

Scientific Seminar

***ADVANCED MATERIALS TO REDUCE THE IMPACT OF TOXIC CHEMICALS ON THE
ENVIRONMENT AND HEALTH***

POSTERS

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ADSORPTION OF O-NITROPHENOL ON LOCAL CARBONIC DSORBENTS

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Introduction. Ensuring daily life with safe drinking water is an essential issue of human society [1]. Among the pollutants identified in water, toxic substances are of particular concern, even at very high dilutions, showing maximum resistance to biological degradation. Phenolic pollutants, which occupy the 11th position in the list of 126 priority pollutants listed in the United States Environmental Protection Agency refers to this category of contaminants [2]. The use of carbonic adsorbents in water treatment technologies is justified by the fact that activated carbons are able to remove almost entirely a very wide spectrum of pollutants.

Materials and methods. In the present research, the adsorption parameters of o-nitrophenol were studied on two samples of autochthonous carbonic adsorbents, obtained from apricot stones (AC-C) and from apple wood (AC-MR). The advantages of the new adsorbent materials were evaluated in relation to the results determined for the retention of o-nitrophenol on two samples of commercial activated carbons, AG-5 and BAU. The time required to reach the adsorption equilibrium of o-nitrophenol on the investigated activated carbons was determined from the adsorption kinetic curves, measured at three initial concentrations (50, 100 and 200 mg/l) in the interval of time between 15 -360 minutes. The adsorption experiments were carried out in a thermostatic shaker by contacting a series of samples using constant masses of carbonic adsorbent (50 mg) with aqueous solutions of adsorbate (50 mL) with the initial concentration between 100-700 mg/l.

Table 1. The degree of immobilization of o-nitrophenol on AC-MR, AC-C, BAU, AG-5

Time, min	15	30	60	90	120	180	240	300
AC-MR	57,92	76,47	91,25	96,36	97,09	97,57	97,7	97,81
AC-C	45,02	57,2	74,52	84,58	88,96	93,78	95,47	96,35
BAU	32,36	50,97	62,07	72,01	76,03	83,94	87,26	87,57
AG-5	13,96	20,57	27,49	32,33	38,5	46,21	51,28	54,36

Acknowledgements: The research leading to these results has received funding from the institutional project DISTOX, number 20.80009.7007.21

Results and discussion. The obtained experimental results show that, at the initial stage the immobilization of the phenolic pollutant is quite a fast process. Thus, in the first 30 min, the autochthonous activated carbons retain approx. 76.5% (AC-MR) and 57.2% (AC-C) from the total amount of adsorbate and on the commercial activated carbons they immobilize between 51% (BAU) and 20% (AG-5). Later, the adsorption process continues more slowly, and the establishment of the equilibrium depends on the nature of the adsorbent.(table.1).The contact/stirring time required to reach the equilibrium of the adsorption process oscillates between 120 min - 180 min for local carbonic adsorbents (AC-MR, AC-C) and 240 min - 300 min for commercial samples (BAU, AG-5).

The adsorption isotherms of o-nitrophenol on the investigated activated carbons were determined at different temperatures (25°C, 35°C and 45°C). The results show that, with the increase of the temperature values by 20°C, the retention of o-nitrophenol decreases by approx. 5-8%, which indicates that the adsorption process studied is an exothermic one. The research carried out indicates the advantage of autochthonous activated carbons over commercial ones in parameters such as the speed and duration of the immobilization process, as well as the retention rate of the investigated adsorbate.

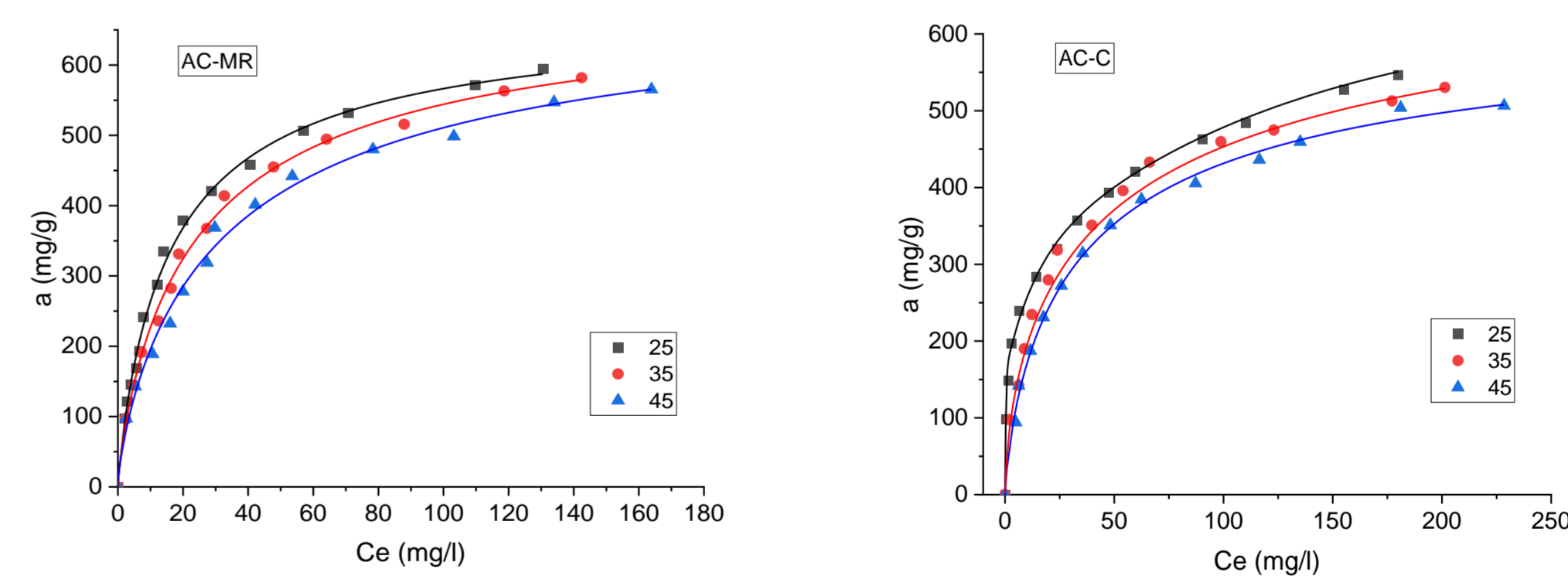


Fig.1. The adsorption isotherms of o-nitrophenol on activated carbons AC-MR and AC-C

Conclusion: The realized research shows that phenolic pollutants can be effectively removed from aqueous solutions using autochthonous activated carbons, which have demonstrated their advantages over some commercial carbonic adsorbents.

