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Introduction of Nippleless Tubing Stop Plug Application in Pakistan

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Abstract

Well control is the management of the hazardous effects caused by the unexpected well release. In a production well, downhole safety valve and X-mass tree are considered the main barriers against the well release in the event of a worst case scenario surface disaster. Inadequate risk management and improperly managed well control situations cause blowouts, potentially resulting in a fire hazard.

This paper describes a case history of a production well where a tubing string was eroded severely during production phase. The problem was detected while attempting to retrieve the separation sleeve in the long string which was not accessible at the required depth. Downhole camera indicated that 90% of the long string had been eroded and remaining 10% is connected with the flow coupling. Thus full workover job was required to replace tubing strings. However, the lack of well control barrier in the tubing to prevent uncontrolled flow of hydrocarbons prior to blowout preventer (BOP) installation for the workover was a serious safety concern.

Introduction of Nippleless Tubing-Stop Plug technology provide an effective, safe and economical remedial solution to the problem.

Introduction

As part of well control standard, double barrier policy is always maintained on the well to avoid unwanted and uncontrolled flow from the well. Before any workover, the well must first be killed as a first well control barrier. A second barrier is required to prevent communication from the wellbore to surface once the wellhead is removed. Tubing plug is an effective second barrier used to isolate the wellbore pressure from tubing.

Nippleless Plug Technology Deployment

In the past, the tubing plug's lock systems have been designed in which landing nipples or profiles are provided along the tubing string's interior surface, and wherein a lock/ plug will be placed in the nipple or profile. However, placement of a lock of this type is limited to those points along the string at which an appropriate nipple or profile is located. In cases where tubing string is damaged or eroded where nipple or profile is no longer usable, the common tubing plug can no longer be a barrier device.

Introduction of "Nippleless" plugs addressed this issue in that they do not require the presence of a nipple or profile to be set within a string. Nippleless plug offer the capability to set plugs at any depth or point within well.

Background of the Problem

This paper describes the case history of the application of Nippleless tubing stop plug in a well in Pakistan where the tubing string was eroded severely during production phase. The well was completed with dual tubing strings with short and long strings of size 2-3/8 in. and 3-½ in. respectively. The discovery of tubing poor conditions happened after unsuccessful attempt to retrieve separation sleeve in 3-½ in. tubing string. Tubing access to the required depth was not possible. Upon investigation through wireline downhole camera, it was diagnosed that the long string was 90% eroded and remaining 10% connected with the flow coupling, as shown in **Fig. 1**. Image of internal damage of flow coupling due to erosional effect of high fluid velocity is shown in **Fig. 2**. Thus, workover was required to replace the tubing strings.

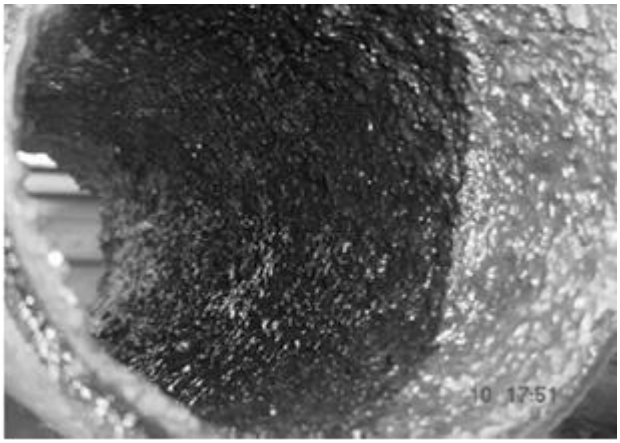

Fig.1 - Damaged tubing due to combined erosional and corrosive action.

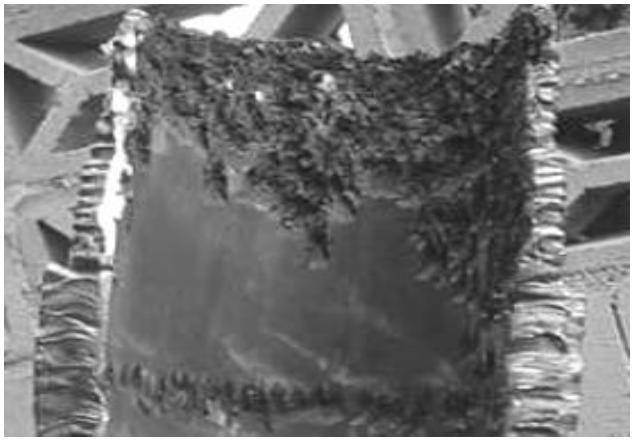

Fig.2 - Image of the internal surface of the flow coupling.

