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RADIATION-CHEMICAL TRANSFORMATION OF SYNTHETIC OIL FROM OIL-BITUMINOUS ROCK

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Abstract: Like as test subject was used synthetic oil from oil-bituminous rocks of the Balakhany deposit. The regularities of synthetic oils radiation-chemical transformations were studied. Laboratory researches were carried out in an interval of absorbed dose 43-216 kGr and dose rate P=0.5 Gr/s (γ - radiation). Concentration, radiation-chemical yields of the received gases in the various absorbed doses were established. Results of researches allow to estimate possibility use of oil products received from synthetic oil for isolation of radioactive sources from environment.

Keywords: *bituminous rock, synthetic oil, radiation-chemical transformations, radiolysis.*

1. Introduction

Bituminous rock (BR) - the natural material formed from oil in the top layers of earth crust, as a result of slow evaporation from it of easy fractions, natural deasphalting of oil, and also processes of interaction of its components with oxygen and sulfur. According to the United Nations world geological resources of bituminous rocks (BR) make ~ 360 billion t, in recalculation on a hydrocarbonic part and are an alternative source of hydrocarbonic raw materials. All world oil extraction from BR makes about 84 million barrels per day. BR resources in Azerbaijan make 200 million t.

The purpose of the given work is research of radiation stability of synthetic oil from BR. Results of such researches will allow to estimate possibility of production different purpose oil products from synthetic oil in a radiation-chemical way, and also use of these materials for isolation of radioactive sources from environment.

2. Experimental

We investigated the synthetic oil received from BR of the Balakhany deposit Azerbaijan. By distillation on Retort Heating Jacket device at temperature 950 F (510^{0}C) from 375 g have been received 50 ml synthetic oil. Content in rock are %: oil - 22, water - 6, sand - 2. Experiments were carried out in γ – source ^{60}Co at dose rate 0,5 Gy/s and at the absorbed doses 43-216 kGy. Gas products were analyzed by a gas chromatography method. On fig. 1 as an example were given kinetic curve of formations gases in vacuum and in the presence of air during gamma-radiolysis of synthetic oil from bituminous rock.

For all gases oxygen operates as accelerating factor in the process of radiation-chemical decomposition of synthetic oil that is connected with behavior of oxidizing-destructive reactions with participation of radiolytic radicals. Average values of radiation-chemical yields of gases are resulted in table 1.

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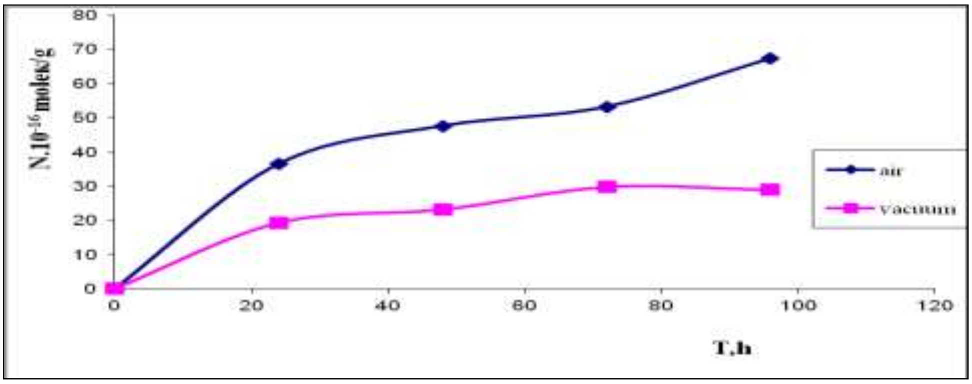

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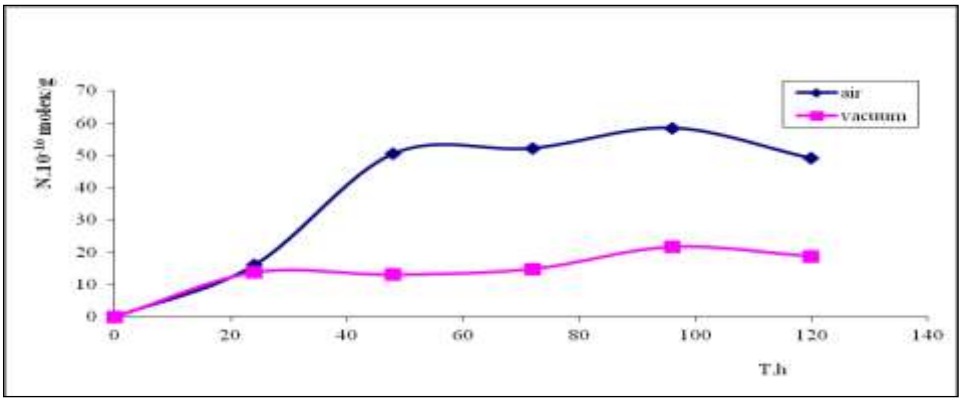

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Fig. 1 (a,b). Kinetic curve accumulation of methane (a) and ethane (b) during gamma-radiolysis of synthetic oil from natural bitumens. P=0,5 Gy/s.

