UTILIZATION OF SOME WATER-SOLUBLE POLYMERS AS FLOCCULANTS FOR TREATMENT OF SEWAGE CONTAINING OIL

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ABSTRACT

Laboratory experiments were conducted in order to investigate the possibilities of some water-soluble polymers to be used as flocculants for treatment of oil containing water. The effect of magnetic activation of the polymers on flocculation process was studied. It was found that preliminary magnetic activation of the polymers decreases the time for precipitation or accelerates the process of flocculation which leads to increasing of the rate of purification of sewer water and protects the environment.

INTRODUCTION

The activities preventing pollution of water have great significance in view of the contemporary rates of industrial development. The treatment of water with flocculants is one of the most frequent methods for treatment of coarsely dispersed and colloid impurities. One of the ways for increasing the effectiveness of flocculation by decreasing the retention time of water in the reactors is utilization of organic coagulants (flocculants) [1,2] and their preliminarily activation by magnetic treatment [3].

The aim of the present work is to examine experimentally the possibilities for utilization of some water-soluble polymers as flocculants for purification of oil containing waste water as well as to determine the effect of magnetic activation of the polymers on flocculation process.

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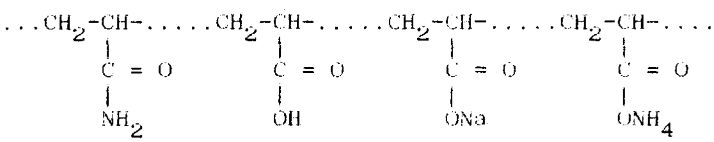
EXPERIMENTAL

Subject of present investigations were industrial and rain sewage water (IRSW). Samples were taken at the inlet of the sewer water treatment unit of Neftochim State Company in Bourgas. The composition of this water for the period January-May 1992 is given in Table 1. Water-soluble polymers used as flocculants (N1 - N4) have been synthesized in Higher Institute of Technology "Prof.Dr. A.Zlatarov" by alkaline hydrolysis of waste polyacrylo nitrile fibres, additionally modified with polyethylene oxide.

TABLE 1 - Chemical composition of IPSW at inlet of the flotator for the period January-May 1992

Characteristics	Dimension	Value
Flow rate	m^3/h	1700 -
pH	-	7 - 10.5
COD	mg O_2/l	300 - 2000
Oil products	mg/l	400 - 8000
Suspended solids	mg/l	100 - 1000
Salts	mg/l	450 - 550

The main fragments of the macromolecule of the polymers are:



Polyethylene oxide $HO(-CH_2-CH_2-O-)_{n+1}Na$ is a nonionogenic water-soluble polymer. As a result of the modification of water-soluble polymer from hydrolyzed polyacrylo nitrile with polyethylene oxide a new fragment is formed

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...CH2-CH-. . .
       |
       C = O
       |
       O-(-CH2-CH2-O-)n+1Na
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More information about studied polymers is given in Table 2.

TABLE 2 - Basic characteristics of the used water-soluble polymers

Characteristics	Type of the polymer			
	N1	N2	N3	N4
Polarity	anionic type	anionic type	anionic type	nonionogenic type
Molecular mass	53000∓500	60000∓500	68000∓500	78000∓500
Viscosity of 0.1 % solution dermined by Ford beaker, s/100 ml	26	28	30	32
Active substance, %	3	2	1	0.75

The laboratory experiments for determination of flocculation capacity of the water-soluble polymers (N1 - N4) were conducted using the following technique:

Five beakers were filled with 1 l of the studied water each. Ten mililiters of the polymer were added to the first beaker, 15 ml to the second, 20 ml to the third, 25 ml to the fourth and 30 ml to the fifth. After adding of the polymer, the mixtures were agitated for 15 min with a rate of 30 revolutions per minute. The time neccessary for sedimentation of the formed floccules was measured (Tables 3 and 4). After that water samples for analysis were taken in order to find out the degree of purification values of COD, oil, suspended solids were determined. The degree was calculated formula , $S = 100(C_1 - C_2)/C_1$, where C_1 is the value of the relevant characteristic in the check sample; C_2 value of the relevant characteristic in flocculated water.

TABLE 3 - Time for settlement of floccules (min) depending on the type and concentration of the polymer without magnetic treatment

N	Concentration, mg/l	Volume, ml	Type of polymer			
			N1	N2	N3	N4
1	15	10	80	75	70	60
2		15	70	65	60	55
3		20	65	60	55	50
4		25	70	70	65	55
5		30	75	85	70	60
1	10	10	75	70	65	55
2		15	70	65	60	60
3		20	65	60	55	45
4		25	70	65	60	50
5		30	75	60	65	55
1	5	10	65	55	50	35
2		15	55	50	40	25
3		20	50	40	25	15
4		25	60	50	30	20
5		30	65	55	45	30
1	2.5	10	70	65	60	50
2		15	65	60	55	45
3		20	60	50	45	40
4		25	65	55	50	45
5		30	70	60	55	45