Failure Analysis of Eroded Tubing

Downhole camera images indicated severe tubing erosion in this particular well, a failure analysis in the tubing was also performed to eliminate the cause. The failure occurred due to erosion mechanism along with some corrosive activity. While keeping in view the factors affecting the rate of erosion like fluid velocity, its composition and particle size etc., some tests very conducted by the operator company to establish and eliminate the cause of failure, such as hydraulic simulation, hardness measurement and inspection with specialized equipment.

Well operational conditions such as pressure, temperature, fluid velocity, mixture and erosional velocity and flow regimes were established through simulation to estimate the severity of erosional phenomena throughout the production time. The visual inspection was done on the flow coupling where severe damage resulted in reduction of thickness of thread wall caused by combined mechanism of erosion and corrosion as shown in **Fig. 3**.

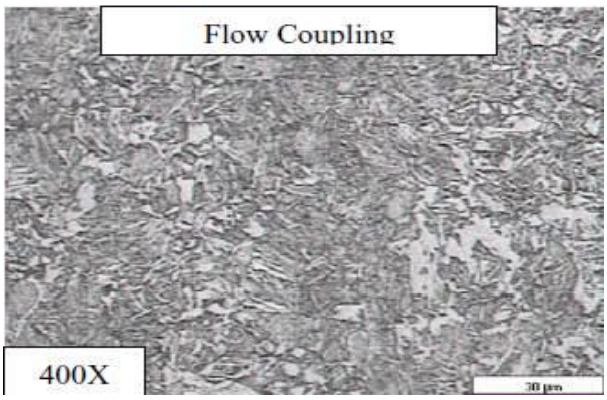

Fig.3 - Picture of the microstructure.

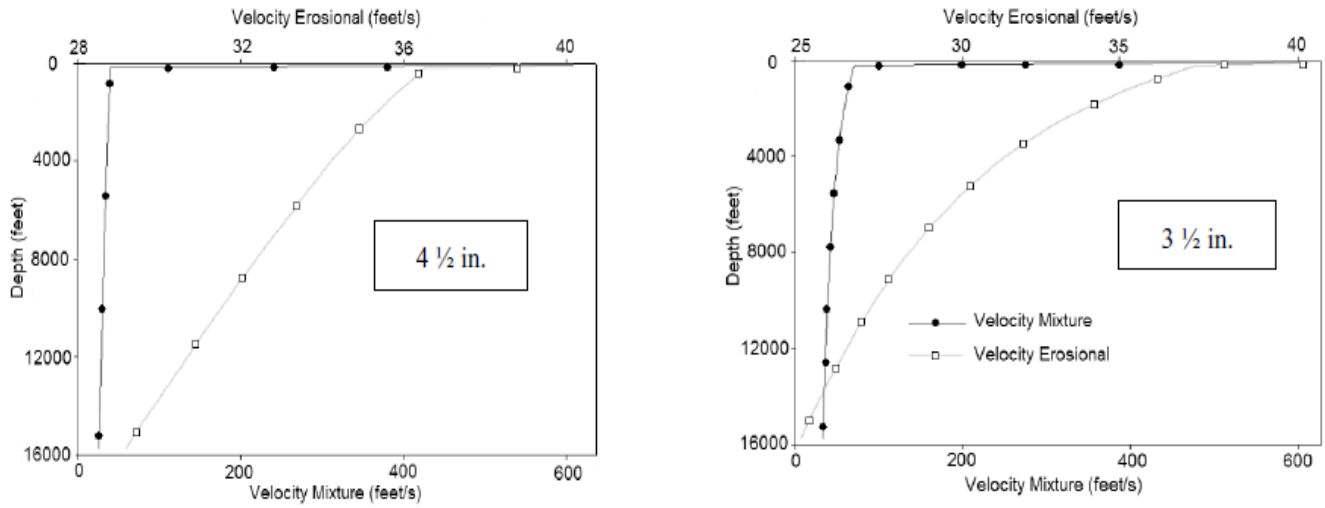

Fig.4 -Results of simulation show variation in mixture and erosional velocity for different diameters.

