

PROMISING TECHNOLOGY FOR ENHANCED OIL RECOVERY OF OILFIELDS WITH DIFFERENT RESERVOIR PERMEABILITY

Anert D. S

Scientific advisor associate professor Manzhai V. N
National Research Tomsk Polytechnic University, Tomsk, Russia

Oil fields present a complex structure, and field development is quite a complicated task. Today, most of the fields are at the later phases of development, and the recoverable oil is characterized by significant water cut, which is caused both by the reserve recovery and often by the high heterogeneity of the geological section in terms of permeability [5–6,8,10]. Even after the use of primary techniques of enhanced oil recovery, for example, during water flooding, the oil recovery factor rarely exceeds 0.50 and generally falls within the limits of 0.25...0.45. About 55-75% of the total geological reserves remain within the Earth's interior. Such indicators are considered unacceptable; therefore, various techniques of enhanced oil recovery are commonly used in fields, including in particular, physical-chemical methods [1,7,9,12]. One of the most viable methods to enhance oil recovery in fields with different reservoir permeability is the multi-component injection of various agents in the form of low-viscosity water solutions ($\eta_{fluid}=1-10$ mPa·s), that easily runs into already flooded channels under the external injection pressure. As time passes, due to the high reservoir temperature, chemical reactions go there to form new compounds of high viscosity and almost non-flowable consistency ($\eta \geq 1 \cdot 10^3$ mPa·s). As a result, layers with high permeability are blocked by pasty system and further water injection leads to displace oil from lower permeable zones [2–4,11].

Oil recovery was simulated in fields with different reservoir permeability during the laboratory experiments using two composites of different composition. Two parallel columns filled with dispersed core material were used as a reservoir model. The previously prepared columns were placed in a laboratory bench to determine the gas permeability, the gas flow rate was fixed, and, the packing density of the core material was corrected, if needed. Then the columns were placed in the SAP-700 laboratory bench, where they were sequentially saturated with water and oil. The initial data of the experiments on oil displacement at the SAP-700 unit is presented in Table 1.

Table 1

Initial data for making experiments on the SAP-700 installation

Composition A (8 % urea, 4 % aluminum chloride)								
Column number	Mass, g					Pore volume, cm ³	Oil volume, cm ³	Permeability, D
	empty	full of core	core	with water	with oil			
1	1190,5	1307,0	116,5	1331,3	1331,0	24,3	18,2	0,17
2	1188,2	1298,8	110,6	1326,6	1328,6	27,8	23,1	0,62
Composition B (8 % urotropin, 4 % aluminum chloride)								
Column number	Mass, g					Pore volume, cm ³	Oil volume, cm ³	Permeability, D
	empty	full of core	core	with water	with oil			
1	1159,0	1275,3	116,3	1300,8	1301,2	25,5	18,9	0,17
2	1144,2	1252,6	108,4	1280,0	1280,2	27,4	22,7	0,59

According to laboratory experiments, dependence diagrams on accumulation of displaced oil on time (Fig. 1), as well as the pressure change dependences during the filtration process (Fig. 2) were plotted. Obviously, the presented dependences (Fig. 1) indicate that, up to injecting composites into the unit, oil displacement is observed almost only from the high-permeability column, which significantly reduces the oil recovery factor.

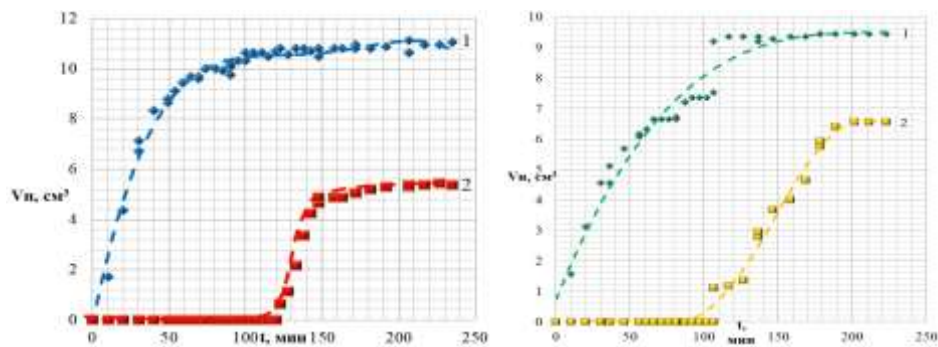


Fig. 1. Relationships of cumulative oil and water production on time using composition based on: A) urea; B) urotropin: 1 – oil from high-permeable sample; 2 – oil from low-permeable sample

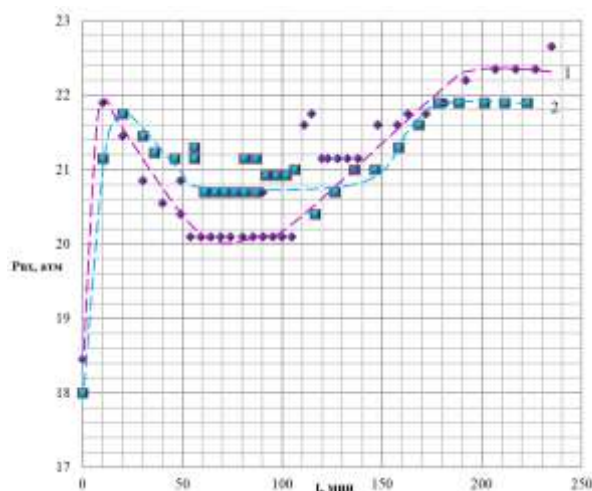


Fig. 2. Dependence of the change in pressure at the entrance to the system on time in the experiment with: 1 – urea; 2 – urotropin

In addition to plotting the dependence diagrams shown in Fig. 1, 2, the recovery factor was also estimated before and after the composites were injected. The results are shown in table 2.

Table 2

Recovery factor (RF) before and after using A and B composition

Composition A (8 % urea; 4 % aluminum chloride; 88 % water)		Composition B (8 % urotropin; 4 % aluminum chloride; 88 % water)	
RF	%	RF	%
Before using composition	25,0	Before using composition	14,0
After using composition	40,0	After using composition	38,0
Additional	15,0	Additional	24,0

As may be inferred from the experimental results (Table 2), the total oil recovery factors for each composition amounted to A=0.40 and B=0.38, respectively, while the values of 0.15 and 0.24 are additional recovery factor values that were obtained through the use of composites. The experimentally obtained results allow for the conclusion that, due to a considerable increase in oil recovery factor, as well as owing to the availability and low cost of the composite components, their use is feasible both from a technological and economic point of view.

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