Junis N. Gahramanly*

FEATURES OF PROCESS OF PURIFICATION
OF A WATER SURFACE FROM OIL AND OIL PRODUCTS
BY FOAMED POLYMERIC SORBENTS
ON THE BASIS OF POLYMERIC MIXTURE

In process of pollution of sea water area by oil products the environment begins to cope hardly with anthropogenic loading. It leads to decrease in quality of biological resources of the sea ecosystem and to reduction of their quantity [1, 2]. In this connection, the researches directed on elaboration of methods on accelerated and safe gathering of oil from water surface and its utilization begin to get paramount significance. In our opinion, application of the foamed polymeric sorbents which are notable for by high sorption capacity, floatability, hydrophobicity and ability to repeated regeneration is the most perspective. Researches in this direction are begun comparatively recently. These researches basically were accented on the sorbents obtained on the basis of individual polymeric materials [3–6].

In given article researches are directed on development of sorbents on the basis of mixtures of polymers. The reason of so particular attention to polymeric composite materials is that efficiency of sorption by foamed polymeric sorbents obtained on the basis of a mixture of diverse polymers turns out considerably above, than of individual polymers.

Polyethylene of high density (PEHD) with a melt index 1.5 g/10 minutes and the recycling block polystyrene (PS) with a melt index 3.2 g/10 minutes were being used as object of research. Blending of components was being carried out in extrusion machine at temperature 413–463 Kelvin degree. Azodicarbonamide (ACA) was being used as a gas developing agent for the foaming of polymeric composite and dicumyl peroxide (DP) was being used as a cross-linking agent. For increase of hydrophobicity of sorbents the petroleum bitumen (2–3 %mass) was being added into the polymeric mixture. Extrudate obtained during the reactionary blending was in the form of foamed, cross-linked, hydrophobic, polymeric material with the closed-cellular macrostructure. Strands of the foamed polymer

* The Azerbaijan State Oil Academy, Baku

were being cut in form of granules in the size 5–7 mm. Next they were being used as a sorbent for gathering of oil and oil products from a water surface. The volume weight (the apparent density) of sorbents was being changed by regulation of technological parameters of extrusion, within 25–520 kg/m^3.

The following materials were being used as a sorbate:

Binagadian oil of Apsheron – density – 293–851 kg/m^3, kinematic viscosity – 5.50 cSt at 323 Kelvin degree, flash temperature – 433 Kelvin degree.

Diesel fuel – density – 293–930 kg/m^3, kinematic viscosity at 323 Kelvin degree – 19·10^{-6} m^2/s, flash temperature 340 Kelvin degree.

Compressor oil of mark К-19 – kinematic viscosity at 373 Kelvin degree – 18.0 cSt, coking ability no more than 0.5%, acid number (mg KOH per 1 g of oil) no more than 0.04 mg, ashes mass fraction, no more – than 0.01%, flash temperature not less 518 Kelvin degree, pour point not above 268 Kelvin degree.

Transformer oil of mark T-1500 – kinematic viscosity at 323 Kelvin degree – 8.0 cSt, acid number (mg the KOH per 1 g of oil) no more than 0.01 mg, pour point not above 228 Kelvin degree.

Sorption was being studied in a laboratory glass with water. Oil or oil product layer in the thickness of 1 mm was being put on water surface. Next the foamed polymeric sorbent was being added on surface of the given layer. Sorbent was being pulled out from a water-oil surface after a certain time slice at temperature 298 Kelvin degree and then sorbent was being weighed. Quantity of the adsorbed oil or oil product was being determined on a difference of weights of sorbent before and after sorption.

Sorption capacity (V_s, kg/kg) of sorbent was being determined as a ratio of quantity of the adsorbed product and initial weight of a sorbent.

Volume weight (the apparent density, kg/m^3) was being determined as a ratio of weight of a sorbent to its geometrical volume.

The sorbents obtained by extrusion method have got basically the closed-cellular structure. Through pores form only 13–16% of this structure. The more the content of pores in a macrostructure of sorbent, the more its sorption capacity and its floatability is worse. The cells located basically closer to a sorbent surface take part in process of sorption of oil and oil products. And the cells which are located in a depth of sorbent are, as a rule, closed and provide to it buoyancy. Therefore, at selection of a macrostructure of a sorbent it is necessary to stick to certain balance in the ratio of closed cells and pores.

In comparison with structure of classic mineral sorbents (active coals, silica gels, etc.) the structure of polymeric sorbents is considerably more labile and is much more sensitive to interaction a sorbent-sorbat, to temperature and to external pressure [7]. Therefore, in the given work we will try to show laws of change of the sorption capacity of sorbents depending on type of sorbate, volume weight and diameter of cells of the under test samples.

Results of research of influence of a ratio of PEHD and PS in a polymeric mixture on sorption capacity of the foamed polymeric sorbents on their basis with volume weight within 25–65 kg/m^3 are shown in the Table 1.

Table 1

Influence of a ratio of PEHD and PS in the polymeric mixture, on sorption capacity of the foamed polymeric sorbents which are obtained on their basis.

