The Evolution of Expandable Technology

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Emerging industry standards and continued technology advances are supporting broad industry acceptance of expandable tubulars as a common element in enhancing the economics and performance of both new and old wells. The growing reliability and utility of the technology have quickly evolved an extensive range of standard applications across drilling, completion, and production operations.

Soon after its introduction, expandable technology was incorporated as more of a contingency of last resort in deepwater drilling programs. However, a far greater scope of wellsite use in much more common applications would require advancement in hardware and experience in running the systems. Today, expandable tubulars are enabling new wells to be drilled in difficult reservoirs and have become a powerful tool in extending the lives of mature assets.

Technology Advancement

While reliability has steadily increased to an average of more than 95%, expandable pipe presents some unique operational challenges related to differential sticking, hole restrictions, and high build rates. Common to all drilling operations, these problems have slightly different ramifications for expandables. Refinements in technology and operating procedures are effectively addressing these issues.

For instance, because the expandable system is run into place while supported at the bottom of the liner string, one could expect that tension be reduced. However, if hole friction or differential sticking restricts the pipe and prevents it from shortening during expansion (a fixed-fixed situation) an additional 100 to 200 kips of tension can be imparted to the string. Combined with other forces, this could exceed connector or pipe tensile limits. Awareness and close observation of restrictions during string installations is a key to avoiding this type of problem.

For this reason, hole conditions continue to dramatically affect the success rate of expandable installations. Tortuosity and hole curvature can result in torsional forces being inflicted upon the connections. Installation in a smooth, nontortuous wellbore ensures pipe is run and expanded efficiently.

Technology refinements and innovation have improved the reliability and broadened the application of expandables. These advances include strengthening the connections, increasing makeup torques, and reducing friction.

Connector development is an ongoing process. Expandable connections have unique stress demands because they must often remain a pressure barrier after expansion. Early improvements added a connection sleeve to protect the connector from damage to the outer surfaces during installation. Scores and notches inflicted during running create stress, so protecting the connectors from this damage prevents associated failure modes during expansion.

Next, the torque shoulder region of the sleeve was modified to increase torsional capacity. More recent innovations include new designs that aid reliability through increased pipe-wall thicknesses and improved seal geometry. To improve the expansion process, friction-reducing coatings have been added on the inner diameter of expandable pipe.

Advances are also taking place in well planning and candidate selection. Analytical tools can also be used to examine hole quality, tortuosity, and curvature to help operators evaluate and rate the borehole for expandable use. In 2009, the refinement of these tools and their application during the planning and execution process will be a continued focus.

Systems with multiple wall thicknesses and sizes will provide operators with greater options for applications. Enabling technologies such as swellable elastomers further allow expandable enhancements to meet specific wellbore requirements. Recent case histories include expandable drilling liners being run without underreaming the hole. Used in conjunction with swellables, the need to cement is avoided. Successful shoe tests were accomplished as well.

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Industry Standardization

Because expandable pipe and connectors are subject to different forces than customary oilfield tubulars, industry standards are being developed. The growing number and type of expandable installations necessitates a method of comparing and rating competing products. Recent advances in this area include the standardization of the methodologies used to rate expandable materials, pipe, connectors, hangers, and expansion tools.

A key area of interest in the standardization process involves quantifying the effect of cold-working the steel during expansion. The Bauschinger effect, in which expansion in one direction may weaken the steel in the other direction, requires that the result be quantified and a rating curve established for multiple steel metallurgies.

Development of this new standard has presented its challenges. For example, standard casing connectors are tested to determine their service rating. Expandable connections require these ratings before and after expansion. The expansion method and fixation can also affect ratings, which are particularly important in planning for fluid-seal integrity during expansion, and for production and drilling scenarios where the connector might come in contact with drilling fluid or production flow post-expansion.

As with existing connectors, expandable connector ratings will be based on the connector application level. For the pipe, a concern is the extent of material weakening that can occur when steel is cold-worked. Standardization will enable engineers to account for the effect of expansion on burst and collapse ratings post-expansion, and to have a common method to use in quantifying the directional properties.

This standardization is the direct result of a level of maturity and acceptance in the industry that requires this information to fully incorporate expandables into well planning. While work remains, the quality and quantity of the data that supports engineers in deciding when and where to apply expandables is improving rapidly.

Industry acceptance of expandables as a preferred alternative in many common drilling completion and production applications is directly related to reliability. Success in these applications requires dependability as a starting point.

This predictable performance manifests itself in cost and time savings. Instead of industry "firsts," the measure of success for expandables is more often consistency of performance, reliability, and design methodology. Technology advances are frequently a matter of scaling a proven system, not reinventing the wheel. This body of experience is a great multiplier in refining expandable methods and technology. A larger number of jobs provide a more statistically meaningful number for examining ways to improve installations.

Risk-Mitigation Partnership

Increased reliability is directly related to lowering risk in expandable tubular installations. Process enhancements are the foundation of risk mitigation—from the way jobs are designed to pipe quality control. Incorporating the practice of risk identification and mitigation for development of individual well-installation procedures is extremely beneficial and engages the operator with a rigorous evaluation. Beginning with a detailed assessment of known risks followed by a line-item checklist, which is carefully reviewed and ranked by risk level, a review process allows drilling engineers and management personnel to join in an assessment.

Once risks factors have been identified and ranked from a review, then a systematic mitigation process to reduce the risk ranking can begin. When all aspects of the job have been satisfied and an acceptable risk level has been reached, an expandable technology installation team can develop the optimal installation procedure. These types of reviews, when incorporated into every installation, yield very high installation-success rates.

Because expandable pipe becomes unusable if significantly marred and because the internal coatings must be intact, pipe inventory maintenance is essential in helping reduce risk. From the mill through connection manufacturing, coating, storage, inspection, and delivery to the rig, quality process provides the basis for enhancing reliability. Managing all inventories through an industry standard, first-in/first-out method, ensures that tubulars are moved expeditiously to the field so that product doesn't degrade "on the shelf." While somewhat rudimentary, this capability is particularly important to the reliability of expandable installations and the growing maturity of the overall technology.

As is the nature of most technology, the application of innovative techniques is not the end of advancement—but many times the start of a new solution. As expandable technology continues to be a viable option producing reliable and consistent results, more information will be gathered and more robust systems developed. **JPT**