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ADSORPTION OF CAFFEIC ACID ON ACTIVATED CARBONS

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Caffeic acid is a phenolic compound (strong and active antioxidant) synthesized by all plant species and found in foods such as coffee, wine, tea and others. Caffeic acid (3,4-dihydroxycinnamic acid) is a hydroxycinnamic acid, belonging to the family of phenolic acids, with a 3,4-dihydroxylated aromatic ring structure linked to a carboxylic acid by a transethylene wire [1].

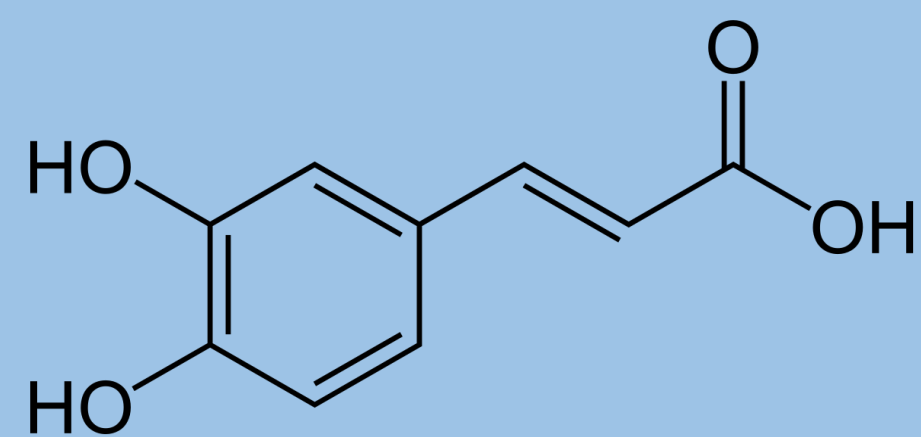


Figure 1. Chemical structure of caffeic acid [1]

The adsorption capacity of caffeic acid on the studied activated carbons was determined from the adsorption isotherms, being of 1.25 mmol/g and 2.0 mmol/g for Granucol FA and AC-C, respectively. The experimental data were fitted by the following kinetic models: pseudo-first order, pseudo-second order, intraparticle diffusion (Weber-Morris model) and the theoretical isotherm models of Langmuir, Freundlich, Temkin-Pyzhev and Dubinin-Radushkevich.

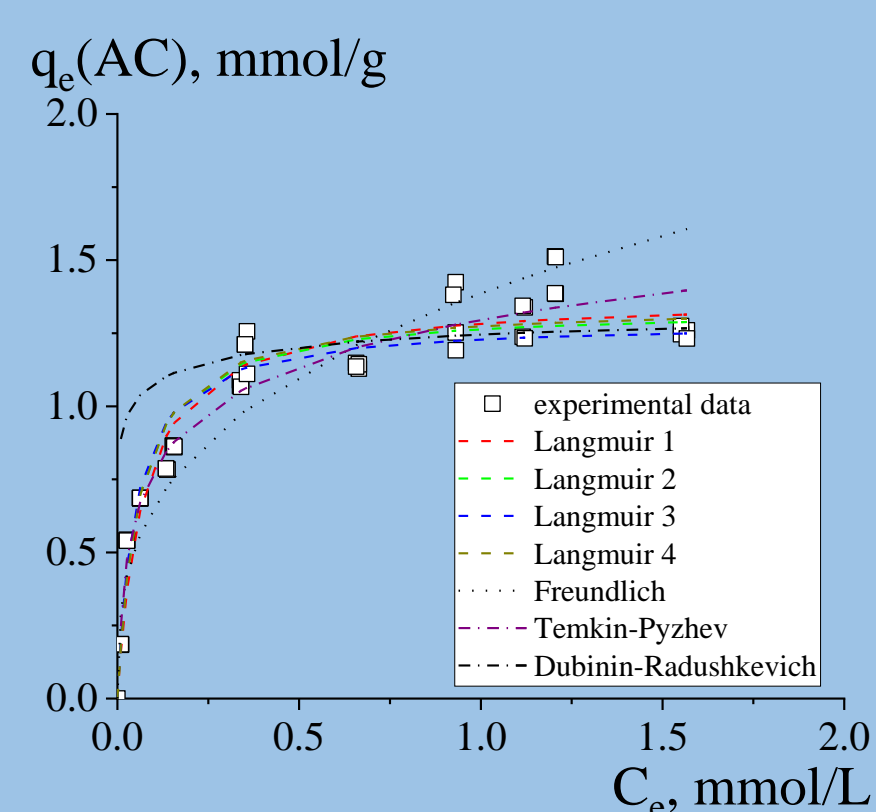


Figure 2. Adsorption isotherm of caffeic acid on activated carbon Granucol FA. Solid:liquid ratio – 1:1000

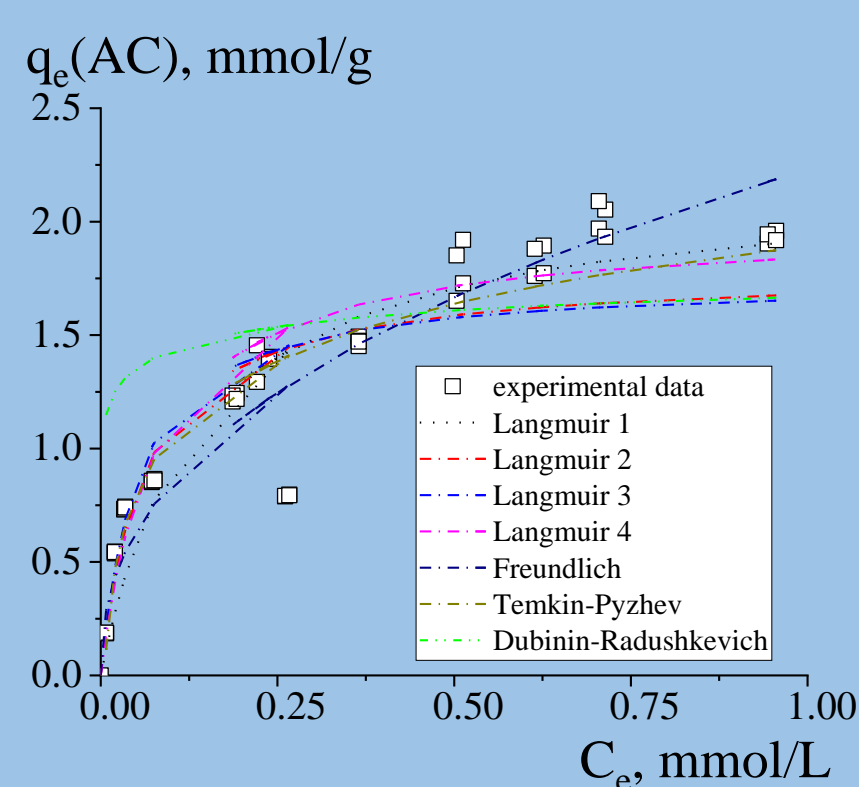


Figure 3. Adsorption isotherm of caffeic acid on activated carbon AC-C. Solid:liquid ratio – 1:1000

The purpose of this work was to perform adsorption experiments of caffeic acid from water solutions on activated carbons of different origin: AC-C obtained from apricot stones (Republic of Moldova) and Granucol FA commercial activated carbon (Germany).

