the ENERGY lab

R&D FACTS

Geological & Environmental Systems

Evaluation of Foamed Wellbore Cement Stability under Deep Water Conditions

Background

Foamed cement is a gas-liquid dispersion that is produced when an inert gas, typically nitrogen, is injected into a conventional cement slurry to form microscopic bubbles. Foamed cements are ultralow-density systems typically employed in formations that are unable to support annular hydrostatic pressure exerted by conventional cement slurries. More recently, the use of foamed cement has expanded into regions with high-stress environments, for example, isolating problem formations typical in the Gulf of Mexico. In addition to its light-weight application, foamed cement has a unique resistance to temperature and pressure-induced stresses. Foamed cement exhibits superior fluid displacement, gas-migration control, and long-term sealing through resistance to cement-sheath stress cracking. As a result of these properties, it is often the system of choice for shallow flow conditions and prevention of compaction damage in deepwater production in offshore environments.

The increased use of foamed cement systems in high-stress environments makes understanding their stability in the wellbore vital. Current testing methods are limited to atmospheric conditions and there is a significant knowledge gap regarding the stability and properties of foamed cement as it is placed in the well and post-placement. Foamed cement stability depends on time evolution of the gas bubble-size distribution (BSD) and varies as it is pumped and placed in the well. Unstable foams can result in uncemented sections or channels and failure to achieve zonal isolation. A stable foam provides the desired zonal isolation and casing support when installed properly in the wellbore.

Primary Project Goal

The general objective of this work is to develop a sufficient scientific base to be able to apply quantitative risk assessment formalism to evaluate the exploration and production of deepwater and ultra-deepwater resources. Adequate definition of materials performance and properties is critical to this effort. The outcome of this project is to develop a dataset comprised of laboratory observations to develop an understanding of the stability and properties of foamed cement as it is placed in the well and post placement.

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This project is part of the DOE/NETL Complementary Research Program under Subtitle J, Section 999 of the Energy Policy Act of 2005.

Objectives

- Address current lack of knowledge and understanding of the stability of foamed cements as they are placed in the well.
- Evaluation of foam stability, bubble size, channeling (bubble coalescence) as affected by pressure, shear, and cement design.
- Correlation between atmospheric and pressure generated foamed cements.

Project Description

NETL recently completed an assessment report to identify research needs in the cementing of offshore wells. The information developed for this report was drawn from a literature search, contacts at various industry professional organizations, and contacts with industry experts associated with the cementing of offshore wells. NETL technical reports can be accessed at the following site: http://www.netl.doe.gov/onsite_research/index.html.

NETL is currently partnering with various industry partners to investigate the properties of foamed cements at various pressures, shear rates, and foam qualities. This study is utilizing NETL's industrial computer tomography (CT) scanner to provide 3-D image data sets of bubble size distribution of 1) atmospheric foam generated with the current API RP 104-B test method across a range of foam qualities, and 2) laboratory generated foamed cement under a range of pressures across a similar range of foam qualities. As part of this project, NETL researchers will determine foam stability at conditions simulating various depths in the well. This study is unique in that bubble size distributions will be measured from high resolution 3D imagery under pressure.

Benefits

The increased use of foamed cement systems in high-stress environments makes understanding their stability in the wellbore vital. If the foam cement is unstable, gas can coalesce and bubbles will increase in size, causing gas pockets to form and rise in the cement column. Unstable foams can result in failure to achieve zonal isolation. A stable foam will be able to provide the desired zonal isolation when installed properly in the wellbore. This research will help bridge the disconnect that is prevalent between cement as tested in the laboratory and as mixed and pumped in the field. Ultimately, this research will provide industry the knowledge to ensure safe operation of deep/ultradeep offshore wells in which foamed cement systems are used.

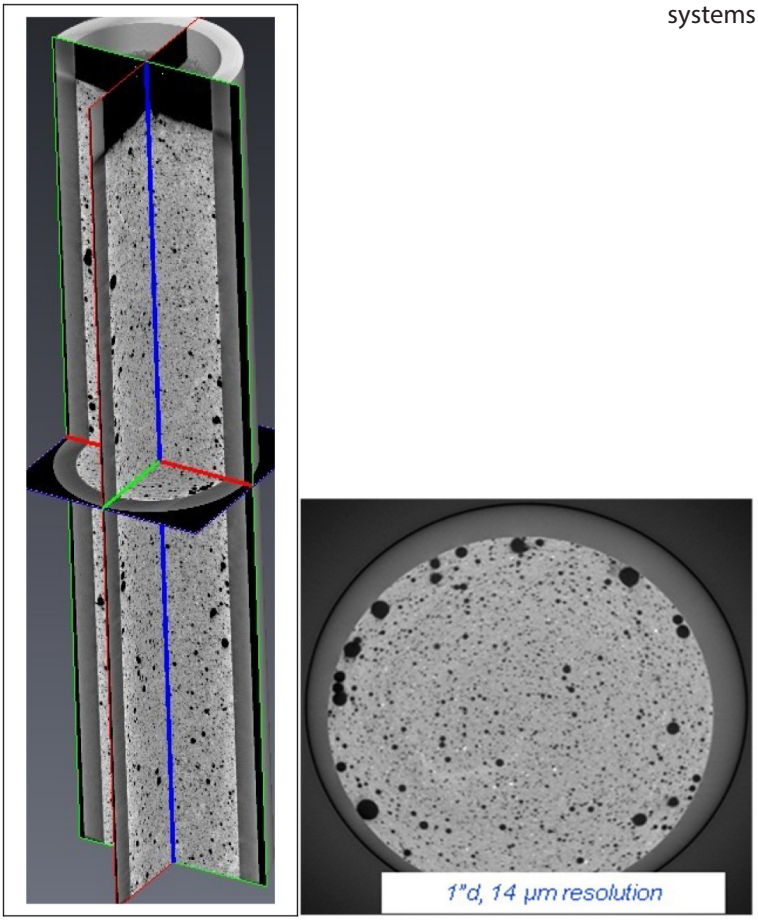

Figure 1: 3D CT-Scans of 1 inch cement core.