LINER CEMENTING

PROBLEMS AREAS AND SOLUTIONS

The practice of using liners to affect a savings in cement and pipe costs does not exist without problem areas. When using liners, the three basic characteristics which cause the bulk of the problem are: 1) the lack of pipe movement to effect mud removal, 2) the typically narrow annulus available in most liners, and 3) the exposed annulus at the top of the liner.

To approach the first difficulty, most equipment used to hang a liner inside a section of pipe generally does not have the capabilities to allow the pipe to be rotated or reciprocated. As has been shown in the industry many times, pipe movement, especially when used in conjunction with scratchers and centralizers, is a very effective way to remove drilling cake from the walls of a drilled hole. This mud removal is essential to achieving a good bond to formation and pipe with uncontaminated pipe.

There are liner hangers now available which allow the liner to be rotated once it is hung, but due to the fact that this technology is fairly new, most operators are reluctant to use the equipment. Even if rotation is available, assistance of scratchers and centralizers is not available because of the second characteristic: a narrow annulus.

Because operator tries to maintain as much working space (inside diameter) as possible, liners are usually a "tight" fit in their drilled hole. Typical annuli can be as small as 3/8 inch on either side of the pipe. This narrow clearance does not allow sufficient space for scratchers or centralizers to fit on the pipe; so many liners are cemented without them. There are alternative methods of achieving desired mud removal. The first method, turbulent flow depends on the presence of eddies and cross currents in the velocities which created considerable problems due to the limited annular clearance. The flow of fluid through any constriction results in friction pressure. As the cement slurry flow through the annulus, the resulting friction pressure is proportional to the velocity and inversely proportional to the annular clearance. Due to the narrow annulus, in many cases it is not possible to achieve turbulent flow without the friction pressure causing a formation breakdown. Prior to reaching turbulent flow, the fluid is in laminar flow which is ineffective totals mud removal.

To alleviate this problem, fluid loss control agents have been developed for inclusion in cement slurries. These materials will reduce the rate at which liquids can be drawn away from a cement slurry. By reducing the rate of liquid leak-off, build up of cement filter cake is lessened and the risk of bridging the annulus with dehydrated cement is greatly lessened.

Now that the problems caused by a narrow annulus are known and taken care of, let's consider the remaining troublesome characteristics of a liner: the exposed annulus at the top of the liner. In normal casing cementing, where the pipe extends completely to the surface, the only place for fluids to enter the pipe is at the bottom or shoe. Because of this, the first concern of a cement job is to obtain a fluid seal at the shoe. But in a liner, fluids can enter not only the shoe, but also at the overlap area where the liner extends up into a previously set pipe. In fairly short liners, less than 2,000 feet in length, this is not too much of a problem, because the temperatures at both ends of the liner will be nearly equal, and the cement will develop strength at about the same rates at both the shoe, and the lap.

Problems occur as the liners get longer. With a length of up 6,000 feet, the temperature difference between the bottom and the top of the liner can easily exceed 100°F. This poses problems in that, a slurry thickening time is based on the pumping time available at the temperature at the bottom of the liner, because it is the hottest. Once the slurry is in place, the cement will take a considerably longer time to develop sufficient strength to seal off the overlap. During this extended time, the cement may be disturbed by formation fluids entering into the upset cement destroying its integrity. If this happens, the seal at the top of the liner may be lost, and a remedial cement job known as a squeeze job must be performed to restore the seal. Even if the slurry is not disturbed, the added time expended waiting for the cement to develop sufficient strength is wasted as far as the rig time in concerned. So, any steps which can be taken t o shorten this waiting on cement (WOC) time will result in a better chance of a good cement job, and a saving of time for the operator. There are essentially two methods of achieving this sealing function in the shortest amount of time, one concerning the slurry design, and one concerning a placement technique.

In the slurry design, the thickening time is based on the projected pumping time plus some safety margin. By reducing the safety margin to bare minimum, you will achieve the shortest WOC time at the top of the liner. But because lack of a large safety margin, if there are nay-unexpected circumstances, the danger exists that the cement will not be completely circulated into place before it sets up.

The placement technique is known as the planned squeeze. Normally, cement is circulated above the liner hanger before shutting in to wait on cement, and it is dependent on the cement in the overlap to develop sufficient strength soon enough to effect a seal in the planned squeeze. Sufficient cement is mixed to fill only 70 or 80% of the annular length, the idea being to purposefully leave the overlap void of cement.

Then, after allowing the cement at the shoe to develop sufficient to seal it, a squeeze tool is run in, and fresh cement slurry (with a thickening time based on the temperatures in the overlap) is forced or squeezed down into the overlap area to achieve a good seal. The disadvantages of this method are the (a) an extra trip into the hole must be made with the squeeze tool and this takes up valuable time; and (b) it is very easy to leave a void space which can expose the casing to corrosive formation fluid which may cause problems later. Because of this, many jobs are performed in a single stage, allowing time for the cement in the overlap to develop sufficient sealing strength. If some leaking is detected during subsequent testing, a squeeze job is planned. Although this method is more time consuming, a better cement job is usually assured.