All the adsorption experiments were performed at the temperature of 293K because caffeic acid is not stable at high temperatures. The adsorption kinetics were studied at different initial concentrations (1, 3, 4.5 mM), at a solid/liquid ratio of 1/1000. The equilibrium of adsorption was established in about 150 minutes.

Table 1. Kinetic parameters and q_e values of the adsorption process of caffeic acid on activated carbon Granucol FA, at different initial concentrations

T, K	C_0 , mmol/L	Pseudo-first kinetic model (Langergren)			
		$q_e(\text{exp})$ (mmol/g)	k_1 (min^{-1})	$q_e(\text{cal})$ (mmol/g)	R^2
293	1.05	0.9498	0.7178	0.1578	0.6342
	2.71	1.3269	5.3292	1.9623	0.3001
	4.82	2.6845	0.8436	0.0077	0.4131

T, K	C_0 , mmol/L	Pseudo-second kinetic model (Ho and McKay)			
		$q_e(\text{exp})$ (mmol/g)	k_2 ($\text{g}/\text{mmol min}$)	$q_e(\text{cal})$ (mmol/g)	R^2
293	1.05	0.9498	19.5286	0.9432	0.9990
	2.71	1.3269	15.1382	1.2751	0.9929
	4.82	2.6845	14.0423	2.5549	0.9987

T, K	C_0 , mmol/L	Intraparticle diffusion model (Weber and Morris)		
		k_i ($\text{mmol}/\text{g min}^{1/2}$)	R^2	\bar{D} (m^2/s)
293	1.05	0.1413	0.6266	-
	2.71	0.0085	-0.0191	6.50×10^{-14}
	4.82	0.1294	0.7003	-

Table 2. Kinetic parameters and q_e values of the adsorption process of caffeic acid on activated carbon AC-C, at different initial concentrations

T, K	C_0 , mmol/L	Pseudo-first kinetic model (Langergren)			
		$q_e(\text{exp})$ (mmol/g)	k_1 (min^{-1})	$q_e(\text{cal})$ (mmol/g)	R^2
293	1.08	1.0092	0.8923	0.1139	0.7334
	2.71	1.9164	0.7752	0.2889	0.3137
	4.82	2.9393	0.5449	0.2478	0.2307

T, K	C_0 , mmol/L	Pseudo-second kinetic model (Ho and McKay)			
		$q_e(\text{exp})$ (mmol/g)	k_2 ($\text{g}/\text{mmol min}$)	$q_e(\text{cal})$ (mmol/g)	R^2
293	1.08	1.0092	30.0509	1.0093	0.9983
	2.71	1.9164	10.0334	1.8884	0.9958
	4.82	2.9393	10.9586	2.8672	0.9966

T, K	C_0 , mmol/L	Intraparticle diffusion model (Weber and Morris)		
		k_i ($\text{mmol}/\text{g min}^{1/2}$)	R^2	\bar{D} (m^2/s)
293	1.08	0.1062	0.5603	-
	2.71	0.0487	0.0176	-
	4.82	0.0615	0.1064	-

Acknowledgements. This research was supported by Republic of Moldova Project “Reducing the impact of toxic chemicals on the environment and health by using adsorbents and catalysts obtained from local raw materials”, no. 20.80009.7007.21.

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Conclusion

The caffeic acid adsorption on both activated carbons is very well described by the pseudo-second order kinetic model and by the Langmuir theoretical model. The applicability of these models suggests that the adsorption of caffeic acid on the studied activated carbons is based on chemisorption.

USING BUFFER THEORY TO ASSESS IONIC POLLUTANT REDUCTION IN SOILS

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As criterion for quantitative assessment of the intensity of buffer action of studied multicomponent heterogeneous systems, as well as the indices of the stability (or the resistance) of ecosystems to external perturbances, the value of buffer capacity β_i^S (the superscript index S specifies the presence of solid phase) which can be defined as a partial derivative, has been used:

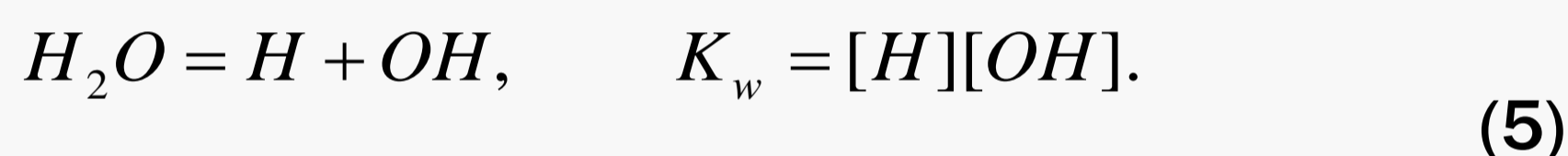
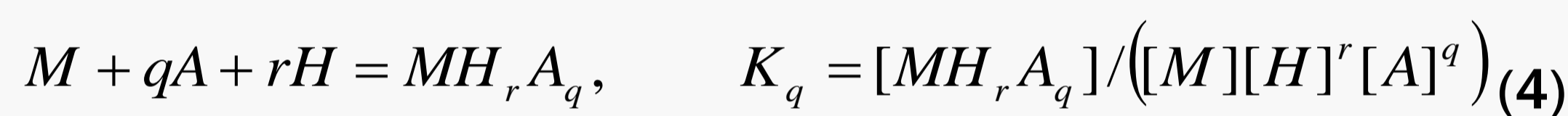
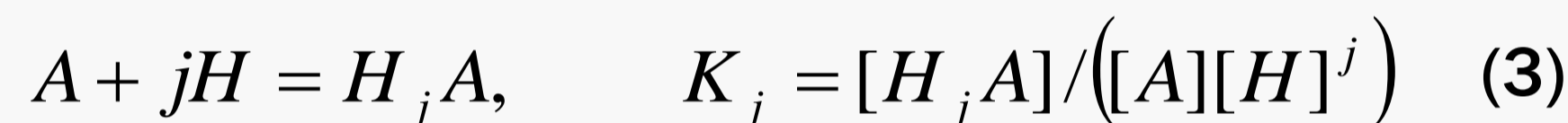
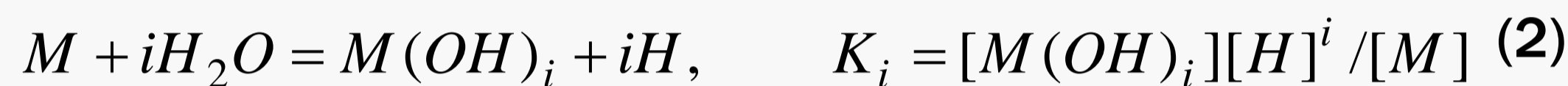
$$\beta_i^S = \left(\frac{\partial C_i^0}{\partial \ln[i]} \right) C_j^0 (j \neq i)$$

where C_i^0 and $[i]$ are the initial concentration in heterogeneous mixture and equilibrium concentration in solution of an component of solid phases, respectively; the subscript index C_j^0 shows, that the initial concentrations of other components in mixture remain constants.

