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Open Hole Inflatable Bridge Plug to Isolate Losses and Place Competent Cement Plug

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Abstract

Operators across the US face significant challenges when drilling through loss circulation zones created by faults, fractures and cross communication with neighboring wells. Encountering these loss zones often results in costly loss control material and high volumes of valuable mud pumped away with further risk of lost drilling BHA's downhole, open hole abandonment and open hole sidetracks. Multiple attempts at placing balanced open hole cement plugs in these loss circulation environments have often proven ineffective, resulting in additional time and resource expenditures.

Utilizing the TAM Abandonment Plug (TAP) as a base for cement in such environments has proven to be an effective solution in controlling losses. This allows for a competent open hole cement plug to be placed, enabling quick and effective sidetracking or abandonment of compromised wellbore sections.

The TAP is a highly reliable and robust solution for all Permanent Bridge Plug applications. It can be deployed on drill pipe, tubing or coil tubing and can be utilized in both cased and open hole. The TAP is a "One-Trip" solution, allowing operators to run in hole, inflate the TAP, release from the packer and place a competent cement plug to cure losses. The TAP has been utilized successfully in open and cased holes across a multitude of areas and regions in all manners of wellbore inclination.

This paper will discuss tool basics, application and some case histories, demonstrating how the system can address the above challenges.

Introduction

The need for fossil fuels is not diminishing. Indeed, most energy forecasting institutions suggest that the global demand for oil will remain on an increasing path for many more years to come. Technological advancements coupled with operational efficiencies are enabling fewer rigs to drill equal or more footage each year, while new production technologies and enhanced oil recovery (EOR) tactics are continually improving operators' ability to extract hydrocarbons. However, as more wells with longer lengths, more complex trajectories, and closer proximity to one another are drilled, the chances of encountering faults or channels of communication with existing systems also increase.

When faults or communication zones are encountered, multiple loss control tactics can be considered. However, this often leads to several days of non-productive drilling time, loss of mud, and additional spending on Loss Control Material (LCM) regimes. To minimize this spending, the deployment of an effective, versatile, and robust loss control tool provides savings in time, resources, and fluid losses, allowing operators to resume the drilling program as quickly as possible.

Conventional Lost Circulation Control Operations

When losses are encountered, an assessment is made to determine the type of losses: static, dynamic, or total. Often, the decision may be made to "drill through" static or dynamic losses, depending on the severity of the loss. This can involve adjusting mud weight, adding additives, reducing circulation rates, minimizing trip speeds to avoid surge/swab effects, and other measures. However, in the case of total losses, specific tactics must be employed to regain the well fluid column for well control and borehole integrity in order to resume the drilling program.

In a total loss scenario, since the well cannot support a column of fluid to the surface, it is often difficult to ascertain where the fluid level is and what amount of hydrostatic pressure can be maintained by the well. This may force an operator to make changes to the mud system (lightening) or to pump water into the well to try and determine the supportable gradient. Use of "balanced cement plugs" or deployment of LCMs is often the next step in the process to restore well integrity.

Balanced cement plugs require a known or approximation of what the loss zone will support. Cement is pumped near the loss zone with a volume that (by estimated calculation) will not overcome the loss zone gradient and allow the cement plug to harden in place, allowing the well to be filled and drilling resumed.

If use of LCM is considered, there are several LCM vendors that provide a range of fibrous, flaky or granular materials. Examples of these being: shredded cane stalks or cedar bark (fibrous), mica flakes and shredded bits of plastic/cellophane (flaky) and ground marble, wood, various nut shells, cotton hulls, corn cobs or Formica (granular). These are all deployed by mixing into the drilling fluid/mud and pumped into the well in hopes to block the loss flow and restore well integrity.

Generally, losses require additional trucks and shipments to be ordered to the rig to supply additional mud, water, oils, LCMs and other products to manage the loss control situation. Determining the path of LCM use, balanced cement plugs or both is often guesswork and requires multiple attempts. These all add time and costs to the operation.

TAP Technology Overview

The TAP is an innovative well integrity support tool that offers a practical and efficient solution to a wide range of wellbore sizes, configurations and scenarios. The TAP utilizes field proven poppet valving for inflation. The valving system ensures the inflatable element is always pressure-balanced while running in the well. As a hydraulically activated tool, the system is designed to handle the differential stresses of unknown fluid levels, can set in a range of open-hole (or cased hole) sizes, can accommodate any manner of wellbore fluid, and provides a competent downhole base to regain wellbore integrity.