TABLE 4 - Time for settlement of floccules (min) depending on type and concentration of the polymer with preliminarily magnetic treatment

N	Concentration, mg/l	Volume, ml	Type of polymer			
			N1	N2	N3	N4
1	15	10	65	60	50	40
2		15	60	55	45	30
3		20	55	50	40	25
4		25	50	55	45	30
5		30	55	60	50	35
1	10	10	60	55	40	35
2		15	50	45	40	30
3		20	45	40	30	20
4		25	50	45	35	25
5		30	55	45	40	30
1	5	10	55	45	40	25
2		15	45	40	30	15
3		20	40	30	15	5
4		25	50	40	20	10
5		30	55	45	35	20
1	2.5	10	55	50	45	30
2		15	50	45	40	25
3		20	45	40	30	10
4		25	50	45	35	20
5		30	55	50	40	25

RESULTS

From experimental data in Table 3 is seen that the result is better for flocculation with polymer N4. The best time for settlement reached with this polymer is 15 min at dosage of the polymer in sewer water 0.1 mg/l. When using polymers N1, N2 and N3 the relevant time was 50, 40 and 25 min, respectively (Table 3). The results indicate that polymer N4 is most promising.

The data in Table 4 show the time of settling of sewer water when the polymer was treated by magnetic field with induction 0.19 T in static conditions for 10 min. It is seen that preliminarily magnetic treatment of the studied polymers accelerates considerably the process of flocculation. The best result concerning the time for settling 5 min is obtained again with polymer N4.

Every value in the tables is an average from 5 measurements made at the same conditions. This is done because of the continuous variation of the type and rate of pollution of the treated water.

The results in Tables 5 and 6 show the rate of purification of sewer water for previously determined optimal content of polymer in sewer water 0.1 mg/l and time for settlement 15 min (without magnetic treatment of the polymer) and 5 min (when magnetic treatment is done) for the period of study mentioned earlier.

Data in Tables 5 and 6 show high degrees of purification of sewer water when preliminarily magnetic treatment of the polymer is done in comparison with the case when auch a treatment is not done. The results obtained can be explained by influence of magnetic field on structure of the water-soluble polymer and ionization of the end functional groups which favour structure-forming effect of the flocculant.

TABLE 5 - Degree of purification (%) of IRSF with flocculant N4 at optimal content of the polymer 0.1 mg/l and time for settlement 15 min, without magnetic treatment of the polymer

N	Month	COD, mg O_2/l		Degree of purification, %	Suspended solids		Degree of purification, %
		before treatment	after treatment		before treatment	after treatment	
1	Febru-	545	320	41	220	50	77
2	ary	830	470	43	325	80	75
3		480	190	60	180	65	64
4		610	290	52	280	74	74
5		360	215	40	135	45	67
1	March	590	335	43	240	45	81
2		870	490	44	300	96	67
3		500	200	60	195	70	64
4		630	295	53	230	50	78
5		400	230	42	140	40	71
1	April	480	305	36	180	30	83
2		675	480	29	205	46	78
3		548	195	64	170	70	59
4		612	207	66	130	60	54
5		380	200	47	140	55	61
1	May	550	310	44	225	98	56
2		820	450	45	204	70	66
3		460	190	59	178	85	52
4		600	240	60	190	65	66
5		350	200	43	165	50	70

TABLE 6 - Degree of purification (%) of IRSF with flocculant N4 at optimal content of the polymer 0.1 mg/l and time for settlement 5 min, with preliminarily magnetic treatment

N	Month	COD, mg O_2/l		Degree of purifica-tion, %	Suspended solids		Degree of purifica-tion, %
		before treat-ment	after treat-ment		before treat-ment	after treat-ment	
1	Febru-	545	250	54	220	30	86
2	ary	830	400	53	325	55	83
3		480	130	73	180	35	80
4		610	190	69	280	30	89
5		360	140	61	135	15	89
1	March	590	260	46	240	25	90
2		870	180	56	300	55	82
3		500	130	64	195	30	85
4		630	210	79	230	20	91
5		400	150	62	140	10	93
1	April	480	220	54	180	15	92
2		675	360	55	205	20	90
3		548	110	80	170	35	79
4		612	130	79	130	18	76
5		380	120	68	140	22	91
1	May	550	210	62	225	62	72
2		820	300	63	204	34	83
3		460	105	77	178	40	78
4		600	120	80	190	28	85
5		350	100	71	165	15	91

CONCLUSIONS

1. The studied water-soluble polymers can be used as flocculants for purification of IRWS in State Company Neftochim-Bourgas.

2. Polymers improve the effect of treatment regarding colloids, coarsely dispered solids and organic pollutants.

3. Preliminarily magnetic treatment of the polymers increases their effectiveness by shortening the time for settling which accelerates flocculation process.

4. Preliminarily magnetic treatment of polymer increases the degree of purification of sewer water.

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