Tubing erosion simulations were carried out showed probability of erosion of the 3-½ in. tubing and revealed the conditions for the existence of corrosion-erosion process as shown in the graph for erosional velocity. These simulations were also run for several tubing diameters. It was found that erosional damage would be minimum after using high grade steel tubing (T-95) with relatively larger diameter of 4-½ in. to reduce the fluid velocity in **Fig. 4**.

Remedial Solution Provided By Nippleless Plug

As observed from downhole camera, the corroded state of the tubing string with eliminate the choice of setting conventional tubing plug as there was no usable profile to set plugs as pressure barrier in order to meet the double barrier policy of well control while removing the wellhead for the workover. Therefore the only option left was to run Nippleless tubing stop plug. The Nippleless plug is shown in Fig. 5. Slickline unit was used to set the Nippleless stop plug with top and bottom anchor mechanical tool assembly (**Fig. 6-9**).

Another concern involved was to ensure that the bottom anchor is firmly placed in the tubing without dropping the plug. A surface dummy test was carried out by running the plug with top and bottom anchors in the tubing to observe its hold up in the string. The plug sealed firmly against the pipe ID and was able to withstand gradual increase of pressure up to 6000 psi.

The setting depth of the plug in the actual tubing string was decided based on the previous downhole camera observation. The entire operation was executed successfully where the well was properly secured as per well control double barrier policy.

Tubing-stop Run and Pull Procedures

The following Running procedure was used for setting the 2-3/8 in. Nippleless Plug in the tubing.

1. The first step is to set the bottom Anchor, this Anchor is engaged by a 2 in. GS Pulling Tool, when the required setting depth comes, the complete Tool String is given a sudden jerk. Due to this action the plastic Shear Pin is sheared and the spring holding the Slips in retracted form is released and touches the wall of the Tubing.
2. Jar down with Tool String on GS Running Tool, so that the cone in the Anchor Tool pushes the jaws firmly against the wall of the Tubing.
3. Jar down several times so that the Anchor is fixed tightly against the wall, at the same time the GS Tool Pin is sheared.
4. Pulling out of hole (POOH) with GS Pulling Tool.
5. Engage the Plug with 2 in. GS Running Tool, running in hole (RIH) up to the Anchor Tool and jar down several times so that the Rubber Seal is intacted with the wall of the Tubing, after several jarring effects, the GS Running Tool pin will be sheared.
6. POOH with GS Running Tool.
7. Engage again this 2 in. Running Tool after re pinning with Top Anchor, RIH and touch the Plug and jar down against the Plug.
8. After several jarring, the slips of Top anchor will be tightly engaged against the wall of the Tubing and the GS Tool will be sheared.
9. POOH with the GS Running Tool.

The following is the Pulling procedure of the 2-3/8 in. Nippleless Plug from the tubing.

1. RIH with 2 in. GS Pulling Tool, engage the Top Anchor, jar up to release the Top Anchor. POOH
2. RIH GS Pulling Tool with Equalizing Prong, run up to the Plug, the Prong will break the Knock out Plug and equalization will start, stay for some time to equalize.
3. POOH with the Plug body.
4. RIH again with 2 in. GS Pulling Tool and POOH with the bottom Anchor.

Conclusion

The newly developed Nippleless plug technology allows slickline to economically provide a methodology to set plug for pressure barrier in a damaged tubing string without profile for setting a nipple plug. The application of tubing-stop Nippleless Plug assembly increases safety and decreases Setting Time in order to complete the job quickly and efficiently. Nippleless tubing-stop Plug run through Slickline continues to provide a potential barrier downhole at low well workover cost without compromising operational safety and efficiency.

Abreviations

in	*inch*
psi	*pound per square inch*
ID	*internal diameter*
BOP	*Blowout Preventer*
POOH	*Pulling out of hole*
RIH	*Running in hole*

Acknowledgement

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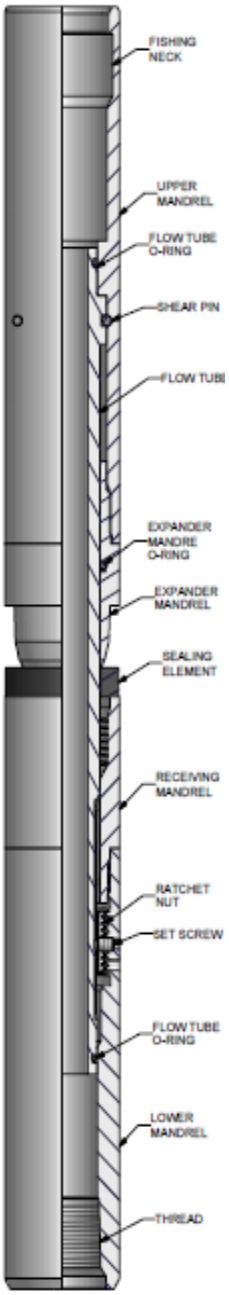

Fig.5 - High flow pack off Nippleless plug.

