APPLICATION FEATURES OF THERMO BAROCHEMICAL EFFECT ON THE BOTTOM-HOLE ZONE

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ABSTRACT

The paper describes features of complex thermobarochemical treatment (TBCT) method applied to bottom-hole zones (BHZ). The method is based on the use of solid rocket fuels, and the authors consider its application regarding for geological and technical safety of works and the geological effectiveness – the two factors contradicting each other to some extent.

INTRODUCTION

The problem of enhanced oil recovery is nowadays most acute in those producing companies which operate many old wells, and the content of asphalt-resin- and paraffin matters (ARPM) in the well production is very high.

Thermal methods are among most effective methods used to clean the bottom-hole zone from ARPM. At the end of the last century thermal methods based on solid gun powder combustion in the well bore – thermal-gas-chemical effect (TGCE) – were a common practice. The main drawback of TGCE methods is that they destroy the well.

In 1966 a group of Russian petroleum engineers and developers of solid fuel started to use convertible solid rocket fuels in combination with combustion retarders of new design, which eliminated mechanical impact on the casing and the cement stone [1, 2, 3, 4]. Here, complex procedures of the bottom-hole thermobarochemical treatment were developed.

METHOD DESCRIPTION

Unlike formerly used TGCE method, when TBCT technique is used, the impact destroying effect of the solid fuel combustion is replaced by depressing impulse action. Not only solid depositions formed on walls of the well are broken, but any movable

deposit is carried away from the formation and the cleaning of the channels is more efficient.

TBCT procedures combine three methods of well treatment: thermal-gas-chemical method based on the use if powder charges; chemical method; and hydroimpulse and depressing methods using various implosive devices.

TBCT techniques have been tested and successfully applied at the Russian oilfields – in Republic of Bashkortostan (over 20 wells), Republic of Tatarstan (over 10 wells), Perm oblast (over 60 wells), and also in Republic of Kazakhstan (RK) (more than 100 wells).

The widest experience of TBCT application was acquired at the oilfields of Kazakhstan.

Below are given specific features of TBCT method used under Uzenskoe oilfield conditions (RK).

1) Formation is not exposed to uncontrolled shock mechanical action since ADS-5 solid fuel with burning retarder is used. E.g., solid fuel cartridge 4.5-m long burns up within 7.5 minutes at the bottom-hole pressure of 14 MPa and the temperature of 65 ^{o}C.

2) Blowing (liquid blowout) when the charge is burning is excluded. For this purpose a small preventer with rams for geophysical cable, which tightly closes the well head, is used instead of perforation gate.

Filling up the well with liquid creates backpressure on the formation during the burning of the charge, the hot gas-liquid mixture is forced into the formation and deeper radial heating of the bottom-hole zone is ensured.

3) Thermal-gas action during TBCT is intensified by the chemical action of the agent delivered in one container with the fuel, heated and displaced into the formation during the burning of the charge. Any non-conducting substances (ARPM solvents, etc.) admitted for use in the oil industry may be used as the chemical agent. At Uzenskoe oilfield, in particular, hydrophobizing agent “Polyseal” mixed with gasoline was successfully used for treatment of the first 20 wells. Good results were obtained when gasoline fractions from Uzen gas processing plant were used.

4) After thermal-gas-chemical attack the depressing chamber is open and additional depressing effect on the bottom-hole zone is created. Series of pressure

impulses breaks solid inorganic deposits in the perforation interval, which have no longer the bond with the walls of the well due to wax melting. Movable organic and inorganic deposits are carried into the well through perforation channels and get partially into the depressing chamber.

5) TBCT excludes the danger of valve plugging and failure of subsurface pumping equipment. This is achieved by proper choice of chemical agents which act as dispersants and exclude re-solidification of waxes and resins recovered from the formation and remained in the bore.

TBCT method may be implemented by means of equipment lowered to the bottom-hole on the tubing or geophysical cable.

Tubing variants of TBCT method (TBT-02, TBT-03) are not discussed in this paper notwithstanding their geological effectiveness, since big amount of work due to complex procedures (overhaul teams are required, well repair period is extended, etc) makes the cable variant, TBO-01, more expedient.

TBT-01 procedure includes pulling out the subsurface equipment, bore hole gaging for better passage of TBT complete set, TBT set assembling and lowering on the cable into the treated interval, thermobarochemical treatment of the formation. The set consists of two containers from 89-mm tubing pipes [5, 6, 7]: the first, thermo-gas-chemical one, contains a solid fuel charge and a chemical agent, and the second serves as a depressing chamber and is filled with air at the atmospheric pressure. There are inlet and outlet valves in the body of the thermo-gas-chemical chamber. The total length of the set does not exceed 9 m.

The set is installed in the treated interval, the well is filled up to the wellhead, the wellhead is sealed and connected to the oil pumping-out line. Fuel igniter is electrically activated. During 10-20 minutes of the fuel burning in the sealed well the thermal-gas-chemical action is in the process. After specified time the wellhead gate is open. Combustion gases move upward and displace the well liquid into the oil pumping-out line – 20-25% of the liquid column, as a rule.

The formation pressure being high enough, the lowering of the level brings to drawdown and induces inflow. The formation liquid flow carries the rest and heated to flowing state depositions away from the bottom-hole zone. The level in the well is being

restored till equalized with the formation pressure. TBT equipment is withdrawn from the well, pump equipment is run in, and the well is put into operation.

Contradiction between geological-technical safety and effectiveness is that safety requirements limit the number of wells where TBCT method could be used most effectively. The method is recommended for formations with rather good reservoir properties, since it is designed for restoration of the formation productivity. Wells with initially low productivity require hydrofrac methods or gas-hydraulic fracturing using powder charges ADS-6, PGD-BK, ZGRP, etc. Such methods improve reservoir's filtration properties and increase inflow of oil.

However, referring to vast Russian experience of using gun-powder charges for gas-hydraulic fracturing, well treatment appears safer and more effective, if performed in 2 stages. At the 1st stage spare thermal-gas effect without sharp increase in pressure should be obtained using, for example, TBCT method described above, or a delayed-combustion solid fuel charge. This will clean the walls of the well from depositions and ensure high intake capacity of reservoir. At the 2nd stage gas-hydraulic fracturing is performed by means of instant-burning charges. Here breaking of the casing and the cement ring in case of no intake capacity of reservoir is eliminated, radial fracturing of formation is deeper and powder charges of less mass are required.

So, the use of solid fuel charges for thermobarochemical treatment of oil formations should be done in carefully selected wells and with account for requirements above.

CONCLUSIONS

1. Methods of spare thermobarochemical treatment without shock pressure waves, based on the use of solid fuel, e.g. rocket fuel, with combustion retarders are preferable for keeping "good" reservoirs' maximum productivity (in Uzenskoe oilfield), regarding for geological and technical safety of works.

2. Spare methods are of low effect if used to increase productivity of formations with poor reservoir properties. Here hydro- and gas fracturing methods are required. Spare TBCT is recommended prior to fracturing procedures in order to remove depositions from the walls in the perforation interval and eliminate breaking of the casing and the cement ring.

3. Application of methods based on use of solid rocket fuels solve ecological problems relating to utilization of such fuels, on the one hand, and help to restore the productivity of oil wells and the intake capacity of injection wells, on the other hand.

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