Coiled tubing artificial lift systems can reduce operating costs and optimize production

Preface

This article will identify technologies developed by a private Canadian company that address specific challenges that new well designs have created. In a case study format, each technology will be examined and implications for future practice presented.

Industry Challenge

Traditional rod drive artificial lift (“AL”) systems were originally designed for conventional vertical wells. Many conventional and unconventional wells have challenging downhole physical characteristics that may cause significant wear on downhole equipment resulting in sub-optimal well production and high maintenance costs. Over time, those producing oil and gas wells could require frequent workovers due to equipment fatigue and production changes. Presently, conventional workover rigs are required to perform these operations. Before any workover procedures are initiated, a well must be pressure contained. Pressure containment, or killing a well with fluid, can lead to sustained degradation of production and potentially the permanent loss of a well’s productivity.

UCT Solution

In 2008, Alberta based CJS Production Technologies (“CJS” or “the Company”) pioneered a method of encapsulating multiple coiled tubing strings in a thermoplastic resin to convey hydraulic and electric pumps into oil and gas wells. In 2013, the Company expanded its umbilical technology to include ArmorPak, an all-metal umbilical design for deeper wells and thermal applications. FlatPak and ArmorPak umbilical coiled tubing (“UCT”) act as a production conduit, integrating hydraulic or electric power for subsurface...
artificial lift systems. Multiple tubes allow for complete isolation of the hydraulic drive fluid from the production fluids. The Company has concurrently developed (all the) running equipment, including injector assemblies, stripper heads and blow out preventers (“BOPs”) to allow (most) industry available coiled tubing units to run UCT products. The Company also carries a line of subsurface hydraulic drive equipment specifically designed to work in connection with the umbilical technology to power hydraulic progressive cavity pumps. These UCT deployed systems support hydraulic reciprocating piston pumps, (“HSP”) hydraulic progressive cavity pumps (“PCP”), jet pumps and electric submersible pumps (“ESP”).

Below are examples of various tubing configurations using coiled tubing in commonly available sizes up to 1.75 inch single tube diameter with plans to expand to 2.0 inch diameter:

FlatPak Hydraulic Umbilical

AmorPak Hydraulic Umbilical

AmorPak Electric Umbilical

AmorPak Dual JetVak / Rapid Jet String

Hydraulic pump systems can be used to dewater natural gas wells and pump oil wells. UCT pumping systems can be used for the permanent pumping of fluid from a well or for temporary service operations to clean wells of fluid and sediment to improve production.

UCT products and complementary downhole pumping systems facilitate “live” well operations minimizing formation damage. By eliminating service rigs and using coiled tubing units to install UCT pumping systems, wells can be fully serviced without the use of kill fluids. Additional efficiencies minimize installation costs, future operating costs and production downtime and location footprint.

UCT products convey hydraulic pumps in a rod-less format, permitting optimal pump placement in the well while eliminating rod and tubing wear. In horizontal wells, pumps can be landed in a horizontal position at the very bottom of the well heel with no concern of rod wear.
Wellbore cleanouts to remove fluids or solids are conducted with UCT products and jet pumps. In low bottom hole pressure wells, lost circulation during foaming or nitrogen cleanout procedures can be problematic due to the hydrostatic pressure of returns up the annulus. In a JetVak operation, the hydraulic loop is closed and the well pumps continuously with limited backpressure on the formation. This vacuums the wellbore clean.

FlatPak: An encapsulated coiled tubing umbilical that conveys and actuates specialized UCT pump systems.

ArmorPak: An all-metal coiled tubing umbilical designed for deeper, higher temperature well applications that convey and actuate specialized UCT pump systems.

JetVak: A well cleanout system designed using either FlatPak or ArmorPak UCT in combination with a custom Jet Pump primarily used in well cleanouts.
Alaska ESP Case Study

An ArmorPak ESP was recently installed in Alaska and placed on production for the following well:

Well A – The subject well went on production in October 1998 producing over 90 billion cubic feet (“BCF”) of natural gas through December 2014. The well produced negligible free water for the first 10 years. Since 2007, water production increased and by late 2014, daily water rates were approaching 500 barrels per day (“BWPD”). During 2014, declining natural gas production created difficulties in lifting free water production and by February 2015, the well loaded with water and stopped producing. Prior to experiencing liquid loading, this 4000 foot deep gas well was producing 7.5 million cubic feet per day “mmcf/d”.

