Some Results of Working the Kalinovka Field

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The Kalinovka oil and gas field, one of the oldest in the Kuybyshev area, is located in the east of the Kinel-Cherkassy oil-gas region.

Sediments of the Permian, Carboniferous, and Devonian Systems are present in the stratigraphic section of the field. The field occurs on an asymmetrical anticlinal structure of E-W trend; it is one of the structural uplifts of the Bol'shekinel dislocation. On the top of the Upper Permian sediments the structure is 20 km long and 6.5 km wide. The south flank is steep with angles of dip from 1 to 6°; the north is more gentle with angles of dip up to 1°. A gas cap occupies the crest of the structure. The oil pool is located on the steep south flank in the form of a narrow fringe. The initial gas-oil contact was determined at the -170 m level, and the water-oil contact at -194 m. The productive horizon of the Kalinovka formation of the Upper Permian consists of fractured dolomites with porosities of 3 to 34% and permeabilities from fractions to 100 md and more. The average effective thickness of the productive horizon is 11.7 m. The oil of the Kalinovka formation is light (sp. gr. is 0.865), sulfur-bearing (3.6%), high in tar (up to 48%) and paraffin (3.5%), viscous (11-24 sst), with a predominance of methane hydrocarbons.

The oil pool was drilled in 1940-46 on a triangular net with a distance of 150-260 m between wells. A total of 321 wells were in production.

The oil and gas pools were worked up until 1950 without maintaining formation pressure. As a result the formation pressure in the pool dropped from 27.5 to 3-5 atm. In 1950 due to the outbreak of gas from the gas cap into the oil pool, there was a sharp increase in the gas-oil ratio from 23 to 402 m$^3$ per m$^3$.

In order to restore the formation pressure, from 1950 to 1955 natural gas was injected into the crest of the Kalinovka field. During the five years a total of 441,791 thousand m$^3$ of natural gas was introduced. No increase in formation pressure was noted, and outbreaks of gas into the production wells were noted. Therefore, the gas injection was halted. In 1954 injection of water was begun in an experimental sector in the center part of the oil pool in order to overcome the outbreak of gas from the gas cap and to increase oil production.

Up until April 1957 a total of 457,812 m$^3$ of water had been injected into the stratum. The formation pressure increased to 7.2 atm, and the gas-oil ratio in the sector of flooding dropped to 150 m$^3$ per ton. Production, however, did not increase, and the water content rose to 86%. No water was injected from April 1957 to June 1958, and the formation pressure dropped anew to 3.7 atm. In 1958 production was halted in the active front of wells, and injection of water was renewed in the experimental sector. After injection of 289,378 m$^3$ of water, the formation pressure in the sector rose to 5 atm.

Results of testing 13 production wells in the summer of 1959 showed that in spite of a rise in formation pressure, oil production did not increase (Vyzhigin, G. B., Geologiya Nefti i Gaza, no. 2, 1962). Therefore, water injection was again halted. Production from the oil pool of the Kalinovka formation was terminated in June 1960 because it has become unprofitable. All wells, except for 38 located on the sub-gas pool, were put on a stand-by status. Casing-head gas is now produced from these 38 wells. Liquid extracted from the wells in order to lower the dynamic level was disposed of by flowing into adjacent inactive wells. See Fig. 1.

The average formation pressure in 1959 was 4.4 atm, the gas-oil ratio was 5428 m$^3$ per ton, and flooding was 69.5%. The recovery factor was 0.161; a value of 0.5 had been planned.

In 1957 injection of discarded water into the productive stratum was begun through wells that had been shut down. These included wells located in the south of the pool close to the water-oil contact (see Fig. 1) and also wells in the experimental area of flooding. Into the latter in 1961-62 had been injected 101,880 m$^3$ of water. For the entire period 1957-63 a total of 450,000 m$^3$ of de-emulsified water was injected into the productive horizon of the Kalinovka formation. Formation water from the Sosna and Deryuzhev fields, which differs from that of the Kalinovka field (see Table 1), has been injected after de-emulsification since 1961. As of December 1, 1963 a total of 1200 thousand m$^3$ of fresh and discarded water had been injected.

For control of the effects of injection of discarded water on working of the pools, measurements have been made since 1960 of yields of gas, flooding, and formation pressure in the oil and gas pools. See Fig. 2.

Thus, after production was halted in the oil pool, there was a drop in the amount of extractable gas and also a drop of pressure in