

Danger to the water ecosystem of phenol and its derivatives

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Phenol and its derivatives are the main pollutants for the aquatic ecosystem. These compounds are discharged from various areas into water bodies and affect their flora and fauna. We analyzed the waters taken from the petrochemical plant (Baku) and analyzed their composition. The main purpose of the work was to determine the presence and amount of phenolic compounds in wastewater after treatment. To obtain accurate results, the composition of water samples was analyzed using a gas chromatographic mass detector. Organic and inorganic C and N atoms were also determined in water samples taken for analysis.

Keywords: *compounds, phenol, water, pollutants, ecosystem.*

Introduction:

We already know that phenol and its derivatives are highly toxic. Phenol dissolves well in water, forming more dangerous derivatives. In sewage waters of industrial enterprises, the content of phenols can exceed 5-10 g/l in very diverse combinations, while the maximum allowable concentration of phenols in drinking water and fishery reservoirs is 1 µg/l. Phenol concentrations are especially high inside the effluent of coke-chemical plants - up to 20 g/l, while a modern coke-chemical plant discharges up to 4–10 tons of phenol per day into reservoirs. Exceeding the natural background of phenol can serve as an indicator of the water reservoirs pollution. In phenol-contaminated natural waters, their content can reach tens and even hundreds of micrograms in 1 liter [1].

However, according to the experts, the presence of phenols in the air leads to circulatory system diseases. Phenol derivatives are very toxic: nitrophenolic compounds - nitrocene (carboniferous phenols), dinitrophenol, etc. These compounds are used as insecticides, fungicides and herbicides [2].

The destruction of phenols takes place fairly quickly at a concentration of more than 1 mg/l and phenol loss is 50–75% in a three days, however, at a concentration of several tens of micrograms in 1 liter this process slows down and the loss for the same duration is 10–15%. The fastest of all is the destruction of phenol proper, more slower cresols, even slower xyleneol. Polyatomic phenols are destroyed mainly through chemical oxidation. The presence of oil

pollution slows the decay of phenols, as biodegradation of petroleum hydrocarbons forms its own phenols, increasing the overall picture of contamination [3].

The concentration of phenols in surface waters is subject to seasonal changes. During the summer period, the content of phenols decreases with increasing temperature, the rate of decay increases. The process of self-purification of reservoirs from phenol proceeds relatively slowly and its traces can be carried away by the flow of the river over long distances, therefore, before discharge, the phenol-containing reservoirs are exposed to sufficient purification [4,5].

As we already know, in order to get rid of phenolic compounds in wastewater, it is possible to apply the modification of the Klibanov method with the use of peroxidase and talc. Peroxidase degrades phenolic compounds to polyphenols which is insoluble in water [6]. When this method is modified, namely when talc is added to the reaction mixture, the insoluble reaction products on the talc are absorbed and precipitated out of the solution. Due to this method, it is possible to completely remove the phenol from the solution, as well as to remove the reaction products. Initially, polyvinylpyrrolidone was used to remove phenolic compounds. In connection with the relative cheapness talc is being used [7].

Experimental part:

We used mass spectroscopy for the analytical determination of contaminated water taken from an oil refinery. Our goal was to determine mainly the phenol in the samples. Dichloroethane for (GC-MS) was used for water extraction. After that, phenol was determined on samples 1,2,3. For more accurate analysis, mass chromatography was carried out. The amount of phenol was determined by mass chromatography, and outweighed the MPC (table 1).

Water samples were extracted into a separatory funnel. Before the extraction, the hydrogen index of the samples was reduced to $\text{pH} < 4$. Methylene chloride was used as solvent. To prevent contamination of the extracts, samples were analyzed using a dichloromethane solvent (Rathburn, Scotland) with chromatographic purity. As internal standard, two deuterated polycyclic aromatic compounds, naphthalene-d8 and phenanthrene-d10 (Cambridge Isotope Laboratories, Inc., Andover, USA) were added to all samples. Extraction was carried out three times. The obtained extracts were combined in round-bottomed flasks and concentrated firstly on a rotary evaporator

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at a water bath temperature of $35 \pm 5^\circ\text{C}$ to a volume of 5 ml, then under a thin stream of nitrogen.

Concentrated extracts were transferred to samplers in a volume of 1 ml.

A chemical analysis of water samples was carried out on a GC-MSD gas chromatograph 6890N with a highly efficient mass-selective detector-Agilent 5975 from Agilent Technologies (USA).

Analysis of results:

Below, mass chromatography of these samples were carried out:(fig. 1,2,3).

