Lost Circulation Testing
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Abstract
Lost circulation can cost operators millions of dollars annually. Representative laboratory data is expensive and difficult to obtain because of the scale of the experiments. Information obtained from DEA joint industry experiments (DEA 13) done on 30x30x30-in. blocks in the 1980s gave insight into the problem. The large blocks made it possible to initiate fractures and stop the propagation without fracturing through the block. Fractures could then be reopened and fractured further. Results showed prevention of lost circulation in oil based mud (OBM) required the inclusion of adequate levels of properly sized LCM in the drilling fluid itself, because the fractures were difficult to stop after propagating past the initiation stage. It was concluded that an adequate loading of properly sized materials causes “tip screen out” immediately after the fracture is initiated, preventing further growth and propagation.

Some of us involved with the original DEA 13 project believe a follow-up project may be of value due to newer concepts and materials that can be applied to preventing lost circulation. The concepts of well-bore strengthening are of particular interest. The DEA 13 contractor was the Drilling Research Lab (DRL) at TerraTek. These facilities (now Drilling and Completions Lab) are available for further laboratory work. The current director, Homer Robertson, will be available to take part in the discussion led by Don Whitfill, Halliburton.

Background:
A New Approach to Preventing Lost Circulation While Drilling”, was published in 1992 by Fuh, et. al, as SPE 24599. The background for that work evolved from Drilling Engineering Association (DEA) 13, a joint industry project conducted in the mid-1980’s to study the fundamental issue of lost circulation with oil-base drilling fluids. The theory resulting from DEA 13 was published in SPE 20409 “Theory of Lost Circulation Pressure” by Morita, et. al., in 1990 and in a discussion of the experimental results in SPE 22581 “An Analysis of Experimental Data on Lost Circulation Problems While Drilling With Oil-Base Mud”, by Onyia in 1991.

Conventional fracturing theory predicts that lost circulation may occur when the tangential stress at the borehole surface exceeds the tensile strength of a rock In order to explain the observed experimental results from DEA 13, a new theory was proposed by Morita, et. al.,. This theory proposes that a stable fracture can exist containing drilling mud with solid and gel components. Lost circulation occurs when the fracture becomes unstable. The coupling of this theory with the experimental observations led to the conclusion that lost circulation mitigation would be enhanced by carrying proper sized, concentration and type of materials in the drilling fluid – and led to the field evaluation reported by Fuh, et. al. A significant result reported from the field evaluation was not that lost circulation could be controlled by these treatments, but the resistance to lost circulation (wellbore strength increased) could be enhanced significantly. This concept does not appear again in the SPE literature until 2001 when SPE/IADC 67740 “Fracture Gradients in Depleted Reservoirs – Drilling Wells in Late Reservoir Life” by Alberty and McLain and SPE 68946 “Formation Pressure Integrity Treatments Optimize Drilling and Completion of HTHP Production Hole Sections” by Sweatman, et. al., was published.
Then, in 2004, SPE/IADC 87130, “Drilling Fluids for Wellbore Strengthening” by Aston, et al. added credence to these resurrected concepts in a paper that coined the phrase “stress cage” to describe the wellbore strengthening phenomena. This paper was followed by SPE 90493, “A Physical Model for Stress Cages” in 2004 by Alberty and McLean which further describes the concept and the model development.

Some methods to accomplish an increase in concentric stresses is described in SPE/IADC 92192 “Fracture Closure Stress (FCS) and Lost Returns Practices by DuPriest, published in 2005. This paper points out that “fracture closure stress” is increased by widening the fracture to compress the adjacent rock. Closing stress determines the fracture reopening pressure and losses cannot occur if the fracture reopening pressure is greater than the equivalent circulating density (ECD). Losses are not stopped by simple plugging. Effective treatments must simultaneously isolate the tip and achieve adequate width.

Interested Organizations

Anyone interested in possible organization and participation in a joint-industry project to continue studies initiated by DEA 13 with emphasis on studying well-bore strengthening concepts contact:

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A minimum of 10 companies with interest in organizing the project will be required before an initial planning meeting will be held in Houston in January of 2009. No obligation is incurred to attend an organizational meeting, but a minimum fee of $100,000 per company is estimated per member if a project develops. If continued, a draft proposal will be presented at 1Q2009 DEA Meeting. The goal will be to include 15-20 companies in the project to be initiated in late 2009 or early 2010.

Further Information

Lost Circulation – Wellbore Strengthening or Remediation – or Both?

A proposal submitted to the Society of Petroleum Engineers to place this topic in the 2010 Forum Series.

Lost circulation planning includes both prevention and remediation methods. While it is critical that losses be stopped once they occur, it is equally important that they be prevented whenever possible. One important part of a preventive plan is the design of “borehole stress, or stress-cage, treatments”. The goal of these treatments is to improve the ability of the well-bore to contain higher pressures without losing circulation.

A forum on “Lost Circulation” has never been held; a concise examination of the current methods and materials to prevent and remediate lost circulation may lead to an improved understanding of the concepts and more efficient application of the materials. This topic is proposed for the North America Region, but could be held anywhere since this is a world-wide issue.