CONCERNING METHYLENE BLUE SORPTION OVER ACID AND THERMALLY ACTIVIED KAOLIN IN ULTRASOUND FIELD

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Native sorbents, under the form of filtering structures, are widely applied in industry for rendering innocuous a variety of toxic substances in sewage waters, draining waters and the like. The rapid development of chemical industry in this country necessitates the undertaking of investigations for establishing the mostly effective utilization of the locally available native sorbents. Thus, the inevitable pollution of water basins, still used as recipients of draining waters, would be avoided.

Native sorbents occurring in nature have comparatively low sorptional capacity which entails systematic research to the end of rising it and accordingly, rendering them more effective. In previous works by the same authors (1, 2), certain conditions of methylene blue sorption over natural sorbents from extensive beds located in Southern Bulgaria, namely, Dimitrovgrad and Kardjali, have been investigated. The method of activation of sorbents, the ultrasound treatment itself and the recording of sorption have been already described in the above cited works (1, 2).

Acid or thermal activation of the sorbents results in a rise of their sorptional capacity towards methylene blue. Anyway, the latter increase is not to be considered as optimal. Hence, it is necessary to search for additional methods of processing with the goal of securing additional activation. As a result of our studies it was established that acid and thermally activied sorbents, after being subjected to ultrasound treatment, furthermore augment their sorption capacity towards methylene blue.

It is a well known fact that any medium subjected to ultrasound treatment undergoes a variety of intensive physico-chemical alterations. Along with pressure changes in the medium (from+3 atm to —3 atm) (2), from the equation

$$A = \frac{P}{2\pi\nu\rho C}$$

it is possible also to estimate approximately the range of fluctuations of the particles within the medium treated with ultrasound $A = 3.5 \times 10^{-5}$ cm, where $p = 3.3 \times 10^6$ dyn/cm^2 is the acoustic pressure within the medium, $\nu = 800$ kHz is the frequency of ultrasound, $\rho = 10^3$ kg/m^3 — water density and $c = 1.48 \times 10^3$ m/s — the diffusion rate of the ultrasound waves. Also, as regards the amplitude of acceleration of the particles, from the equation $a_0 = 4\ \Pi^2\ \nu^2\ A$, it results that $a_0 = 8.8 \times 10^8$ cm/S^2.

The physical and chemical processes taking place in the liquid under the effect of ultrasound are observed only in the presence therein of certain

acoustic parameters, corresponding to the apperance of the cavitational regimen, which, in general outline, appears to be the cause for all changes in the medium. High local temperatures, reaching up to several hundred degrees are produced in the pulsating resonances of the cavitational bubbles, depending on the nature of the gas (5, 6, 7, 8).

Table 1

Methylene-Blue Water Solutions' Sorption over Acid Activied Kaolin from the Village of Senovo, District of Razgrad in Kg/Kg Sorbent

Ultrasound parameters / Percent of HCl	0%	2%	5%	10%	20%
Control	0.0130	0.0167	0.0163	0.0162	0.0160
22 kHz 4 W/cm²	0.0150	0.0184	0.0176	0.0173	0.0165
800 kHz 3 W/cm²	0.0162	0.0190	0.0185	0.0180	0.0172

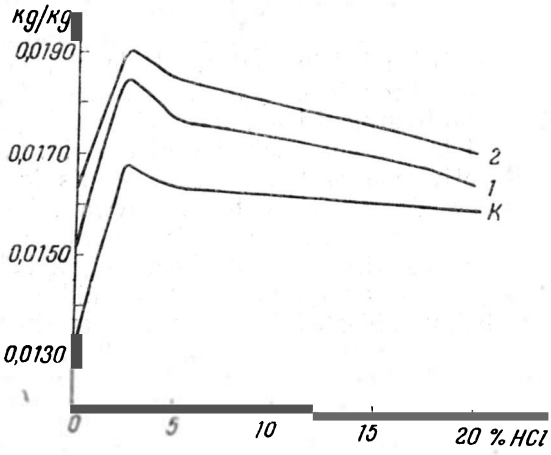

Fig. 1

Methylene-Blue Water Solutions' Sorption over Thermally Activied

Ultrasound parameters / Temperature in °C	25°	75°	105°	125°	150°	175°
Control	0.013	0.018	0.019	0.019	0.019	0.019
22 kHz 4 W/cm²	0.014	0.020	0.021	0.021	0.021	0.021
800 kHz 3 W/cm²	0.015	0.022	0.023	0.024	0.025	0.025

In the opinion of Y. N. Frenkel (7), the presence of high electric tensions under conditions of cavitation leads to the occurrence of high energy particles (ionized and excitated molecules, ions, free radicals etc).

According to some investigators (4, 9), upon occurrence of cavitation in the liquid treated with ultrasound, the chemical bonds are disrupted and the coagulational linkages in the molecular and supramolecular structures as well. Thus, the physical essence of ultrasound treatment is practically reduced to the formation in the medium investigated of cavitational bubbles, whose disruption creates enormous pressures with ensuing blast wave, high temperature, electric and photochemical phenomena. All this appears to be a powerful source for exerting influence and intensification of the physico-chemical processes.