We will examine the process of formation of the sparingly soluble salt of arbitrary stoichiometric composition (metal ion, anion of salt):



The following set of possible simultaneous reactions in the saturated solution is taken into account:



After a series of transformation, one can finally get:

$$\beta_M^S = \varphi_3 - \frac{\varphi_1^2}{\varphi_2} \quad (6)$$

$$\beta_A^S = \frac{n^2}{m^2} \varphi_3 - \frac{n^2}{m^2} \frac{\varphi_1^2}{\varphi_2} = \frac{n^2}{m^2} \left(\varphi_3 - \frac{\varphi_1^2}{\varphi_2} \right) = \frac{n^2}{m^2} \beta_M^S \quad (7)$$

$$\beta_H^S = \varphi_2 - \frac{\varphi_1^2}{\varphi_3} \quad (8)$$

were:

$$\varphi_1 = \sum_{i=1} \sum_{j=0} ij [M_i(OH)_j] + \frac{m}{n} \sum_{l=1} l [H_l A] - \sum_{q=1} \sum_{r=1} r [MH_r A_q] + \frac{m}{n} \sum_{q=1} \sum_{r=1} r q [MH_r A_q] \quad (9)$$

$$\varphi_2 = [H] + [OH] + \sum_{l=1} l^2 [H_l A] + \sum_{i=1} \sum_{j=0} j^2 [M_i(OH)_j] + \sum_{q=1} \sum_{r=1} r^2 [MH_r A_q]$$

$$\varphi_3 = \frac{m^2}{n^2} \sum_{l=0} [H_l A] + \sum_{q=1} \left(\frac{m^2 q^2}{n^2} - 2 \frac{mq}{n} + 1 \right) \sum_{r=0} [MH_r A_q] + \sum_{i=1} \sum_{j=0} i^2 [M_i(OH)_j]$$

The buffer capacities towards different components are reciprocally proportional, while the buffer capacities in relation to the ions of the solid phase are interconnected through its stoichiometric coefficients:

$$\frac{\beta_A^S}{n^2} = \frac{\beta_M^S}{m^2} \quad (10)$$

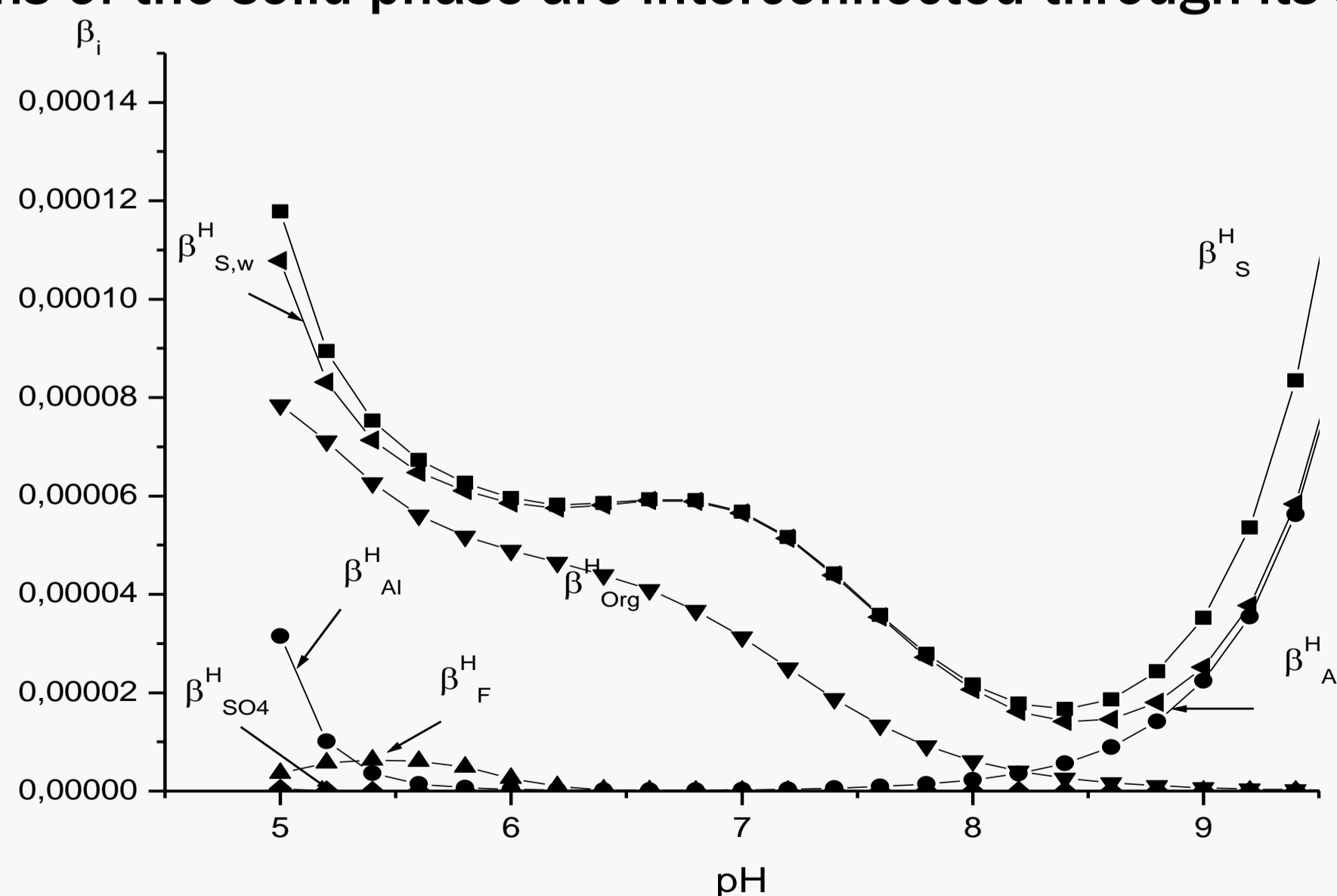


Figure 1. The contribution of separate components of the heterogeneous mixture β_i in the total buffer capacity in the heterogeneous system "Gibbsite $Al(OH)_{3(S)}$ -saturated aqueous solution". The $\beta_{H,W}^S$ value means the buffer capacity β_H^S without [contribution of $[H^+]$ and $[OH^-]$]

Conclusions: The derived equations have been applied to assess the buffering action in "natural mineral - soil solution" systems, encompassing soluble and insoluble phosphate forms. The utilization of the results of this research will enable the prediction of changes in soil composition and reactions as a consequence of increased anthropogenic load. he obtained results are of interest to soil scientists and ecologists.