Table 1 Average values of radiation-chemical yields of gases (molec/100 eV) synthetic bituminous oil

Average values of radiation-chemical yields of gases (molec/100 eV) from BR	H_2	CO	CO_2	CH_4	C_2H_6	C_2H_4	C_3	C_4	C_5	C_6	C_7
Air	0,31	0,85	0,66	0,06	0,05	0,024	0,13	0,33	0,32	0,16	0,04
Vacuum	0,37	0,26	0,67	0,03	0,02	0,005	0,014	0,022	0,176	0,13	0,06

On figure are resulted chromatograms samples of synthetic oil. According to chromatograms are defined components in the input and irradiated samples of synthetic oil.

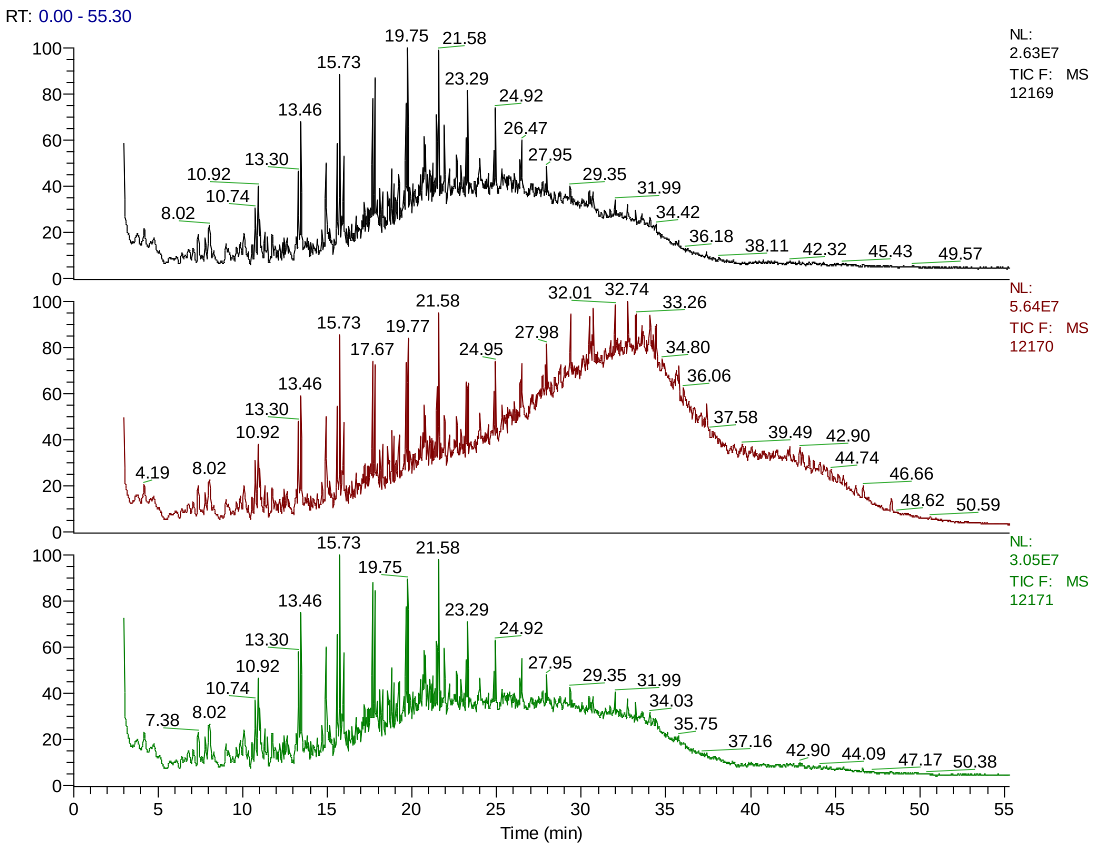

Fig. 2. Chromatograms the input and irradiated synthetic oil in air and vacuum

The identified components of input synthetic oil are resulted in table 2.

Table 2 The identified components of input synthetic oil

№	**RT, *min***	**The identified components of input synthetic oil**	**Formula**
1	4,17	Toluene	C_7H_8
2	7,37	p-Xylene	C_8H_{10}
3	7,79	cis-2-Nonene	C_9H_{18}
4	8,02	Nonane	C_9H_{20}
5	9	Octane, 2,6-dimethyl-	$C_{10}H_{22}$
6	9,65	1-Octyn-3-ol, 4-ethyl-	$C_{10}H_{18}O$
7	10,09	Benzene, 1-ethyl-3-methyl-	C_9H_{12}
8	10,56	Benzene, (1-methylethyl)-	C_9H_{12}
9	10,74	1-Decene	$C_{10}H_{20}$
10	10,92	Decane	$C_{10}H_{22}$
11	11,31	1-Octanol, 2-methyl-	$C_9H_{20}O$
12	11,75	Benzene, 1-ethyl-4-methyl-	C_9H_{12}
13	13,3	1-Undecanol	$C_{11}H_{24}O$
14	13,46	Undecane	$C_{11}H_{24}$
15	14,67	Undecane, 6-methyl-	$C_{12}H_{26}$
16	14,93	Benzene, 1,2,4,5-tetramethyl-	$C_{10}H_{14}$
17	15,58	Cyclopropane, nonyl-	$C_{12}H_{24}$

