# Cement pulsation improves gas well cementing

World Oil, July, 2001 by Ken Newman, Dr. Andrew Wojtanowicz, Brian C. Gahan

Ongoing research successfully shows that application of the cement pulsation technique to the casing annulus delays cement gelation and maintains hydrostatic pressure. Maintenance of pressure should eliminate formation fluid influx during the cement transition period

A 1995 study by Westport Technology revealed that 15% of primary cement jobs fail, and that these cementing problems cost oil and gas-producing companies about $470 million annually. Approximately one-third of these problems are attributable to gas migration or formation water flow during placement and transition of the cement to set. In the 1990s, John Haberman of Texaco E&P proposed applying pressure pulses to the casing annulus above the cement to delay the onset of cement gelation and maintain the hydrostatic pressure. If the hydrostatic pressure is maintained, formation fluid influx during the cement transition period should be eliminated.

This article summarizes results from an ongoing research project funded by GTI, managed by CTES, L.C., and participated in by LSU to determine if cement pulsation (CP) does, indeed, reduce gas migration problems. The results discussed in this article show that the applied pressure pulses do maintain hydrostatic pressure while the cement is setting.

CP PROCESS

As soon as possible after the plug is bumped, the annular BOP is closed around the casing to seal the annulus. Then, a CP unit begins applying pressure pulses of about 100 psi, Fig. 1.

An air compressor continuously pressurizes an air tank. To pressurize the annulus, the control system opens a valve between the air tank and a water tank. The air pressure forces the water into the casing annulus and pressurizes it. To release pressure, the control system closes the pressurization valve and opens an exhaust valve. As pressure is released, water returns from the casing annulus to the water tank. Once pressure is fully released, water is added to the water tank if needed, to keep it full.

The pulses are quite slow, with built-in delays. Pressure is applied, followed by a delay of 10 to 25 sec. After the pressure is exhausted, there is another delay of 10 to 25 sec. Thus, a single pulse cycle lasts from 30 sec. to 1 mm. The volume of water displaced to the well for each pulse is determined by measuring the water level in the tank. This water volume is the "compressible volume" of the casing annulus. As the cement sets, the compressible volume of the casing annulus should decrease.

PURPOSE

The purpose of the CP process is to keep the cement in motion, delaying the onset of gelation, and preventing a significant decrease in hydrostatic pressure in the cement. If hydrostatic pressure is maintained, fluid influx from the formation during the critical time between placement and setting of cement (sometimes called the transition period) should be reduced or eliminated.

As the pressure pulses travel down the casing annulus, one would expect the magnitude of the pulse to decrease due to pressure attenuation. Some of the objectives of this project are to determine how much the pressure attenuates, how much pressure reaches the bottom of the casing, and if the hydrostatic pressure is maintained.

RECENT TESTS

Tests were performed on two very similar wells (Wells A and B) about 8,600 ft deep, with 5 1/2-in. casing inside a 7 7/8-in. hole. The lower 1,700 ft of each casing string were cemented. Instrumentation for both wells was accomplished by attaching three pressure and temperature gauges to the outside of the casing string. A 3/4-in. OD, "disposable" pressure/temperature gauge developed by CTES for this testing is shown in Fig. 2. In Fig. 3, the three wire-line cables from the three gauges can be seen being clamped to the casing, at a casing collar. As the casing and cables were run in the hole, clamps were attached to every third joint to support the cables.

One gauge was placed near the bottom of the cement column, one gauge in the middle and one gauge at the top. In Well A, the top gauge was just above the top of cement, in the drilling fluid. In Well B, the top gauge was just below the top of cement.

In both tests, the clamps used to attach the pressure and temperature gauges to the casing caused errors in the pressure calibration. The pressure data were adjusted for this calibration error, based upon the known hydrostatic pressure of the drilling fluid column at various depths.

RESULTS

The results from Wells A and B were similar. For brevity, only the results from B are shown in this article. Figs. 4 through 6 summarize the results from Well B. The following paragraphs are comments about the test results.

Initially, pulses were begun with 10-sec. delays after pressure was applied, and after exhausting the pressure, with 107-psi pulses introduced at the surface, Fig. 4. Four times during the process, the pulsing system was paused for 2 to 3 min. Each time the pulses were paused, there was a significant decrease in downhole pressure. It is believed that this pressure decrease was due to gel strength development in the cement. Within two to three pulses after pulsing was resumed, hydrostatic pressure was recovered.