PILOT STUDIES OF PHENAZONE ADSORPTION ON CARBONIC ADSORBENT AC-K

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Introduction. In the last few decades, the anthropic pollution factors of the environment have increasingly affect the health state of people. Pharmaceuticals, personal care products, drugs, flame retardants, herbicides and other chemicals, known as emerging contaminants (ECs), receive a special attention for the reason of their potential impact on the environment and human health [1]. The efficiency of ECs removal strongly depends on the technology implemented in the wastewater treatment plants which are usually based on conventional systems: chlorine, biological treatments, activated carbon adsorption, advanced oxidation processes, electrochemical systems [2]. The use of activated carbons (ACs) in this technologies have demonstrated a high adsorption capacity for ECs depending on their porous structure and surface chemistry.

Materials and methods. Here we present the research of the adsorption processes of phenazone (analgesic and antipyretic used in testing the effects of other drugs on metabolized enzymes in the liver, $C_{11}H_{12}N_2O$, MM 188.23) on activated carbon AC-K in order to establish its adsorption capacities against ECs. The measurements were carried out at two pH values (pH=3 and pH=5.5) at the temperature of 35°C. Acetate buffer solution (mixture of CH_3COOH 0.2 M and CH_3COONa 0.2 M) was used to obtain and maintain the required pH values. The adsorption kinetic curves of phenazone on the active carbon AC-K, determined from solutions with an initial concentration of 100 mg/l, were measured in the time interval between 5-300 minutes. The adsorption experiments were carried out in a thermostatic shaker by contacting a series of samples using constant masses of carbonic adsorbent (50 mg) with aqueous solutions of adsorbate (50 mL) with the initial concentration between 50-500 mg/l.

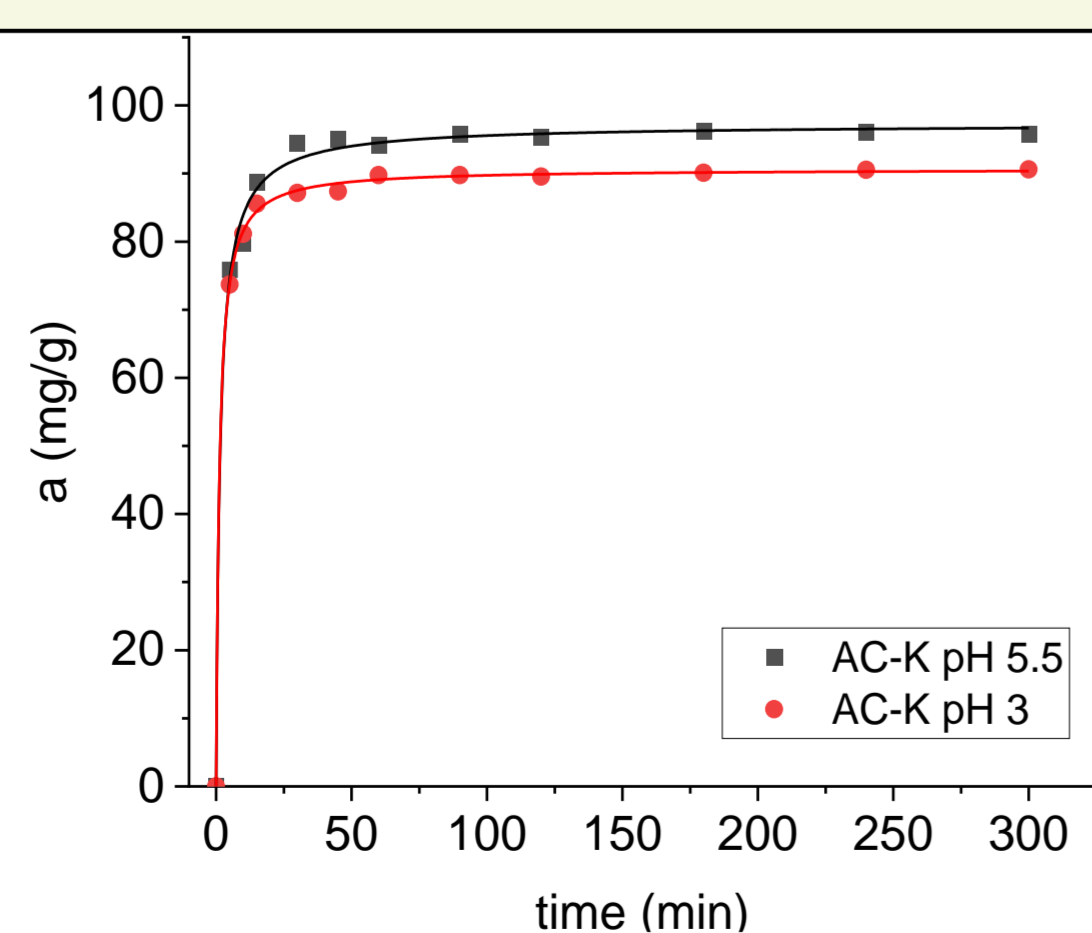


Fig. 1. The adsorption kinetic curves of phenazone on AC-K at pH 3 and pH 5,5

Results and discussion. It has been established that the adsorption process of phenazone is rather fast and the establishment of the adsorption equilibrium is reached after approx. 30-60 min of contacting/stirring, depending on the pH value (fig.1). The degree of immobilization of phenazone on AC-K coal is significant, its value being about 90% (pH 3) - 95% (pH 5) of the total amount of adsorbate.

The adsorption isotherms of phenazone on AC-K coal were determined after establishing equilibrium in the adsorbate/adsorbent systems at pH values 3 and 5.5 and temperature 35°C (fig.2). The obtained data shows a major dependence of the immobilization rate of phenazone on the pH value of the contact medium. It was determined that increasing the pH value from 3 to 5.5 increases the maximum adsorption value (a_m) of Phenazone on AC-K charcoal by more than 30%.