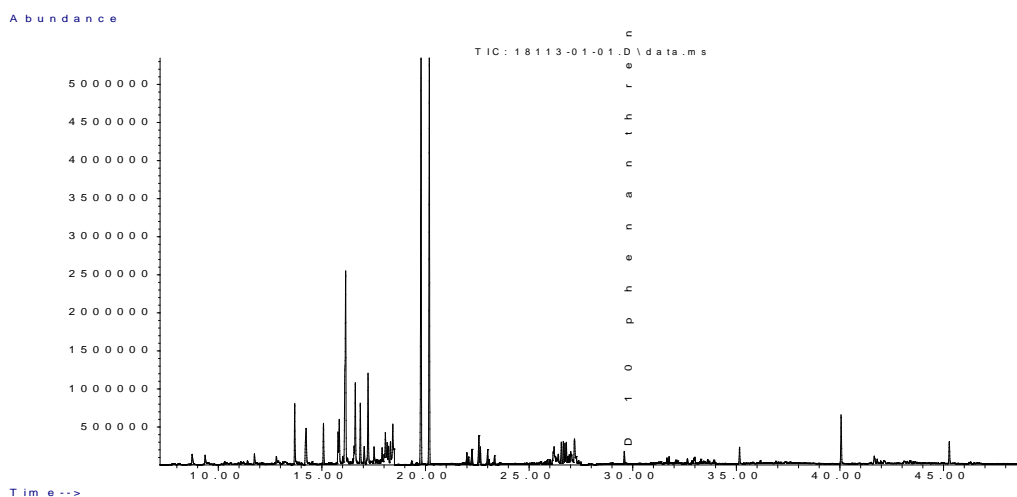


Fig. 1. Mass chromatography of wastewater -1.

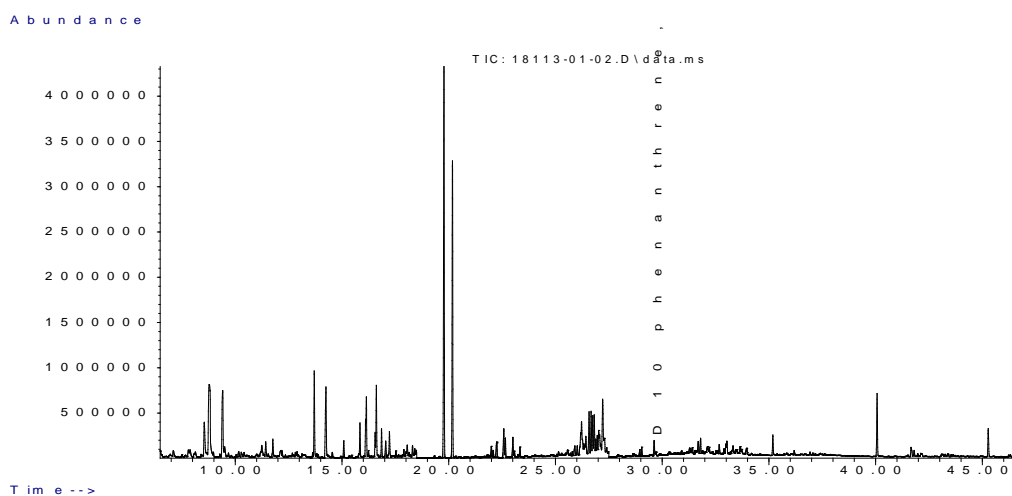


Fig. 2. Mass chromatography of wastewater -2.

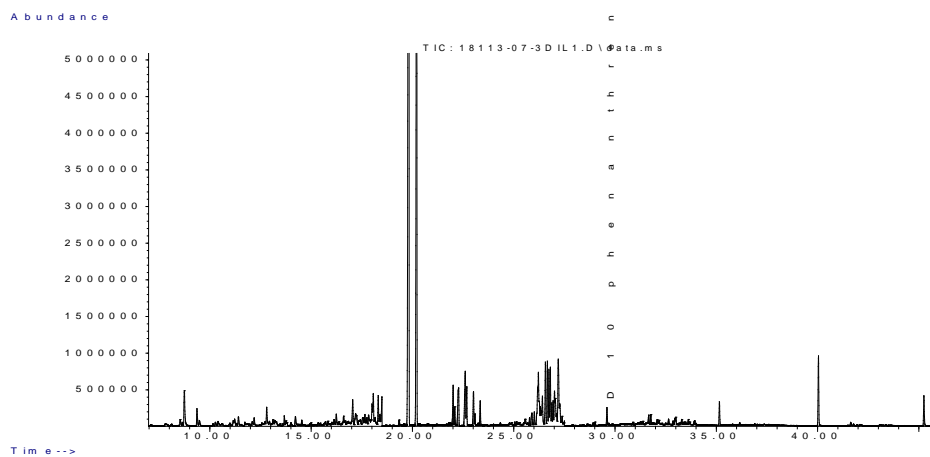


Fig. 3. Mass chromatography of wastewater -3.

Also the total number of inorganic and organic C atoms and N atoms in the water samples-1,2,3 is found (table 2). The curves in the graph below are shown: (Fig. 4, 5, 6).