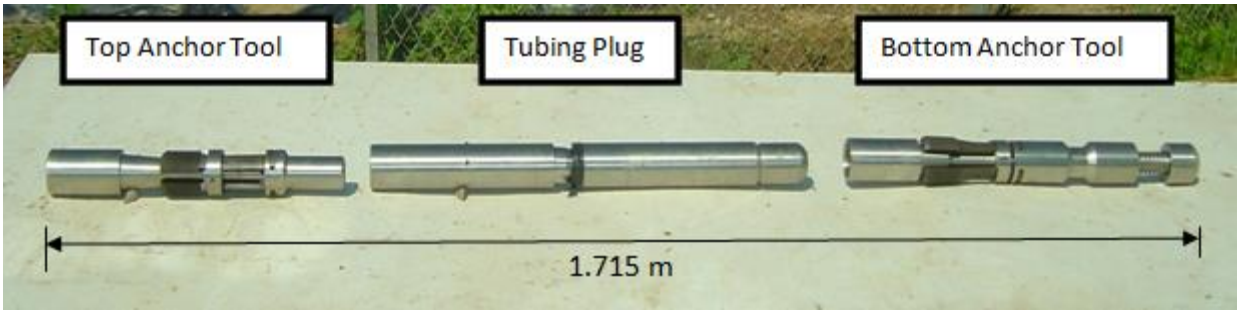

Fig.6 - 2-3/8" TBG Nippleless Plug Assembly.

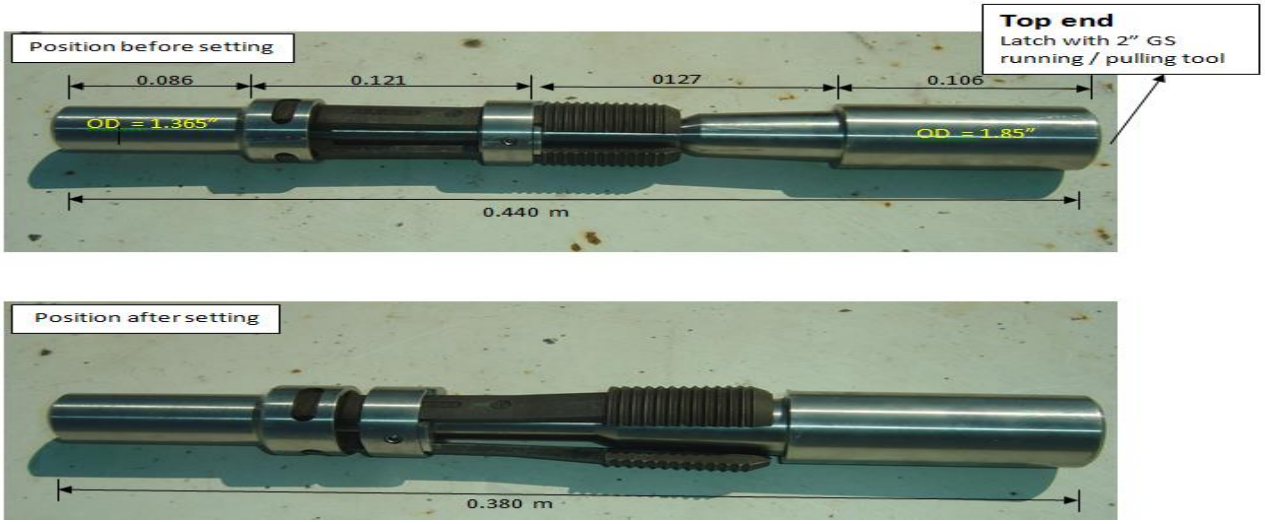

Fig.7 – Top anchor tool.