The TAP operates by pressuring up the work string to create a differential between the work string and the wellbore. Releasing the applied differential locks the inflation pressure into the element. Once set, right hand rotation disconnects the Release Sub and work string from the plug and provides a full ID, allowing cement to be pumped on top of the plug during the same run into the well. Although designed as a permanent plug, two contingencies are built-in to deflate the element if retrieval is required.

The TAP packer utilizes a 2 in 1 Hydraulic Release/Safety Joint interface to ensure effective disconnection after setting the plug. Once the packer is confirmed as engaged with the open hole wall, right hand rotation is applied to disconnect from the packer and pump cement. In the event rotation cannot be achieved at the tool, pressure can be increased in the work string to activate the backup Hydraulic disconnect mechanism.

The most common elements used on the TAP system are the 788-SE3 and 550-SE3. These two sizes offer a very wide range of engagement in most open hole environments. The working pressures for each are depicted in the "Graphics" section below:

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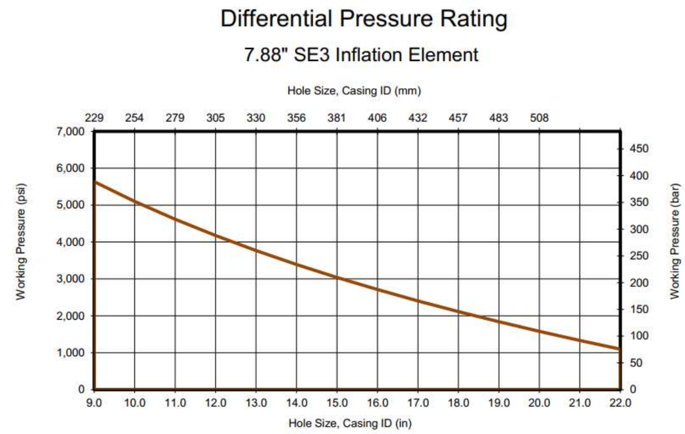
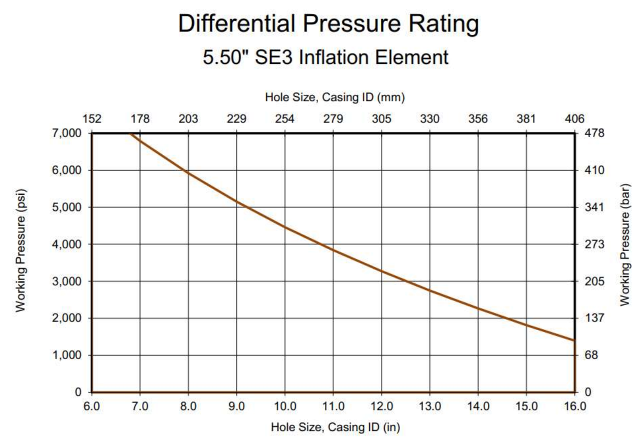
Graphics





Loss Control Operations with a TAP Inflatable Packer

In the event of total losses, the TAP tool would be requested and deployed to the rig site. Information on hole conditions, "competent rock" zone depths, expected fluid level, hole size, temperature and operations up to current time would be discussed.

If the operator has opted for LCM treatments, a closed system is recommended as follows:

- TAP Abandonment Plug with appropriately sized open hole element
- Hydraulic Release Sub with built in Safety Joint
- A stand of clean drill pipe (used to carry 3x the anticipated inflation volume of element)
- Foam Pig (if required) to separate mud/drilling fluid from inflation fluid
- XO to work string

The system is then run in the hole. If fluid level is known, "top filling" of the work string can be engaged to maintain hydrostatic balance from outside to inside. The TAP system can also accommodate running in the hole without any filling of the pipe.

Once at the setting point, the work string is filled with water with the final string weight recorded. Depending on the fluid level, filling the work string may initiate the setting of the TAP Plug. Once the work string is full, pressure is increased to ~1000psi for 10 mins to fully engage the inflatable element with the well bore. The work string is then picked up to 15k lbs. over string weight to confirm packer engagement, then brought back to neutral. Pressure is then bled to 0psi and tubing left open for 10 mins. A second overpull test is conducted to confirm packer anchoring, then work string is again returned to neutral. With 2000-5000 lbs. of overpull applied, the work string is rotated to the right for 12 turns to disconnect from the TAP. Work string is moved up 20 feet to confirm disconnection from the TAP and circulation can commence to confirm returns are achieved. Cement can now be pumped on top of the TAP to provide an effective sidetracking plug for continued operations.

Case Histories:

Case History #1

CHALLENGE: A Midland Basin operator encountered losses during drilling of their intermediate section, resulting in the drilling BHA becoming stuck. The BHA was ultimately left down-hole, prompting the need to abandon the originally drilled section. In this scenario, placing a competent balanced cement plug above the fish was not possible due to the total losses.

