the sub had a maximum working pressure of 3,500 psi.

f) An actual flow model was developed to determine the pressure drop across the nozzles and snap ring. The model showed it would be below 3,500 psi and could withstand the operational forces.

g) Upon completion of the preliminary design, manufacturing was started, and a prototype test was performed.

h) Upon completion of the prototype test, production was initiated, with the first sub sent to Canada to be utilized by the operator for a one-year period.

ADVANTAGES DELIVERED

- The sub can be designed with the drill string connections and port layout required.
- The sub allows for the flexibility of running in-line with the drill string, making it possible to perform short trips to jet the BOPs, wellhead or subsea tree cavities with directional ports and nozzles for appropriate flow area, with the nose port either open or closed.
- The sub can be used for a dedicated cleanout run with the bullnose and open jet.
- Rig time is improved by using one tool with adjustable jets allowing for operational efficiencies.
- Improves cleaning of the BOP, wellhead and subsea tree cavities and is more efficient due to the directional ports and adjustable nozzles for coverage.
- During post-jetting, there is a reduction of surface maintenance time due to the improved performance of the tool and the enhanced cleanliness provided.
- The bullnose portion of the sub can be dressed as needed in an open or closed position.
- Readily available nozzle sizes to reduce cost from special designed jets.
- The nozzles can be readily changed out on surface.

A HISTORY OF ENGINEERING SOLUTIONS

Although challenges in the oilfield are often complex, it is the simplest of solutions that enhance or improve rig operations, save time or positively benefit safe operations and the environment. In this case, Workstrings International engineered and custom designed a tool for the operator in terms of port configuration but also used standard, available jets for flexibility of TFA. The readily available and adjustable jet sizes in the sub reduced the extra expenditure that may have been required to source specially designed jets. Through the development of a single tool with adjustable nozzles and a new design of the jet flow configurations, the sub enabled improved cleaning of the BOP, wellhead and subsea tree cavities. This improvement in initial cleaning standards has the effect of minimizing the time required to perform post-jetting surface maintenance.

JetString is a trademark of Workstrings International.