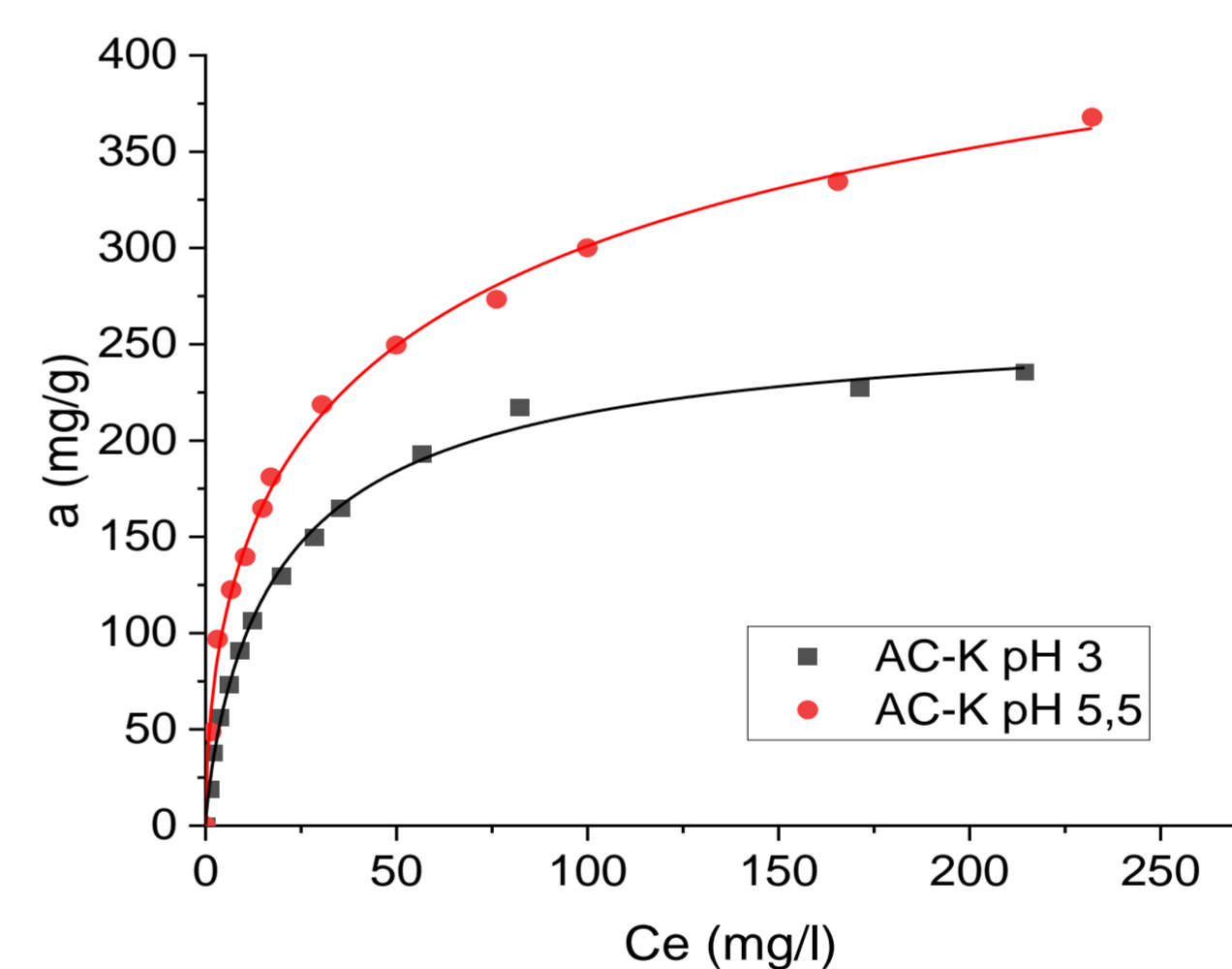


Fig. 2. The adsorption isotherms of phenazone on AC-K at pH 3 and pH 5,5

Conclusion: The realized research shows that the speed and degree of immobilization of phenazone on AC-K coal indicates to an encouraging potential for its use for the removal of emergent contaminants from various water sources.

Acknowledgements: The research leading to these results has received funding from the institutional project DISTOX, number 20.80009.7007.21

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SYNTHESIS AND CHARACTERIZATION OF POLYMERIC AND CARBON MATERIALS FOR SEPARATION APPLICATIONS

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INTRODUCTION

Polymeric materials, especially those of spherical in shape, have been utilized in numerous applications for decades. Numerous polymerization techniques are used to obtain polymeric sorbents with different grain sizes. Polymers in the form of porous or non-porous microspheres we can obtain by one of the heterogeneous polymerization: emulsion, suspension dispersion polymerization, membrane emulsification, or swelling and polymerization techniques.

The obtained materials can be used in solid-phase extraction for the isolation of organic compounds from water and air, and as stationary phases in high performance liquid, supercritical fluid, ion-exchange and size-exclusion chromatography [1, 2]. For certain applications, polymer materials are chemically modified. For this purpose, functional groups or unreacted double bonds present in the polymer structure are used.

Carbonization is one method which enables the generation of polymer microspheres with carbonaceous surface. However, polymers often undergo sintering or shrinking during carbonization. This has an unfavourable influence on the porous structure and causes that the material to become microporous and lose its sorption properties. For this reason, to improve sorption properties of carbonized sorbents, various pre-treatment methods are employed. Our experience shows that modification with phosphoric acid is an effective method [3,4].

SYNTHESIS OF POLY(HIPE) SORBENT

In a 100 ml round-bottom flask, an oil phase consisting of a mixture of monomers (7.5 g, unsaturated polyester in styrene, Fig. 1), porogen solvent (7.5 g, toluene), emulsifying agent (2.25 g, triethylamine) and copolymerization initiator (0.15, azobisisobutyronitrile, AIBN) was stirred continuously (500 rpm) at ambient temperature.

Water-in-oil high internal phase emulsion (HIPE) was prepared by the slow, dropwise addition of distilled water (42.5 g) to the organic (continuous) phase under constant mechanical stirring.

After adding the entire aqueous phase, the mixing process was continued for another 10 min and then the obtained contents were poured into Falcon tubes and heated in an oven at 70 °C for 24 hours.

Porous polymer monoliths were synthesized using the HIPE method (Fig. 1) and then purified with methanol using a Soxhlet apparatus.



Fig. 1. Synthesized poly(HIPE) monolith.