In the work submitted a description is made of the experimental results of methylene blue water solutions sorption over acid and thermally activied kaolin from the bed in the village of Senovo, district of Razgrad, as well as of the results after ultrasound treatment. In Table 1 the experimental data are presented concerning the sorption of acid activied sorbent, graphically illustrated in Figure 1. Table 2 illustrates the data concerning the sorption of thermally activied sorbents, graphically presented in Figure 2. In both figures, the curve «k» represents the sorption capacity of the control samples (untreated with ultrasound), curve 1 — samples treated with ultrasound for 20 min at frequency 22 kHz and intensity 4 W/cm², and curve 2 — samples treated with ultrasound for 20 min at frequency 800 kHz and intensity 3 W/cm².

It is evident from Fig. 1 that subsequent to ultrasound treatment, an increase occurs of the sorption capacity with 14% in relation to the control, subjected to acid activation with 2% HCl for the samples treated with 800 kHz frequency, and with 10% for those treated with 22 kHz ultrasound frequency.

The acid activied sample with 2% HCl shows sorption capacity with 28% higher than that of the crude sorbent, the sample activied with 2% HCl and subjected to ultrasound treatment with 800 kHz has 46% higher sorption capacity than that of the crude sorbent, whereas in the sample subjected to ultrasound treatment with 22 kHz, the increase obtained amounts to 42 per cent.

Table 2

Kaolin from the Village of Senovo, District of Razgrad in Kg/kg Sorbent

200°	250°	300°	350°	400°	450°	500°	550°	600°
0.019	0.019	0.018	0.018	0.017	0.016	0.013	0.010	0.017
0.021	0.020	0.019	0.019	0.018	0.018	0.015	0.012	0.018
0.025	0.025	0.022	0.022	0.022	0.019	0.017	0.012	0.020

It is obvious from Fig. 2 that thermally activied sorbents at temperature ranging from 100 to 250° C, possess the highest sorption capacity. At identical temperature interval, the samples subjected to ultrasound treat-

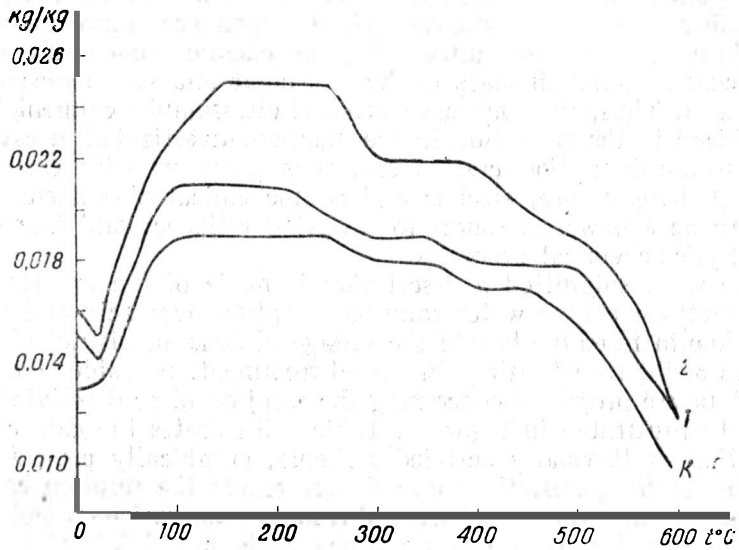

Fig. 2

ment with 800 kHz frequency display about 92% higher sorption capacity as compared to the crude sorbent, the samples treated with 22 kHz — 62% and those subjected to thermal activation only — 46 per cent.

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О СОРБЦИИ МЕТИЛЕНОВОЙ СИНИ НА КАОЛИНЕ ПОСЛЕ ЕГО КИСЛОТНОГО И ТЕРМИЧЕСКОГО АКТИВИРОВАНИЯ В УЛЬТРАЗВУКОВОМ ПОЛЕ

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РЕЗЮМЕ

В работе приведены результаты изучения сорбции метиленовой сини из водных растворов в сорбенте Kg/Kg на активированном кислотой и термически каолине из с. Сеново, Разградского района.

Активацию каолина кислотой проводили 2, 5, 10 и 20%-ной соляной кислотой, а термическую активацию — при 25, 75, 105, 125, 150, 175, 200, 250, 300, 350, 400, 450, 500, 550 и 600° С. Сорбцию производили в ультразвуковом поле следующей характеристики: 22 кгц и 4 вт/см^2 и 800 кгц и 3 вт/см^2. Полученные результаты представлены в двух таблицах и двух рисунак.

Было установлено, что вследствие озвучивания получаетя повышение сорбционной способности в размере 14% при частоте ультразвука 800 кгц и 10% — при частоте 22 кгц по сравнению с контролем, активированным 2%-ной соляной кислотой.

Активированная 2%-ной соляной кислотой проба обладала на 28% более высокой сорбционной способностью по сравнению с сырым сорбентом, а в ультразвуковом поле при 800 кгц — на 46%, и при 22 кгц — на 42%.

Наиболее высокой сорбционной способностью обладали термически активированные сорбенты в температурных границах от 100° до 250° С. В ультразвуковом поле при 800 кгц пробы обладали сорбционной способностью, приблизительно на 92% превышающей таковую сырого сорбента, а в ультразвуковом поле при 22 кгц — на 62% выше, чем при сыром сорбенте, и на 46% выше по сравнению с термически активированным.