18	15,73	Dodecane	$C_{12}H_{26}$
19	15,97	Undecane, 2,6-dimethyl-	$C_{13}H_{28}$
20	17,67	1-Tridecene	$C_{13}H_{26}$
21	17,8	Tridecane	$C_{13}H_{28}$
22	18,81	1-Pentadecanol	$C_{15}H_{32}O$
23	18,92	Cyclohexanol, 5-methyl-2-(1-methylethyl), [1R-(1à,2á,5à)]-	$C_{10}H_{20}O$
24	19,64	1-Tetradecene	$C_{14}H_{28}$
25	19,75	Tetradecane	$C_{14}H_{30}$
26	20,73	Naphthalene, 2,7-dimethyl-	$C_{12}H_{12}$
27	20,81	Tetradecane, 2,6,10-trimethyl-	$C_{17}H_{36}$
28	21,45	2,6-Dodecadien-1-ol, 3,7,11-trimethyl,(E,E)-	$C_{15}H_{28}O$
29	21,58	Pentadecane	$C_{15}H_{32}$
30	21,92	1H-Indene, 2,3,3a,4,7,7a-hexahydro-2,2,4,4,7,7-hexamethyl	$C_{15}H_{26}$
31	22,64	Naphthalene, 1,6,7-trimethyl-	$C_{13}H_{14}$
32	23,19	1-Hexadecanol	$C_{16}H_{34}O$
33	23,29	Hexadecane	$C_{16}H_{34}$
34	24,84	1-Heptadecanol	$C_{17}H_{36}O$
35	24,92	Heptadecane	$C_{17}H_{36}$
36	26,4	8-Heptadecene	$C_{17}H_{34}$
37	26,47	Octadecane	$C_{18}H_{38}$
38	27,95	Nonadecane	$C_{19}H_{40}$
39	29,37	Eicosane	$C_{20}H_{42}$
40	30,49	Octadecane, 3-methyl-	$C_{19}H_{40}$
41	30,72	Heneicosane	$C_{21}H_{44}$
42	32,74	Allopregnane	$C_{21}H_{36}$
43	33,26	Octadecane, 3-ethyl-5-(2-ethylbutyl)-	$C_{26}H_{54}$

For studying composition of bituminous oil we have divided it's distillation into 3 fractions: to 110^0C, 125^0C, 145^0C. Samples of fractions have irradiated on a γ – source ^{60}Co at dose rate 0,5 Gy/s and at the absorbed dose 86.4 kGy. Radiation-chemical yields of gases are resulted in table 2.

Table 2 Radiation-chemical yields of gases (molec/100 eV) bituminous synthetic oil at the absorbed dose 86.4 kGy, P=0.5 Gy/s

Fractions from BR, ^{0}C	H_2	CO	CO_2	CH_4	C_2H_6	C_2H_4	C_3	C_4	C_5	C_6	C_7
1. T< 110	0.70	1.96	0.38	0.91	0.22	0.02	0.04	0.01	0.05	0.28	0.23
2. 110<T<125	0.42	3.72	0.89	0.60	0.41	0.03	0.07	0.04	0.28	0.38	0.14
3. 125<T<145	0.67	3.51	2.18	0.24	0.53	0.08	0.09	0.02	0.09	0.13	0.05

From table 2 it is visible that total radiation-chemical yields of gases are from fraction 1: - 4.8 molec/100 eV, from fraction 2 - 6.9 molec/100 eV and from fraction 3 - 7.5 molec/100 eV, that is connected with concentration and differences of molecular structure of the compounds, which are a part of these fractions.

3. Results and discussions

It is necessary to note that, paraffin and polycyclic aromatic hydrocarbons have relatively high stability to radiation influence. At the same time, functional groups, especially oxygen-containing, and also, olefinic hydrocarbons, less radioimmunity. Stability of these organic compounds to radiation depends on potential of the excited conditions and ionization and that defines behavior the energy transmission processes between components. In the presence of the polyconjugate aromatic structures the absorbed energy dissipate π-electrons and bond breakage occur in functional groups. The irradiation of these samples in the air reduce to small growth of destruction process, but yields of products remain relatively low. For increase of a radiation-chemical yield of gases and for achievement chain mechanism of hydrocarbons decomposition in such systems, it is necessary to apply high temperatures.

4. Conclusions

Relatively high radiation stability of synthetic oil from BR in vacuum and in the air, is connected with presence in its structure paraffin and polycyclic aromatic hydrocarbons. It is identified that the products received from BR, have high stability to influence of radiation and temperature 50^0C. Synthetic oil can be used as feed stock for manufacture of the waterproofing material, which will applied in the conditions of radiation influence. Organic part of BR can serve as a perspective source for the receiving of various kinds of fuels, oils, coke, bitumen. For the receiving of hydrogen, hydrocarbon gases and olefinic hydrocarbons from synthetic oil combined influence of ionizing radiation and temperature is necessary, at the coordinated value of temperature and capacity of radiation.

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