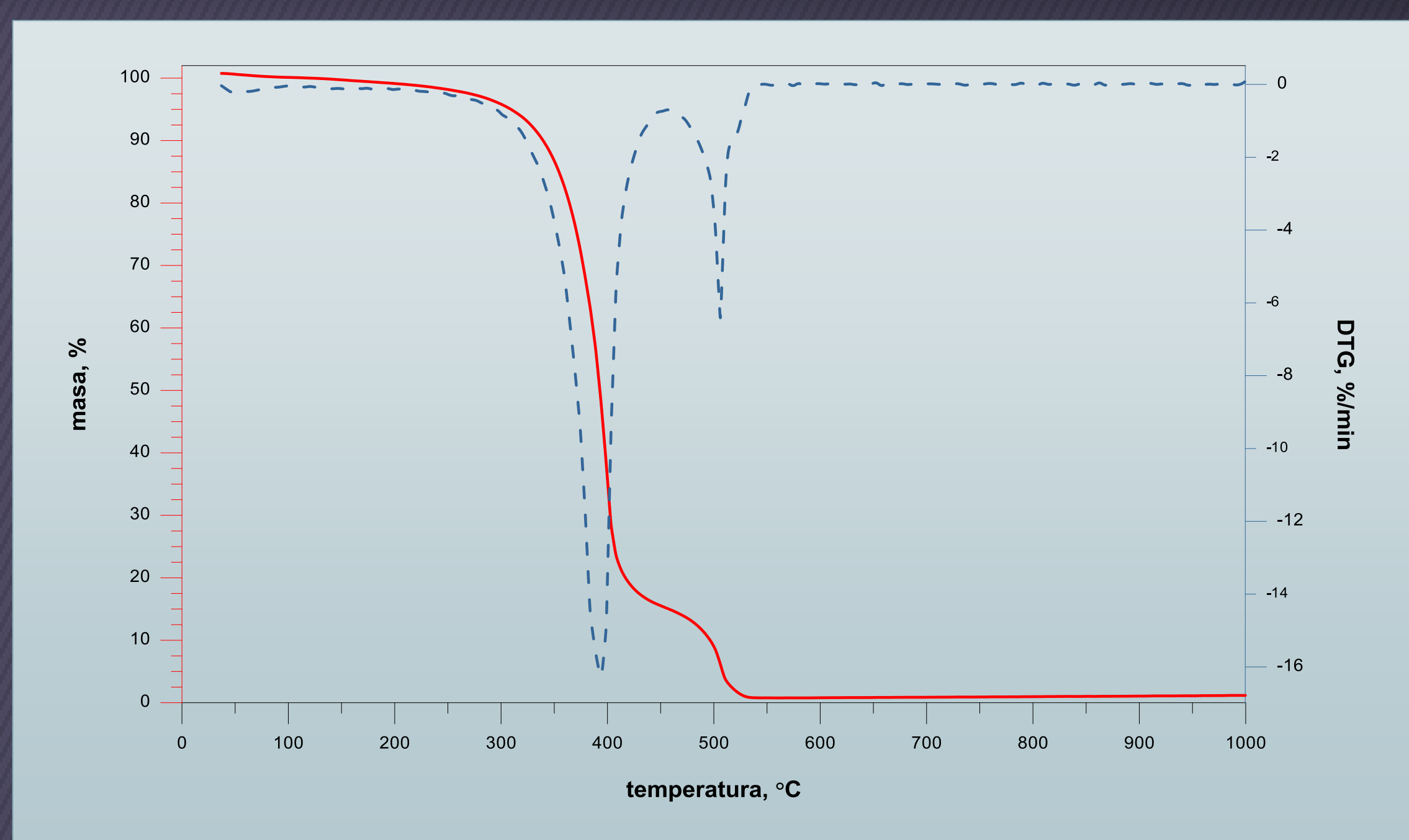


Fig. 3. Thermogravimetric curves of poly(HIPE).

Table 1. TG-DTG data of thermogravimetric analysis of poly(HIPE).

Sample	$T_{2\%}$ [°C]	$T_{50\%}$ [°C]	T_{max} [°C]	Mass Change [%]
poly(HIPE)	259	388	394; 506	- 84,5; - 14,1

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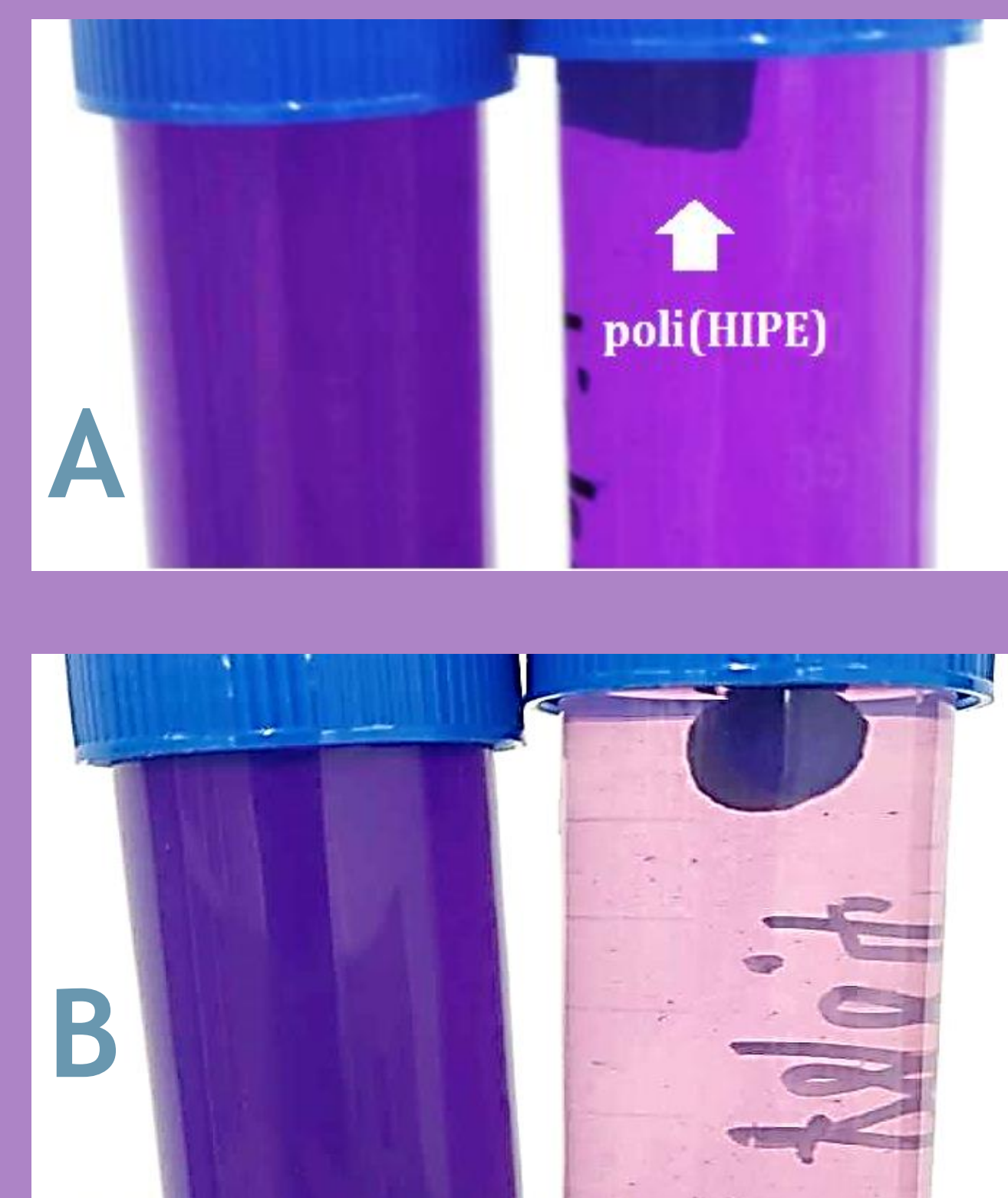


Fig. 2. Sorption of crystal violet.

