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Resurrecting a Low-Pressure Gas Well Offshore: Through-Tubing Foamer Injection via a Capillary Tubing System and a Specialized WRSCSSV

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Abstract

Liquid loading can have a detrimental impact to the production rate in gas wells causing many wells to be shut-in prematurely. Many artificial lift methods have successfully alleviated liquid loading and allowed the operator to reach the abandonment pressure more quickly, reducing expense. However, most artificial lift methods are not applicable to offshore production due to the regulatory requirements of certain safety systems, in particular an SCSSV (Surface Controlled Sub-Surface Safety Valve) and SSV (Surface Safety Valve), which would be impeded if traditional artificial lift methods were used.

A fail-safe, through-tubing capillary injection system has now been applied to an offshore well having an SCSSV and SSV. The offshore well maintained full compliance and functionality of the SCSSV by utilizing a specialized WRSCSSV (Wireline-Retrievable Surface Controlled Sub-Surface Safety Valve). The SSV was addressed through the application of a unique wellhead adaptation called a Y-body. These two systems were combined with a capillary foamer injection string that allowed the well to flow at a lower bottomhole pressure. This lower flowing pressure enabled additional reserves to be produced and has improved the ultimate recovery from the reservoir.

Introduction

Artificial lift installation methods typically fall into one of two categories: workover and through-tubing. Workovers imply that production tubing is pulled from the well. Subsequently, various artificial lift hardware components are installed and the tubing is re-deployed into the well.

Some examples of artificial lift by way of a workover are:

- Electric Submersible Pump
- Beam Pump
- Progressive Cavity Pump
- Velocity String (Smaller Production Tubing)
- Gas Lift
- Foamer Injection via Chemical Injection Lines

Offshore wells are limited to velocity strings and gas lift since the other methods would require hardware across or through the SCSSV, rendering it in-operable.

Through-tubing artificial lift systems, as the name implies, are systems that can be installed without the use of a workover. Such systems include:

- Coiled tubing velocity strings
- Plunger lift
- Capillary Strings

Due to operational restrictions created by the SCSSV and SSV, artificial lift options on offshore wells are limited. The methods in the short list above cannot be installed while maintaining the full operability of the SCSSV and SSV; therefore, they create a unique set of challenges in their application. The technical challenges and the development of an artificial lift system that overcame them are the subject of this paper.

Because this was a pilot program, some of the methodology outlined in this paper was determined to be less than optimal, as has been noted where appropriate. In these instances, design improvements are discussed or methodologies recommended for future applications.

Liquid Loading

In depletion-drive reservoirs, the pressure and corresponding gas rate in a well is expected to decline over time. That decline rate is often accelerated due to the onset of liquid loading. Turner *et al.*[1] describe the entrainment drop movement model as a means of explaining minimum critical velocity. Liquid loading occurs when the velocity of production flow drops below the minimum critical velocity necessary to lift liquid droplets. It is typical for a solution gas-drive reservoir to produce connate water. Under sufficient BHP (bottomhole pressure) conditions, the well can produce the water with the gas: High flow rates provide velocities adequate to lift the water droplets. As the BHP decreases due to reservoir depletion, the velocity in the production tubing drops below the minimum critical velocity, and liquid hold-up begins.