History of Client Operations

In November 2012, Client contacted CJS to investigate the potential for using UCT technology to install an ESP pumping system into the above noted Alaska well. A drilling rig exists in the area which can be used for well workovers; however, the costs of using this rig to re-complete or service wells is significant due to rig type, mobilization, setup and time on location inefficiencies. In 2014, CJS was contracted to manufacture and deliver a UCT conveyed ESP system and provide the necessary on-location well services to install this pump system. The Company used its intermediate depth tractor equipped coiled tubing unit to install this pump system. Including the aggregate costs of the manufactured pump system and associated installation costs; Client recompleted this well at considerable savings compared with the rig-based alternatives available at the time of analysis. Subsequent pump service operations could also save significant capital.

Following the contracting process and during the electric pump system design phase, numerous onsite Client reviews were undertaken and significant designing and re-designing took place by CJS to satisfy Client requests. By October 2014, the electric pump system was completed and ready for installation. Specific to the ArmorPak ESP system, the Company and its associates designed the following system for use by Client in Alaska:

Wellhead Penetrator - Electric Feed-through
A custom downhole penetrator and wellhead feed through system were designed to support this coil tubing deployed ESP system.

ArmorPak
ArmorPak 1.5 inch dual banded coiled tubing was preloaded with specially designed and custom manufactured cable to power the downhole ESP.
Pump Connector
The pump connector threads to the top of the ESP, connects to the dual coil string and leaves room to use cable splice technology to connect the ESP cable to the ArmorPak cable. A profile in the production side of the connector allows a dart to be dropped and seal off the production coil.

Shear Assembly
A tapered guide on top of the pump connector was incorporated to mitigate the risk of getting planted. A shear sub was designed to run above the ESP pump to allow the coil tubing to pull free from the pump connector. The power cable was designed to part downhole at the splice connector.

Tubing Hanger
The Company designed a two-piece dognut to be installed around the dual coil string that grips the coil as it is landed inside the wellhead. The nitrile rubber element ensures well control.

Isolation and Coil Cutting
A wireline retrievable plug was set in the profile of the pump connector and pressure tested to provide isolation during running and cutting of the coil.
The Client Field Operation

Field operations were deferred until 2015 due to weather logistics in Alaska. Equipment was shipped to Alaska in July 2015 and operations began on Well A. Client elected to kill this well for this operation, given the high-expected well production rates, remote location, environmental and safety concerns and the additional delay that would be incurred for installation to wait on the Company to complete its CT Stripper development. The wellhead workover stack and injector head was unusually tall, requiring a boom crane height of over 80 feet (shown at left).

The ArmorPak ESP system was installed into Well A and the well was placed on production immediately. At the time of writing, this well had returned to a natural gas production rate of 3.5 mmcf/d while lifting 600 BWPD. The well is continuing to build rate as the UCT ESP system operates at the designed capacity.

Subsequent Developments

The Company has designed a dynamic pressure containment system “CT Stripper BOP” that will be used in the future to facilitate live well deployment of UCT. This pressure containment system works in connection with ArmorPak. The dual conduit clamped system does not degrade the elastomer inserts used to contain well pressure when running into a ‘live’ well that is under pressure.

Implications for Future Practice

The results of this operation proved that an electrically powered pump system could be reliably installed on a rig-less, coiled tubing deployed basis using UCT while providing the following advantages:

- UCT installation of an ESP is more time and cost efficient when compared to traditional installation methods by eliminating the need to engage cable spool units when conveying electric pumps reducing mobilization, lease footprint and associated cost
- Upon validation of UCT dynamic stripping system, UCT ESP installation would provide the advantage of live well ESP deployment reducing costs of well kill operations and the possibility of decreased or permanent loss of well productivity
- UCT methods do not require a wet connect unlike other rig-less ESP installations