Expandable technology enables casing repairs

EXPANDABLE TECHNOLOGY

NARROW PORE PRESSURE/fracture gradient windows often necessitate additional casing strings to reach deeper objectives. Operators are constrained by the number of strings of conventional casing that they can run through subsea or surface wellhead equipment. Planning solid expandable tubulars into the well design allows the operator to run additional casing strings and drill to deeper objectives.

The authors will discuss how combining solid expandable tubular technology with surface stack technology has pushed the technical limits of surface stack drilling into deeper water and deeper formations. Using a solid expandable tubular in the upper sections of the well design preserves hole size from the onset and allows more casing strings to be run without having to push casing points to the frac-gradient limit. Preserving hole size alsocontributes to drilling efficiency, reduces equivalent circulation density (ECD) and minimizes risk associated with small hole size in deeper sections of the wellbore.

The authors will examine two case histories. The first compares two deepwater offset wells in Mississippi Canyon. One well used expandable casing as a contingency while the other well incorporated the casing as part of the base design. The second case history will evaluate a well where solid expandable tubular technology allowed up to three additional casing strings to be run in a surface stack application.

Solid Expandable Tubular Technology: The Value of Planned Installation vs Contingency (SPE/IADC 92622) **C N Carstens**, **Unocal**.

EXPANDABLE LINERS

During the initial completion operations on the Llano LL1 well (GB 386 #3 ST-4), the 7 ¾-in. 46.1 lb casing failed the official pressure test in the production liner. Subsequent operations located the casing leak 1,800 feet above the target completion intervals. The original completion was a stacked, commingled frac pack with reservoir depths over 23,000 feet and pressures over 14,500 psi.

With the goal of keeping the original well objectives, a solid expandable tubular (SET) was selected to isolate the casing leak. An expandable liner was run in the well. The first expandable was unsuccessful in starting expansion and was recovered. A series of reviews, lab mechanical tests and yard prototype tests were conducted to investigate the unsuccessful start and to plan a second run to remediate the casing leak.

Expandable casing technology can provide high-strength casing patches to isolate holes from perforating gun misfire or leaks resulting from corrosion. It provides a cost effective reliable alternative to squeeze cementing, installing packer straddles or cementing in place liners to isolate production perforations and worn, weakened or corroded casing. SPE/IADC 92330.

The revised design made for this well included smaller OD launcher, closed-end system and shorter length launcher than standard equipment. A number of procedural changes were made based on experiences during the first attempt.

The second SET liner was run in the well just over a month later and was successfully installed. Over 2,300 feet of expandable liner was installed with eight seal joints specifically located to allow completion operations to resume essentially as planned, with only minor changes to equipment and procedures. The post expansion liner changed the completion to a 7-in. 38 lb equivalent ID casing, utilizing standard available completion equipment.

Expandable Liner Installation Avoids Sidetrack Following Production Casing Failure: Llano 1, Gulf of Mexico SPE/IADC 91923) **C A Butterfield**, **Enventure Global Technology**; **M Chustz**, **D L Mason**, **Shell International**; **J M Schober**, **Covenant Drilling**.

EXPANDABLE CASING REPAIR

During field trials, 2,530 ft and 8,380 ft expandable casing patches were installed in Wyoming and Texas gas wells previously shut-in due to corrosion leaks. Another application was in a new-drill well where a 205 ft patch isolated holes in casing from a perforating gun misfire. The patches pressure-tested successfully, enabling all three wells to be fracture stimulated and produced. The product, designed initially as a one-trip system, was simplified and made more reliable by running as a two-trip system. First, the lower expandable seal with polished bore receptacle is installed. Next, the spacer string with upper seal is stung into the lower receptacle and the upper seal is expanded. The system is versatile in that the upper expandable seal also provides a receptacle to which a tieback liner, production tubing or another patch can be attached.

The author highlights job design and execution including use of casing inspection logs, problems encountered, system improvements and best practices resulting from this work.

Versatile Expandables Technology for Casing Repair (SPE/IADC 92330) **W J Winters**, **BP America**.

EXPANDABLE CASING PATCH

The authors will focus on a unique feature of a high-pressure, large through bore expandable casing patch system from the initial customer contact to the trials and tribulations of the design and the research and development process. Actual field use of the tool including applications and sizes will also be discussed.

The authors will also discuss how the development process of this particular tool led the manufacturer to the design of several other new tools for various down hole applications.

Development and Testing of an Expandable Casing Patch System (SPE/IADC 91856) **B O Braddick**, **G D**

Jordan, **S F Baker**, **M A Stulberg**, **TIW Corporation**.

COMPUTER MODEL

The authors will present the mechanics of expandable tubulars in oil and gas wells and outlines, the development of a computer model based on force and energy balance. The computer model includes the effects of stress and strain, expansion cone diameter and angle, friction between the expansion cone and the expandable tubular, tubular length shrinkage, and expansion rate.

The model calculates changes in tubular mechanical properties as expansion occurs (burst and collapse pressures) and predicts the required expansion force (or liquid pressure if the expansion cone is pumped). Examples will illustrate applications of the model for cone design, mechanical properties evaluation, expansion force calculation for both solid casing and sand screen expansion, and monobore design. The model predictions have been calibrated with extensive test data and finite element analysis. The comparisons show that the model, as calibrated with real measured data, can accurately predict expansion forces and other parameters.

A Computer Model for Expandable Tubulars (SPE/IADC 92281-Alternate) **G C Ruan**, **W C Maurer**, **Maurer Technology**.

GAS TIGHT PATCH

The authors describe the design, development and testing of a casing patch system for installation in an offshore well to repair damaged 9 5/8-in. casing. The casing repair was required to have an effective metal-to-metal seal to hold lift gas injection pressure together with the potential for increasing levels of H2S during the life of the well.

The expansion technique used pressures in excess of 25,000 psi to compliantly expand the casing into an external profiled overshot. The authors also describe the development of a method of generating and controlling such hydraulic pressure downhole.

In addition to theoretical calculations, full scale laboratory testing of the mechanical and the hydraulic sealing properties of the connection have been performed in qualifying the casing patch for well deployment. Tests were performed on samples of casing taken from a candidate well to support the theoretical calculations.

A case history will be presented showing that this technique of connecting tubulars in a well bore has application in remedial work on older or damaged completions and as contingency for new wells where a casing string may not reach TD due to differential sticking, swollen shales, etc.

Further development of the technique of direct high-pressure expansion is discussed in relation to the design of ultra-deep and slim wells, where the technique employed may broaden the options for completion design, particularly in HPHT wells where the design envelope is challenging.

Development of a Gas-Tight External Casing Patch Using Direct Hydraulic Expansion of Standard Casing to Achieve a Permanent Load Bearing Connection (SPE/IADC 92583-Alternate) **C Nussbaum**, **P Wood**, **P R Hazel**, **Read Well Services**; **A J Gorrara**, **Shergor Technology**.