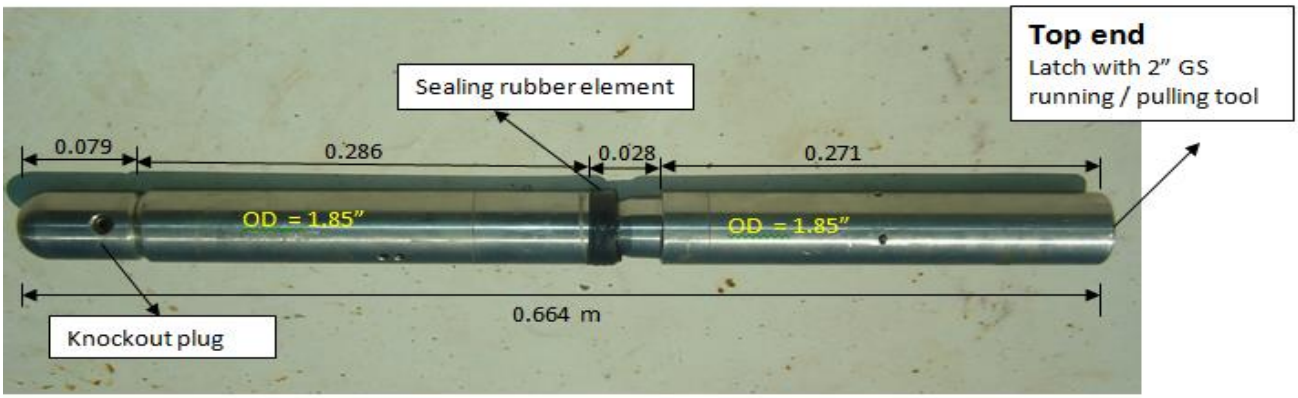

Fig.8 – Middle plug section with dimensions.

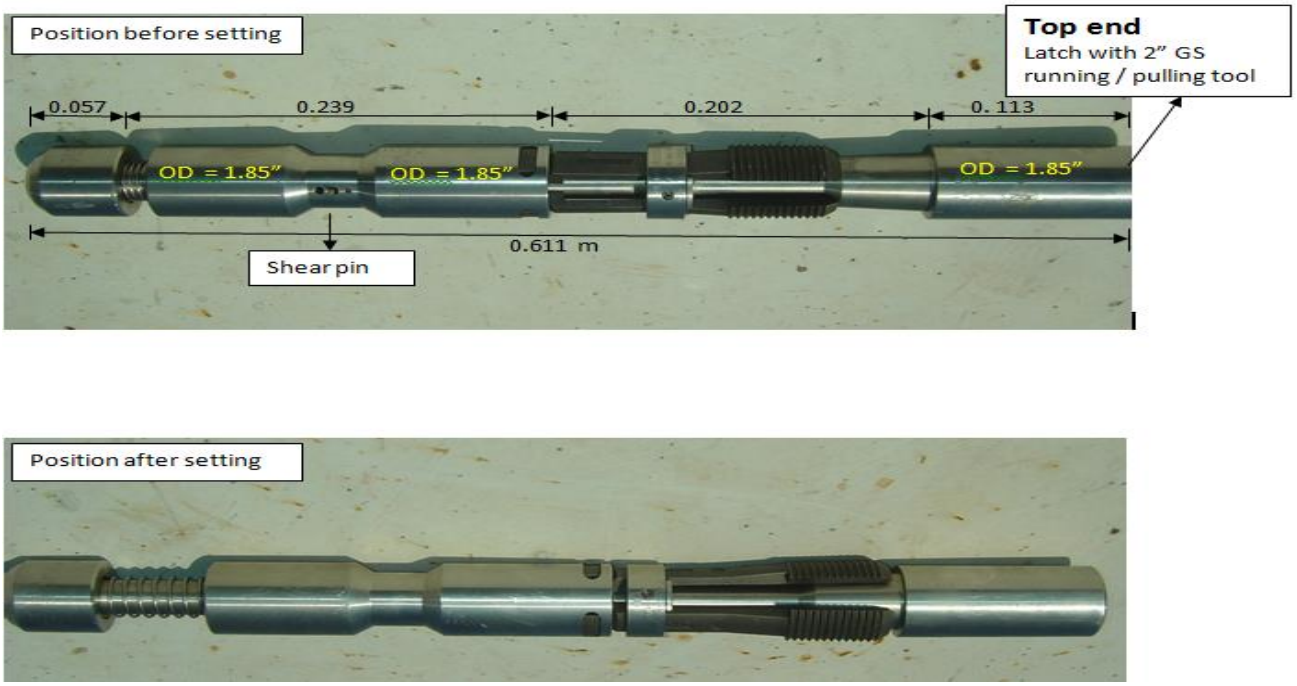

Fig.9 –Bottom anchor tool.