Temperature 298 Kelvin degree. Volume weight of sorbents 25–65 kg/m^3

Sorbent name	Ratio of components in a mixture	Oil	Diesel fuel	Compressor oil	Transformer oil
		Sorption capacity, kg/kg			
Sorbent on the basis of mixture PEHD+PS	0:100	18.4	4.0	10.7	10.5
	20:80	18.0	4.9	11.4	11.2
	40:60	22.2	5.6	13.6	14.0
	50:50	20.3	6.9	14.5	14.0
	60:40	15.1	7.3	12.5	10.6
	80:20	10.2	5.6	9.3	7.6
	100:0	8.1	4.8	7.8	7.0

Analyzing the data shown in this table it is possible to establish the sorption capacity of sorbents on the basis of the polymeric mixtures is being characterised by comparatively high values. Sorbents with a ratio of components in mixture PEHD+PS which is 40:60 have the maximal sorption capacity on oil and oil products. It is necessary to notice, maximum sorption capacity on oil and minimum on diesel fuel are observed at sorbents with volume weight 25–65 kg/m^3. Apparently, it is connected by that sorbents with volume weight 25–65 kg/m^3 are being characterised by comparatively large diameter of cells which is 0.8–1.0 mm. It is possible to explain low values of the sorption capacity on diesel fuel by comparatively large cells on diameter, where the retentivity of molecules of diesel fuel becomes lower. The maximum sorption of diesel fuel (8.0 kg/kg) takes place at ratio PEHD:PS = 60:40.

Maximum sorption of the compressor and transformer oils takes place mainly on sorbents with the ratio of components 50:50.

Sorption features of sorbents with volume weight 290–330 and 470–520 kg/m^3 have been investigated similarly. In this case the maximum values of sorption of oil and oil products have been established on sorbents with a ratio of components in the mixture PEHD:PS = 40:60 – 60:40. It is established at use of the sorbents obtained on the basis of polymeric mixtures PE and PS, the best results of sorption capacity on oil and on oil products have been got at ratio of components PEHD:PS = 50:50. The maximal sorption capacity on oil has been got at the volume weight of a sorbent 25–65 kg/m^3. In case of use of sorbents with volume weight 290–330 kg/m^3, comparatively high values of sorption capacity were taking place in process of sorption of the compressor and transformer oils. At use of sorbents with the small-cellular macrostructure and with volume weight 470–520 kg/m^3 the maximum sorption capacity has been established in process of sorption of diesel fuel.

Last circumstance allows asserting about selective behavior of sorption process of oil and oil products in the multicomponent foamed polymeric sorbents.

To understand features of sorption of oil and oil products by the polymeric mixtures, at first we will address to structural features of a sorbent. The spatial netlike structure between polyethylene macrochains, macrochains of polystyrene and macrochains of polyethylene with polystyrene is being formed in process of cross-link. Thus as a result of cross-link the new polymeric material with spatial structure has formed. Polyethylene is alicyclic compound on a basis of ethylene. It is possible to consider the linear part of a macrochain of polyethylene as a high-molecular paraffin, and polystyrene as the high-molecular aromatic compound, whose macrochain consists basically of benzene rings. Oil is a product consisting of paraffins, aromatic and cyclic compounds and of various compounds containing nitrogen, oxygen and sulfur which as a whole characterise oil as a polar product. On the basis of a principle «the similar is better dissolving in similar», presence in sorbents on the basis of mixtures PE+PS simultaneously of aromatic and paraffin macrochains leads to improvement of their compatibility with oil and oil products. For confirmation of the above-stated we had been carried out researches by definition of wetting angle of oil on a surface of the plates made from PE, PS and also from mixtures PE+PS at a ratio of components 50:50. It has been established, that the wetting angle of oil on a surface of a polyethylene plate – 14°, on a surface of a polystyrene plate – 16°, and on a surface of plate made from a mixture of polymers PE+PS – $10–12^{o}$. Low value of a corner of wetting at polymeric mixes testify that first of all, good wettability of a surface of a sorbent by oil and oil products is the reason of such high sorption capacity of sorbents on the basis of a mixture of polymers.

REFERENCES

[1] Parenago O.P., Davidova S.L.: *Neftekhimiya*. T. 34, No. 1, 1999, 3–13
[2] Khlestkin R.N., Samoylov N.A., Mukhutdinova R.Kh.: *Ekologicheskaya promishlenaya bezopasnost*. No. 2, 2006, 118–121
[3] Gahramanly J.N.: *Transport khraneniye nefteproduktov uglevodorodnogo sirya*. Moscow, No. 1, 2010, 30–35
[4] Gahramanly J.N.: *Neftepererabotka neftekhimiya*. Moscow, No. 12, 2010, 42–45
[5] Gahramanly J.N.: *Voda: Khimiya ekologiya*. Moscow, No. 12, 2010, 35–40
[6] Sirotkina Y.Y., Ivanov V.G., Glazkova Y.A.: *Neftekhimiya*. T. 38, No. 2, 1998, 151–154.
[7] Tager A.A., Tsilipotkina M.V.: *Uspekhi khimiyi*. T. XLVII, Issue I, 1978, 152–175