SOLUTION: An Inflatable Bridge Plug was run and set inside the 12.1/4” open hole above the loss zone in a competent formation interval. A push/pull check was completed to confirm packer anchoring. Right hand rotation was applied to disconnect from the inflatable packer, then a cement plug was immediately pumped and placed on top of the packer.

RESULTS AND BENEFIT: Operator regained full returns, confirming the effectiveness of the packer and sidetrack cement plug. The open hole sidetrack from the original leg allowed for successful completion of the well program.

Case History #2

CHALLENGE: An Eagleford operator encountered partial losses while drilling the 8-3/4” horizontal production section (>90 deg) with complete loss of returns experienced at TD (~20,000ft MD/~11,000ft TVD). Numerous attempts with various fluid and material combinations to reduce the losses failed. Without reducing these losses, the well would be unable to be completed. As additional challenges, the circulating temperature was high (290F - 295F) and the depth of the loss zone(s) was unknown.

SOLUTION: A High Temperature Inflatable Bridge Plug (HT-IBP) was set in the open hole near the bottom of the well. After being confirmed as set by weight (up and down), rotation was applied to disconnect from the packer. Good returns were experienced at 3.5 BPM. When circulating rates were increased to 12BPM, losses were again experienced, suggesting more than one loss zone was in play. Decision made to deploy a second HT-IBP. To verify the first packer had not failed, it was tagged and confirmed as at original setting depth. The second packer was then set 50ft above the first packer and successfully disconnected from by right hand rotation.

RESULTS AND BENEFIT: The operator was able to achieve full returns at 7BPM, which allowed them to maintain suitable conditions to run their production casing. The well was completed successfully.

Case History #3

CHALLENGE: A New Mexico operator encountered issues running a 7-5/8” casing string, ultimately becoming stuck and unrecoverable. The casing was cut at free-point and then a balanced cement plug was spotted. Once the cement setup time elapsed, the sidetrack BHA was lowered to tag the cement, but the top of cement was not where it was expected to be, nor was the cement compressive strength conducive to sidetracking. Obtaining a competent sidetracking cement plug became critical to proceed.

SOLUTION: An Inflatable Bridge Plug was set inside the 9-7/8” open hole and confirmation of packer anchoring was verified. Right hand rotation was applied to disconnect from the inflatable packer, then a sidetracking cement plug was placed on top of the packer, providing the operator a good base to sidetrack the well.

RESULTS AND BENEFIT: The cement plug was maintained in a condition that allowed the proper setup and cure to reach suitable compressive strength for the open hole sidetracking operations. The operator was able to sidetrack from the original leg and TD the well. The 7-5/8” casing string was run and the well was completed without further incident.

Conclusion

Conventional methods to manage fluid losses while drilling have been deployed in the industry for many years with mixed success. In today’s pad and batch drilling approach, there is a need to find ways to reduce rig time and limit nonproductive time. The TAP offers an efficient, versatile and effective means to bring a loss situation under control, limit costly LCM material, eliminate the uncertainty of balanced cement plug attempts and establish a quality base of cement for sidetracking from a loss zone.

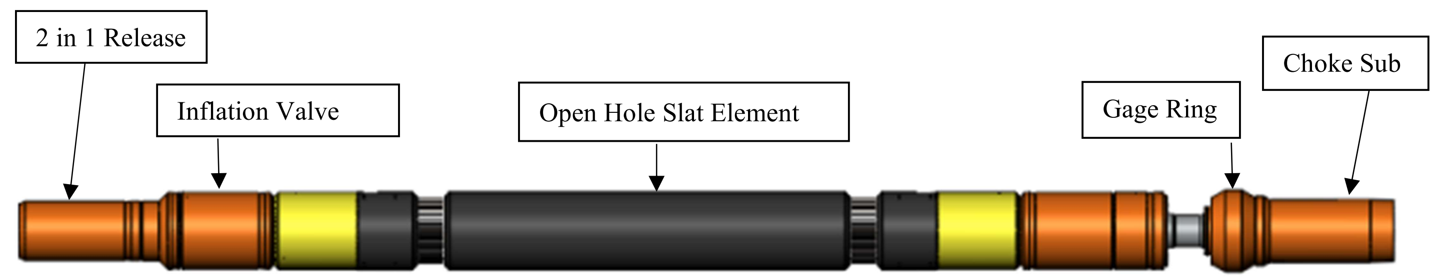


Figure 1 – Basic components of an Inflatable Open Hole Bridge Plug.

Figure 2 – Depiction of an Inflatable Open Hole Bridge Plug deployed in horizontal open hole