Tubulars I

SPE/IADC 52842

"Casing Running Milestones in Extended-reach Wells"

In the pursuit to access reserves at ever increasing departures the requirement to run very long casing strings for Extended-Reach wells is necessary. Even though casing running has been extensively studied, it is apparent in high departure wells, that both theoretical understanding and modeling are beginning to lag behind operational experience. In this paper we study a range of different field experiences from British Petroleum's world-wide drilling operations. In particular, we examine cases where long intermediate casing strings, in excess of 20,000 ft length, have been run at significantly different vertical depths. We identify through comprehensive data collection and analysis a number of key results that are fundamental to future progress.

We evaluate the impact of using OBM and WBM systems, centralisation strategies, drag reduction techniques and refined operational procedures. We also present the latest learning from full and partial casing flotation techniques—which are now in routine use at the Wytch Farm oilfield in Southern England.

In order to meet future requirements, it is desirable that metrics are developed to quantify benefits whenever new techniques, technologies or strategies are used. To this end, we detail the current shortfall in drag modeling techniques and prescribe where future improvements are needed. Whilst the content of this paper is focused on casing running, many of the general comments and observations can be applied to both liner and screen running operations.

—C J Mason, F Allen, BP Exploration Operating Co Ltd
–L Wolfson, Halliburton Energy Services

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"High Strength Sour Service C110 Casing"

Drilling high pressure, high temperature wells over the last 5 years has brought forth and accentuated the need for higher strength casing grades which are suitable for use In sour gas environments. Drilling engineers are designing casing strings at depths where higher burst resistance is needed but the presence of hydrogen sulfide has traditionally restricted the use of casing grades with minimum yield strength:; from 90-110 KS1 (API Grades C90 and T95). Recent advances in metallurgy and pipe making now enable the drilling engineer to utilize casing grades with yield strengths from 110-125 KS1 (C110).

The paper will discuss the metallurgical attributes of high strength, -.our service casing and accessories and will report several cases where without these grades. safe and successful completions would not be possible. The paper also discusses the manufacturing techniques necessary to assure that casing products are suitable for use in sour environments and details the testing necessary to assure proper serviceability when these products are exposed to hydrogen sulfide Specialized testing. which the National Association of Corrosion Engineers (NACE) has standardized oil for oil and gas production equipment (NACE MR0175) will -also be discussed Details will be provided on both casing, accessory and coupling stock with thickness' which traditionally have been difficult it) tile metallurgical uniformity and resistance to hydrogen sulfide attack for proper serviceability.

—B E Urband, Tubular Corp of America-Grant Prideco

SPE/IADC 52844

Deep sandstone reservoirs in the Central North Sea may, upon depletion of their hydrocarbons, develop significant compaction deformation. This poses a challenge for the integrity design of the production casing or liner running through the compacting zone. This paper focuses on the research performed in support of a limit-state design approach of such a liner.

The study was concerned with establishing the mechanical integrity of both the liner pipe body and the premium connection under the severe loading generated in and above the compacting formation.

The relevant failure mechanisms for the liner include buckling in beam mode, helical mode and local mode as well as localisation of the deformation just outside the connector box. Both analytical models and comprehensive finite-element models have been developed to analyse these failure mechanisms and to investigate the effect of pipe weight, pipe material properties, formation stiffness and cementing quality on the axial strain the liner can withstand.

The connections may fad *by* pull-out, thread jumping, local buckling and loss of sealing integrity. Here, the results of detailed finite-element analyses were used to define the particular machining tolerance combinations of the connection specimens used for the qualification testing. The tests of the connections under the anticipated compaction loading fully supported the findings of the analyses.

It was concluded that a significant axial deformation, both in tension and compression, can be taken *by* the liner pipe body and the connections without jeopardizing the integrity or loosing the necessary conduit clearance

—F J Klever, Shell International Exploration Production

SPE/IADC 52845

"Application of Dope-Free Tubular Connection to SAGD and Its Works"

This study concerns the first running case of casing connection made-up without thread compound grease.

The steam assisted gravity drains (SAGD) method has become popular for recovering more heavy oil and bitumen of oil sands in Canada. The well drilling requires good make-up properties at low temperature and gas tightness at elevated temperature for the tubular connections. This report deals with an innovative technology to solve these, and describes the actual results in the field and the handling performance in arctic conditions, compared to their laboratory evaluations.

