PHILLIPS #1
SW-SE, Sec. 26-32S-4W
Sumner County, Kansas

INTERPRETATION OF BOTTOM HOLE PRESSURE SURVEY

During the period September 30 to October 6, 1969, a bottom hole pressure survey was conducted in the Phillips #1, SW-SE, Section 26-32S-4W, Sumner County, Kansas. The first phase of the survey was a static bottom hole pressure test during which period of time, the well was shut in for 72 hours. The second phase of the survey consisted of a flowing bottom hole pressure test, during which period of time, the well was flowed for slightly in excess of 72 hours in a attempt to ascertain the draw-down characteristics of the well. The survey was conducted in an effort to determine the reasons for the poor performance of this well and also to determine whethere any remedial measures might be feasible.

Prior to running the bottom hole pressure guage for the static bottom hole pressure test, the well had been produced for approximately 50 days without any appreciable interruption. During this period of time, the well had produced 688 bbls. of oil plus approximately 1960 bbls. of salt water and approximately 8500 MCF/gas. After the bottom hole pressure guage reached test depth of 3941', the well was flowed on a 17/64" choke for 1 hour and then shut in for a 72 hour build-up. Prior to shutting in the well, the flowing tubing pressure was 150 psig, while the casing pressure was 525 psig. The flowing bottom hole pressure at the same time was 562 psig. As the difference between the flowing bottom hole pressure and the flowing casing pressure was only 37 psig, it does not appear that the annulus was loaded up with fluid. At the end of 71 1/4 hours, the static bottom hole pressure at 3941' was 1406 psig. Prior to conducting the flowing bottom hole pressure test, a static well gradient was run to ascertain the fluid level and also, the content of the fluid column in the well. The fluid level was indicated to be at 3169' with oil to 3682'. Salt water was indicated from 3682' to 3941' (50' above the mid-point of the casing perforations). A tubing collar stop at 3962' prevented the bottom hole pressure guage being run any deeper. The gauge was set at 3941' to facilitate the extrapolation of the pressure data at the mid-point of the perforations.

The bottom hole pressure guage was re-run and set at 3941' preparatory to commencing the flowing bottom hole pressure test. Prior to opening the well, a bottom hole pressure of 1410 psig was recorded. The well was flowed on a 14/64" choke for approximately 20 hours during which period of time the bottom hole pressure declined to 763 psig. During the final two hours of this 20 hour period, the well produced oil at the rate of approximately 10 BPD, water at the rate of approximately 40 BPD and gas at the rate of 171 MCF per day.

The choke setting was increased to 17/64" and the well flowed for an additional 52 1/2 hours. During this period of time, the bottom hole pressure declined to 615 psig and remained constant for the final 6 1/2 hours of the test. During the final 3 hours of this test, the well produced at the rate of 10 BOPD, 35 to 40 BWPD and 171 MCF per day. As may be noted, these rates are approximately the same as those noted while the well flowed on a 14/64" choke. As the flowing bottom hole pressure was still declining on the 14/64" choke, the fluid production data for that portion of the test did not represent stabilized conditions. Prior to pulling the bottom hole pressure guage from the flowing test, the casing pressure was 535 psig. This indicated a difference of only 80 psig between the bottom hole pressure and the surface pressure. Once again, it was indicated that little or no fluid buildup had occurred while the well was producing.

The interpretation of the shut in pressure obtained on DST #2 in the interval 3978' to 4008' indicated reservoir pressure of approximately 1645 psig plus a fault or permeability barrier in the vicinity of the well. This indicated reservoir pressure of 1645 psig was 200 to 300 psi less than noted in the Yarnell #1 and the Zook #1. An extrapolation of the shut in bottom hole pressure obtained on the subject survey indicated reservoir pressure of approximately 1950 psig and no fault or permeability barrier. In addition, the bottom hole pressure survey indicated that the transmissibility of the producing zone in the Phillips #1 actually is 5% of the value obtained from the drill stem test. The average permeability of the area being drained by the Phillips #1 is probably in the order of 1 to 2 millidarcys. Calculations based on flowing bottom hole pressure data indicates slightly higher values for permeability. It is believed, however, that the values based on the data of the static bottom hole pressure are more representative as the well was not completely stabilized at the end of the 3 day flow test. This is based on the fact that the flowing bottom hole pressure on a 17/64" choke at the end of 3 days was 615 psig while the flowing bottom hole pressure on a 17/64" choke prior to shutting in for the static bottom hole pressure was 562 psig.

The radius of investigation of a drill stem test normally is quite small due to the fact that small quantities of fluid are produced during a relatively short flow period. As a matter of fact, it is estimated that the depth of investigation of DST #2 in the interval 3978' to 4008' was probably something less than 50'. Apparently the good recovery on the drill stem test (2100' of gassy oil and 125' of salt water) plus the reasonably good transmissibility value of 245 was the result of vuggy porosity in the immediate vicinity of the well bore. This porosity was noted in the cores that were obtained. Unfortunately, this vuggy porosity apparently was a very localized condition. The permeability barrier indicated by the drill stem test data is possibly the result of a rather abrupt change from this predominately vuggy porosity to intercrystalline porosity with some hair line fractures. This area of vuggy porosity with fair permeability (30 to 40 millidarcys as indicated by core analysis and drill stem test data) cannot be very extensive based on the values obtained from the static bottom hole pressure data. Little or no formation damage was indicated on either the drill stem test or the bottom hole pressure survey data.

A review of the data obtained prior to the completion of the Phillips #1 appeared favorable with the exception of the static pressure obtained on the drill stem test. The core analysis and log data were comparable and indicated favorable conditions. The flow pressure data, oil recovery and transmissibility calculations based on the drill stem also appeared favorable. During completion operations, however, the well did not flow as readily as the Yarnell #1 or the Zook #1. At the time, it was thought that the well was loading up with fluid.

As the bottom hole pressure survey data does not indicate any "skin effect" or formation damage, it is not possible to recommend reacidizing the presently producing zone. In view of the fact that the well is producing approximately 80% water, a fracture treatment cannot be recommended. As vertical fractures were observed in the core, it is very possible that a fracture treatment would follow the vertical fracture pattern and result in more water production. Any appreciable increase in water production would probably necessitate installation of a pumping unit. As it is doubtful whether any appreciable increase in oil would result from a fracture treatment, this type of remedial work does not appear economically feasible.

There is a possibility that some additional oil production might be realized by perforating and treating the interval 3970' to 3980'. The indicated log porosity and permeability appear lower than that found in the producing interval 3886'-3996'. As the unexploited interval 3770' to 3780' is less than 20' from the Chat zone, it is recommended, however, that any work be deferred until the gas line is operational and we have a market for the gas. In the event that we establish communication between the interval 3770'-3780' and the Chat zone, we would not be forced to waste the excess gas, by flaring. In addition, it would be more economical to exploit the possible oil zone found 3770'-3780' while we have the unit in to open the Chat zone for gas production.

N. B. GOVE

October 20, 1969