

## **Section 6**

### **Production Logging**

Tools used to diagnose production problems are referred to as production logs. Production logs include:

- Cement bond logs
- Casing and tubing inspection logs
- Radioactive tracer
- Temperature logs
- Spinner logs - Bulk flow logs
- Multiphase flow and Fluid identification
- Gradiomanometer - pressure gradient
- Noise logs
- Oxygen activation and other pulsed neutron
- Bottom hole pressure gauges

One or more likely, a combination of these tools will help diagnose production problems. The data obtained with these tools is always evaluated in the context of all other available information of the well or field.

#### Cement bond logs

The cement bond log (CBL) and now combined with the variable density log (VDL) have been the standard way to check the quality of the casing cement job. The CBL checks the cement bond with the casing and the VDL measures the bond of the cement with the formation. The basic principle used in these tools is transit time of an acoustic wave.

There are now logs that directly measure and map the cement distribution around the pipe, ultrasonic pulse echo. It will find gas cut cement behind the pipe and access the compressive strength of the cement.

When running these logs it is a good idea to make several pass with the tools to see any anomalies. If possible run these logs with and without pressure on the casing to check for a micro-annulus. Run the log over the cement top for correlation purposes.

Remember in the areas that indicate intermediate bonding, the log does not give a good indication of hydraulic sealing integrity of the cement job.

## Downhole casing inspection

The major inspection tools are:

Mechanical calipers

Acoustic tools – assess the pipe ID, surface roughness, and wall thickness.

Electromagnetic tools – examine and discriminate the inner from the outer pipe surfaces.

Casing potential profiles – foresee electrochemical corrosion and used in the design and evaluation of cathodic protection.

Borehole video cameras – actual view of the casing and possible damage.

The major things that you are looking for when running these logs are pipe separation, splits, holes and corrosion.

## Radioactive tracers

These logs trace radioactive markers that are either run in materials placed in the well during jobs (frac sand) or fluid pumped into the well.

Radioactive markers are used to find the frac height by tagged sand run at the end of the job or in the frac fluids. Markers are also used in gravel packs to show the placement of the gravel.

Radioactive markers are used to follow fluid flow. To find both fluid channeling behind the casing and high permeability zones in the formation. The radioactive tracer log should include a diagram of the well as well as the tool. This will help in locating where the tracer is in the well or formation and ease the evaluation process. Anomalous results, such as the flow rate apparently decreasing and then increasing further downhole, should be presented, not smoothed, on the interpreted log. This will show either a real physical effect or an indication of log quality.

Radioactive as well as chemical tracers are also used to measure flow times between wells in water floods.

## Temperature logs

A temperature profile of the well is helpful in locating fluid movement downhole. Applications include the location of production and injection zones. Determination of gas vs. liquid entries. Also in assisting in locating channels. Used in locating the zones of acid placement. If run at the right time, finding the cement top.

### Spinner logs

Spinner or bulk flow logs measures the velocity of the fluid in the tubing, thus the flow rate at various depths. This is used to find where the production is coming from in wells with several zones open. Also in water flood injection wells, which zones are taking fluid and which are not. Needed in the planning for the amount of treatment and the use of flow blockers in workovers. Used in getting information for water conformance work.

The tool can be moved over the production interval to record the data or can be stationary if entry points are far apart. May be difficult to interpret in wells with high GOR's.

### Multiphase flow and Fluid identification

A flowmeter that measures the bulk total flow rate regardless of the number of phases present. And identifies the liquid holdup of the fluid phase that is present. Two methods are used to identify the fluids, the density and the capacitance of the fluid. The density method works better in stationary situations.

### Noise logs

Fluids make noise as they flow through rock or perforations, the amplitude of this noise is measured by this log. Also gas expanding is a great noise maker. This log is used to find gas flows and movement behind the pipe. Here again it is best to display the data on a well diagram to help in the interpretation.

### Oxygen activation and other pulsed neutron

Used in finding the water flowing in the wellbore, both in the pipe and behind the pipe. Used both in production and injection wells to find the water flows. It accurately detects and quantifies the downhole water flow to enhance the planning and improvement of conformance and water management.