Petroleum Technology Transfer Council
APPALACHIAN BASIN

OPEN HOLE COMPLETION DEPTH CONTROL

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Since open hole completion work has experienced a resurgence of popularity, some of the techniques inherent in this style of completion are relatively new to some of the people involved in that work. One aspect of this type of completion is the need to use a careful system of depth control. Whereas in a cased hole completion the perf guns are guided by a correlating gamma ray log, the open hole work must be done in a similar fashion except that one extra tool is needed. This tool is called a steel line and the steel line measurement or SLM as it is referred to, must be used continuously throughout the open hole procedure. This is so that any differences of depth between the original open hole logs and the rig' s steel line are compensated for, permitting the placement of the treatment accurately in the target zones.

The normal procedure in open hole completions involves "notching" or cutting a groove in the formation using a blast of sand and air through a jet on the end of a string of tubing. It is at this point that the correlation of the logger's depths to the steel line used by the rig occurs. With the tubing string run into the well, a

slim-hole gamma/CCL log is used to locate the position of the tool on the end of the tubing relative to the formation. This is an important step since all other depths needed during the procedure will be determined with this steel line, including packer sets and plugback depths. This procedure is necessary because, for various reasons, the depth determined by the SLM may be different from the original depths recorded on the open hole logs. The calibration of logging tools, reference points from which the logs were run and hole conditions may all contribute to this difference.

Several steps can be taken to enhance the accuracy and reliability of the SLM. First, a permanent reference point at the surface should be established from which the correlation gamma ray will be measured as well as all future depths during the completion. Usually the top of the collar on the water string is as good a choice as any since this casing will usually not change for the duration of the completion. Next, when running the tubing string for the notch, place a short joint, perhaps ten feet long, on the bottom of the string. With the known length of this joint and the notch tool installed, the exact position of the notch tool can be noted with the aid of the CCL log. I have found it helpful to always set the tubing a known distance above the reference point so that the calculations for the SLM will always use this same amount. When working repeatedly with the same rig crew, this is not a difficult request and can add to the procedural regularity of the operation.

At this point, the most important series of calculations will be made. In doing the calculations a pre-established format or work sheet is helpful. It is a good idea to record at least the minimum pertinent data on this sheet, including the well number or other identification, date, log zero or permanent reference point such as "top of the 7" casing" and perhaps the name of the target formation and its depth from the open hole logs. Once the SLM is run inside the tubing, it should be noted and labeled as such on the work sheet. If after the gamma ray log is run it is determined that any tubing

needs to be added or removed to facilitate the notch procedure, the change in tubing should be shown in the SLM. If more than three joints are added or removed, it may be wise to re-run the SLM.

Next, the slim-hole gamma ray CCL tool is run. Common practice in the Appalachian Basin is to use an expanded scale of either 20 or 25 inches per 100 feet of hole. Of course it is not necessary to log much more that the zone of interest and perhaps a couple of additional correlating marker beds or stringers. Once the log is run, the completion engineer can compare it to the original open hole logs and identify the desired location of the notch points. With this information and the calculation of the SLM it can then be determined how far the notch tool must be raised to cut the first notch. If more than one notch is desired, the same calculation can be made proceeding from the lowest notch point in the hold towards the surface. If it becomes necessary to remove more than three joints of tubing while proceeding with the notch procedure, it is wise to repeat the SLM and gamma/CCL procedure.

Once notches have been cut and the tubing pulled, a confirmation log can be obtained using a three arm caliper and gamma ray. The notches should appear as slight hole enlargements on the caliper, perhaps as much as three-fourths to an inch deep depending on the hardness of the formation. During the balance of the treatment procedure of the well, the SLM notch points will be used once again for calculation of the depths to wash-down and packer set. On frac day, in addition to the pipe tally, a cross hair affixed to the bottom of the frac packer makes it possible to measure the depth of the packer with a SLM prior to the start of the wash-down of the first zone. This adds to the assurance that the zone being treated has been accurately isolated.

While some parts of this procedure may seem too cautious, it would seem possible that in the past a causal attitude toward depth measurements during the completion work contributed to wells

that should have been better. In one case of reworking a well that had been walked away from by the operator, a three arm caliper was first run to check the depth of the original notches. It was determined that they had been cut in the zone but not in the best porosity. It can only be assumed that the treatment did not penetrate the portion of the zone with the most gas. With accurate depth control we re-notched and re-fraced the well and the result was a producible well where before there has been little production and considerable water influx.

In conclusion, the extra care and time that it may take to utilize a precise method of measurement and correlation during open hole work should pay off in dividends from a more productive well.