Preliminary Results of Production Tests in the Bavly Field

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Many problems of efficient development of oil fields are debatable. They include such questions as distribution and density of producing wells, their production, the terminal production coefficient of the reservoir rocks, and permissible production pressure.

In the development of large oil fields where reservoir pressure is to be maintained, relatively wide hole spacing is now recommended (up to 60 hectares 150 acres per hole) with the greatest theoretically possible output and injection pressures significantly higher than the initial formation pressure. It is understood that with a wide hole spacing the losses are insignificant and do not exceed 5% of the reserves if the distance between holes is not greater than 1000 meters. This philosophy is reflected in the work of VNII in the past 5-6 years, in particular in the Romashkin oil field and vicinity.

New points of view developed by VNII were submitted to broad scrutiny at the sessions of the Central Commission for Oil and Gas Field Development of the MNP (Ministry of National Production) in March, 1957, during the inspection of the development project of the Shkapov field and several areas of the Romashkin field. Many of those views encountered opposition from geologists and engineers, who feared greater losses due to the wide hole spacing and an injection pressure greater than the initial formation pressure.

To test some of these concepts in practice, the Central Commission accepted the offer of Tatar producers to make tests in the Bavly field. It was to be determined whether established production could be maintained with half the wells shut down and without increase in the amount of injected water.

The Bavly field is ideally suited for such an experiment.

Discovered in 1946, its principal producing bed is D₁ of the Pashiy beds of the Frasnian stage of the Devonian, composed of comparatively uniform, highly permeable (600 millidarcies) sandstones with a 20.6% porosity on the average. Initial formation pressure was 172 atmospheres. The deposits form a large sloping dome.

Bed D₁ was fully drilled by 1958. Producing wells, distributed within the production contour, including the very top of the anticlinal part of the deposit, are drilled 400 meters apart in circular and semicircular rows (more or less parallel to the contour) 500 meters apart. Injection wells are irregularly distributed beyond the outer production contour 1,5 to 3 km from the outermost row of production wells and 1 to 3.5 km apart.

At the beginning of the experiment most of the petroleum (over 90%) from bed D₁ was produced by free flow. On May 1, 1958, the group included 80.7% of flowing wells, 10.5% of wells with submersible electric pumps, 7.3% of wells with deep pumps, and 1.5% of wells flowing periodically.

Many of the operating wells yield water. Forty wells produce less than 1% water, 20 wells 1-5%, 17 wells 5-15%, and the remaining wells more than 15%. All wells with more than 1% water are outside the contour of free flowing production, but wells with less than 1% water are both inside and outside this contour.

Flooding from beyond the contour is done with 26 injection wells with a daily injection of 18,300 cubic meters (tons) of water.

The capacity of the wells varies from 200 to 1700 cubic meters and averages 700 cubic meters per day. The total injection is irregularly distributed through the field, primarily due to the inhomogeneous nature of the reservoir bed and also due to the different length of time the wells have been in production. In the last few years the situation was somewhat improved by putting in operation new injection wells and by hydraulic fracturing of the reservoir in holes with low capacity. Nevertheless, the production is not yet equalized, which produces the irregular rise of the oil-water contact and raises the contour of oil production.

In the past five years, the daily oil production was kept level, and not much higher than foreseen in the planned quota.

The Table lists the formation pressure in bed D₁ of the Bavly oil field (as of the first of January of each year).

The injection pressure has remained at 190-200 atmospheres for a long time.

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