The casing connection used in SAGD is a "dope-free type" which can be made-up without grease and maintain the connection performance.

The number of connections run into the well was 45 joints, 9 5/8-in. x 40 lb/ft, L-80. In experiment, the galling resistance for more than 20 joints was evaluated for make-and-break tests even at low temperature. The axial load behavior in SAGD was predicted, and then the gas tightness and the joint strength were evaluated.

As for the results of test, the casings were run into the well without doping the compounds grease on the connection, so that the running efficiency was improved as compared with the traditional methods. It was apparent from the field running that the shoulder torque at the field make-up was 2.7 times higher than that at the mill makeup. It was validated from the laboratory tests that the galling resistance was not deteriorated by low temperature make-up or handling damage at below -20C, and the gas tightness and the joint strength were maintained for the predicted excessive load, even at 350 C.

It can be concluded that the dope-free make-up is useful for improving the running efficiency and the high temperature performance as well as for environmental conservation. The connection performance, the make-up procedure, and the handling methods are given for the dope-free type which is expected to be widely used in the market.

—E Tsuru, et al, Nippon Steel Corp
–R Wakishima, Japan Canada Oil Sands

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"Development of a New International Recommended Practice for Casing/Tubing Connection Testing"

Physical testing of casing and tubing connections has been a substantial activity within the Industry for decades. Early testing was performed with fundamental objectives such as determination of appropriate joint strength equations for API 8-Round and Buttress connections. Tubular failures coupled with the trend to drill deeper in the 1970s resulted in continued physical testing of OCTG connections and the first industry standard on the subject, API RP 37. Due to a variety of issues, RP 37 became obsolete and Industry consensus grew to replace RP 37 with a more advanced document that reflected then available experience with testing connections. During the late 1980s, a focused effort was again exerted by API to address these problems, and the development of API RP 5C5 resulted. API RP 5C5 represented a substantial advancement relative to RP 37 and was first published in January 1990. Although API RP 5C5 has been used successfully on a number of products, its use has not been as widespread as was hoped. Two primary concerns expressed with R-P 5C5 surround the costs of the program and the philosophy of favoring higher numbers of test specimens vs. favoring more stringent test procedures.

As a result of these observations and a limited acceptance of API RP 5C5 internationally, ISO TC67/SC5 activated a work item to address a new international RP for casing and tubing connection testing. Those ISO efforts were initiated in 1993 and continued with some limited success until 1995. In 1995, the Convenorship was exchanged over this work program and a new method of working towards international consensus on the key technical issues was employed. From 1995 until January 1998, ISO TC67 / SC5 / WG2 worked through many challenging issues in order to produce ISO CD 13679 by WG resolution in January 1998. That CD has now been under international review for an approximate 6-month period and the final areas for refinement of the document have been identified.

ISO CD 13679 represents a major advancement relative to API RP 5C5 and a major international achievement in technical collaboration. ISO CD 13679 represents the culmination of a technical exchange that involved approximately 15 proprietary Company-based casing and tubing testing procedures and true international representation from USA, UK, Norway, Germany, The Netherlands, Italy, France, Japan, and Argentina. ISO CD 13679 also incorporates various state-of-the-art technologies including accelerated testing principles, biased sampling and path-dependent failure modes. This paper will overview the ISO work program leading to CD 13679 and will be of high interest to all personnel involved in well design, casing and tubing design, connection selection, field running procedures and other areas of equipment qualification.

—M L Payne, Arco E&P Technology
–B E Schwind, Mobil Technology Co

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"Helical Buckling of Pipe with Connectors"

The effect of connectors an pipe buckling is acknowledged, but has received little attention, Lubinski analysed the effect of connectors on pipe in tension in 4 curved borehole, while Paslay and Cernocky extended this analysis to pipe in compression. These papers indicate that bending stresses are greater due to connector stand-off. However, these papers do not consider a buckled pipe.

This paper presents an analytic solution of the beam-column equations in 3 dimensions for a helically buckled pipe with connectors. For low axial compression, the solution approximates helically buckled pipe without connectors, however, at higher axial forces, the effects of connectors on contact forces and bending stress becomes significant. Sag between connectors is calculated so that pipe body contact between connectors can be determined.

Applications include the analysis of bottom hole assemblies, drill pipe, casing, and tubing. The solutions are simple formulas that are suitable for hand calculations.

—R F Mitchell, Enertech