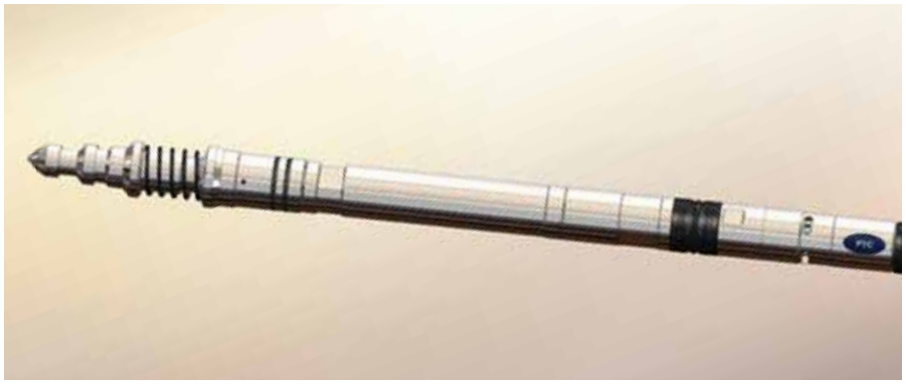
Development and application of a new unloading valve on **Sleipner 15/9 B-02 T2**

Introduction

A novel approach was needed to unload a new well on Sleipner B due to deck space limitations and economic factors preventing the use of coiled tubing. A Side Pocket Mandrel (SPM) which allows communication between the annulus and tubing can be used in conjunction with a gas lift valve (GLV) to artificially lift wells via gas injected into the annulus.

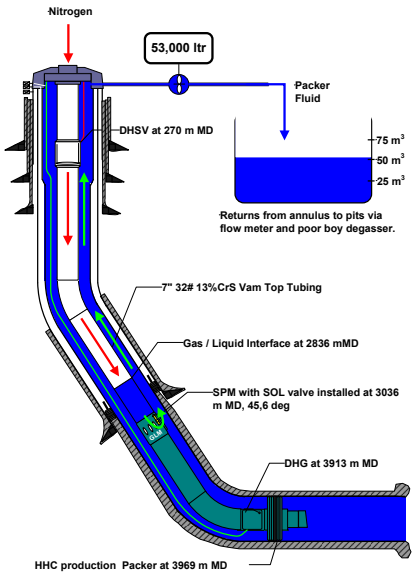


A standard GLV however, does not allow for circulation from tubing to annulus. Nitrogen must therefore be pumped into the annulus to lift the well in the "traditional" manner. This is less controllable than direct displacement and is also less effective for an equivalent GLV installation depth.

Direct displacement of the tubing can be achieved by changing out a dummy valve for a circulation valve, but this method requires at least four wireline runs, a time consuming operation that entails additional risks. We wanted a solution that eliminated the need for wireline altogether.

SOL Valve Development

A new Shear Open Lock (SOL) valve was therefore developed in collaboration with PTC. The valve itself incorporates the well proven SafeLiftTM metal to metal seal technology and is rated gas tight to a pressure of 690 bar. It has the same dimensions as a normal 1,5" safe lift valve and can be mounted in any SPM built to ISO specifications. It is suitable for sour service and can tolerate the same fluid flow as a gas lift valve of the same size.



The SOL valve is locked open by applying differential pressure from annulus to tubing. It can then be locked closed by applying higher pressure. Fluid can be circulated in both directions when the SOL valve is locked open and the operational sequence to displace tubing to nitrogen using an SOL valve is as follows:

- Set production packer, test completion to well design pressure
- Shear-open SOL valve
- Perform displacement operations
- Shear-closed SOL valve
- Leak test SOL valve

Operation

The SOL valve was pre-installed into the side pocket mandrel and tested to well design pressure prior to being shipped offshore. As a contingency, the SOL valve may be changed out with a kick-over tool and wireline if required; therefore the SPM was installed at a depth of 3036 mMD where the deviation is 45 degrees to facilitate slickline access.

After setting the packer and testing the completion, the SOL valve was sheared open successfully, but at a higher differential pressure than expected. Nitrogen was then pumped into the production tubing, displacing the packer fluid through the open SOL valve and returns were taken from the annulus. Returns were monitored with a flowmeter and via the pits to ensure volume control and to avoid nitrogen entering the annulus.

After sufficient packer fluid had been displaced, to leave the gas-liquid interface approximately 200 m above the SPM, the annulus was closed in and nitrogen pumping continued. The SOL valve sheared closed as expected and annulus pressure was bled off to 5 bar and an inflow test was performed to APOS requirements (K - 21330, table A.2.).

Conclusions & Recommendations

The higher differential pressure experienced when shearing open the SOL valve is believed to be due to additional friction in the SOL valve. Further development and testing will be undertaken to solve this.

The Shear Open Lock Valve is an ideal solution for unloading a well when coiled tubing operations are unfeasible and to avoid multiple slickline runs to change out valves in the side pocket mandrel.

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