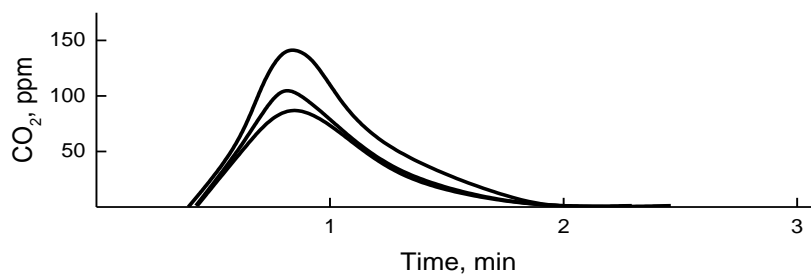
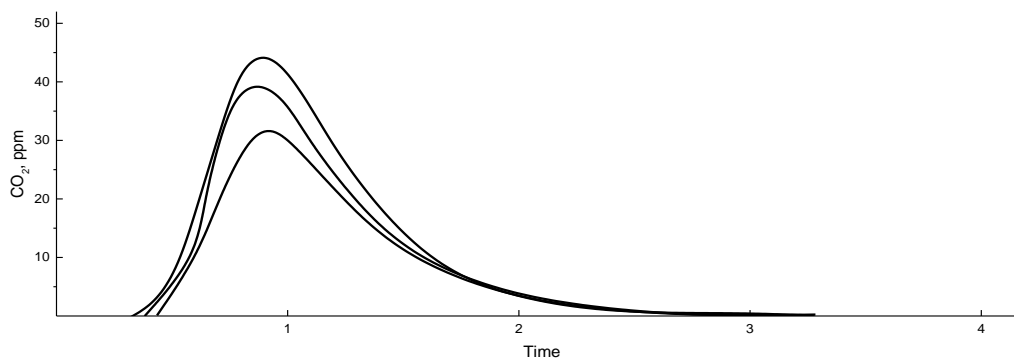


Fig. 4. Dependence of concentration of inorganic C atoms from time.



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Fig. 5. Dependence of concentration of organic C atoms from time.

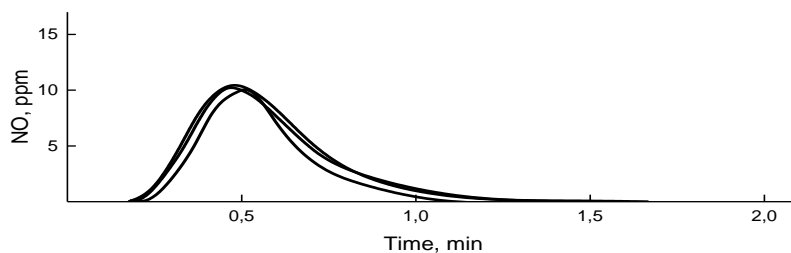


Fig. 6. Dependence of concentration of N atoms from time.

Table 1.

The amount of phenol in the samples taken from the refinery

Determinable substances 1 mkq/l=0,001mq/l	1	2	3
Phenol, mkq/l	5.33	5.66	1.45
o-cresol, mkq/l	0.76	0.26	0.16
2-nitrophenol, mkq/l	0.59	0.48	0.08
2,4-dimethylphenol, mkq/l	31.99	8.71	0.20
m,p-cresol, mkq/l	20.59	3.81	0.85
2,6-dichlorphenol, mkq/l	1.14	0.67	1.80
4-chloro-3-methylphenol, mkq/l	0.63	0.43	0.69
2,4,5-TCP, mkq/l	0.48	0.28	0.18
2,4,6-TCP, mkq/l	0.14	0.04	0.25
2,3,4,6-tetrachlorophenol, mkq/l	0.27	0.18	0.002
2-methyl-4,6-dinitrophenol, mkq/l	<0.04	<0.04	<0.04
pentachlorphenol, mkq/l	0.27	0.25	0.06
2-sec-Butyl-4.6-dinitrophenol (Dinoseb), mkq/l	<0.08	<0.08	<0.08
Total Phenols	62.19	20.77	5.722

Table 2.

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Total number of inorganic (IC) and organic (TOC) C and N (TN) atoms in the water samples

	C	I _{eff}
TOC	15.10 mg/l	
IC	27.61 mg/l	3961
TC	42.70 mg/l	6989
TN	53.81 mg/l	629.1

In surface waters, phenols can be in a dissolved state in the form of phenols, phenolate ions and free phenols. Phenols in water can enter condensation and polymerization reactions, forming complex humus-like and other fairly stable compounds) [8] .

As can be seen from Table 1, the quantity of taken phenols increases: 1.45–5.33–5.66 75 mg/l. The amount of phenol increases at the samples 1 and 2 , since these contaminated waters were taken from the initial stage of the cracking process at the refinery[9]. The amount of phenol at the total yield was 1.45 mg/l; as we see in the third trial, the amount of toxic substance decreases due to dilution. Such contaminated water must be cleaned, and after the flow of water can be poured into water resources[10]. The maximum permissible concentration (MPC) of phenol should not exceed 0.1 mg/l in water resources, and in other case, it is already a serious reason for the flora and fauna of water resources.

Conclusions:

1. Phenol and phenolic derivatives were calculated in the analyzed water samples.
2. A chemical analysis of water samples was carried out on a GC-MSD gas chromatograph 6890N with a highly efficient mass-selective detector-Agilent 5975.
3. Organic and inorganic C as well as the total number of N atoms was determined in the water samples.
4. In water samples 1 and 2, the amount of phenol exceeded the permissible limit.
5. In 3 water sample the amount of phenol was close to the permissible level .

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