(A – after few days; B – after two months)

SORPTION

As a rule, porous materials have the ability to sorb various compounds, e.g. dyes. To check whether the obtained material had such characteristics, it was immersed in the form of a polymer disc in an aqueous solution with crystal violet at a concentration of 1 mg/ml.

Both Falcon tubes, the reference starting solution (left tube) and the one containing poly(HIPE) (right), were stored under identical conditions (Fig. 2).



Fig. 4. Monolith disc after crystal violet sorption.

CONCLUSIONS

- ✓ The unsaturated polyester and styrene are interesting monomers in the HIPE method, which was used to obtain a porous polymer material (Fig. 1).
- ✓ Based on thermogravimetric analysis, poly(HIPE) showed high thermal resistance up to 260 °C (Fig. 3, Table 1).
- ✓ As shown in the photographs, poly(HIPE) porous polyester material has the ability to absorb crystal violet (Figs. 2 and 4).
- ✓ In further research, we will attempt microwave-assisted carbonization of the polymer material.



PHOTODEGRADATION OF DOXYCYCLINE BY ADVANCED OXIDATION PROCESSES (AOP) IN WATER SOLUTIONS



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The SARS-CoV-2 outbreak, which caused countless deaths and infections in 216 countries, has become the biggest pandemic of last 100 years [1]. Moreover, the absence of any permanent medicine protocol caused medical, social and economic problems worldwide. The rapid spread of the virus has required doctors to urgently develop treatment using all known drugs.

Doxycycline (DOX), a tetracycline antibiotic originally used only in veterinary medicine, was found to be effective against COVID-19 [2]. The DOX structure is presented on Figure 1. Due to the high consumption of DOX and other anti-covid drugs, they have penetrated surface waters with human and animal excreta, from industrial wastewater, from human waste, due to improper disposal of expired drugs in the garbage chute or sewerage, from pharmaceutical industries producing antibiotics. This is why it is very important to solve the problem of deep DOX oxidation by applying advanced oxidation processes (AOPs). Among the AOPs, there are used UV, UV/H₂O₂ systems and the last one represents a cyclic process with OH• radicals generation. The application of these systems is promising for solving the problem of wastewater treatment in the pharmaceutical industry

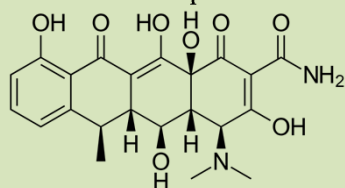


Figure 1. (4S,4aR,5S,5aR,6R,12aS)-4-(Dimethylamino)-3,5,10,12,12a-pentahydroxy-6-methyl-1,11-dioxo-1,4,4a,5,5a,6,11,12a-octahydrotetracene-2-carboxamide

In this work there was studied the kinetics of DOX oxidation under UV irradiation and by the UV-H₂O₂ system using the spectrophotometric method. Antibiotic concentrations varied between (1,69 -5,625) ·10⁻⁵ mol/L. For the DOX degradation in the UV-DOX system the mercury-deuterium high-pressure lamp “DRT-100” was used. The degree of degradation at different concentrations of the drug was only 9.1 -11.4%.

The conditions of DOX decomposition in the UV/H₂O₂ system were studied and optimal degradation conditions were identified: [H₂O₂] = 0.005-0.02 mol/L; [DOX] = (1.69-7.75)·10⁻⁵ mol/L; pH = 4,8; T = 298 K; t = 30 - 40 min; λ = 275 nm. As you can see from Figure 2, the degree of DOX degradation in UV/H₂O₂ system is 85.58%, which is 74.18% more than in the previous system.

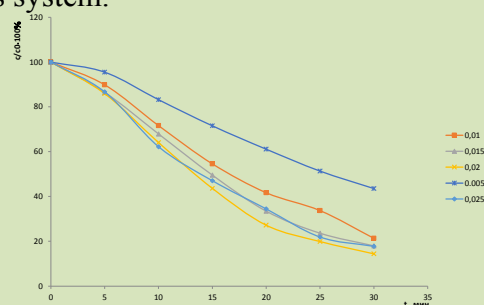


Figure 2. Degradation kinetic curves in the UV/H₂O₂ system [DOX] = 5,625·10⁻⁵ mol/L; pH = 4,8 ; T = 298 K; λ = 275 nm.

It was found that in both systems the decomposition kinetics corresponded to the pseudo-first model, with rate constants varying in the range 0.0289-0.0685 min⁻¹, which is shown on figure 3.

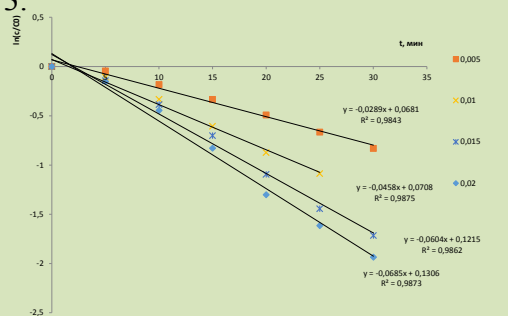


Figure 3 Pseudo-first order kinetic plot of DOX against reaction time at t = 25 °C , [DOX] = 5,625·10⁻⁵ mol/L; pH = 4,8; T = 298 K; λ = 275 nm.

The principal particles that oxidized antibiotic used are hydroxyl radicals that are generated from H₂O₂ during the irradiation by “DRT-1000” high pressure mercury-deuterium lamp. By the method of competing acceptors, the rate constant of the interaction between OH• radicals with the drug used was determined: k_{OH+DOX} = 7.2·10⁹ L/mol·s.

Acknowledgements: This work was fulfilled with the financial support of the State Programme 20.80009.5007.02.



THE INFLUENCE OF ISONIAZID ON THE SELF-PURIFICATION CAPACITY OF AQUATIC SYSTEMS

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The presence of isoniazid (INH) in aquatic systems is inevitable, so the goal of this research was to find out how this drug mixture affects the natural waters' self-purification capacity.

For this purpose, the following systems were modeled:
INH-H₂O-H₂O₂-PNDMA-hv; INH-H₂O-H₂O₂-Cu(II)-PNDMA-hv.

All model systems were irradiated with the polychromatic lamp DRT-400. In this way, the inhibition capacity and stationary concentration of OH radicals in the modeled systems were determined, using the radical trap PNDMA (p-nitroso-N,N-dimethylaniline)

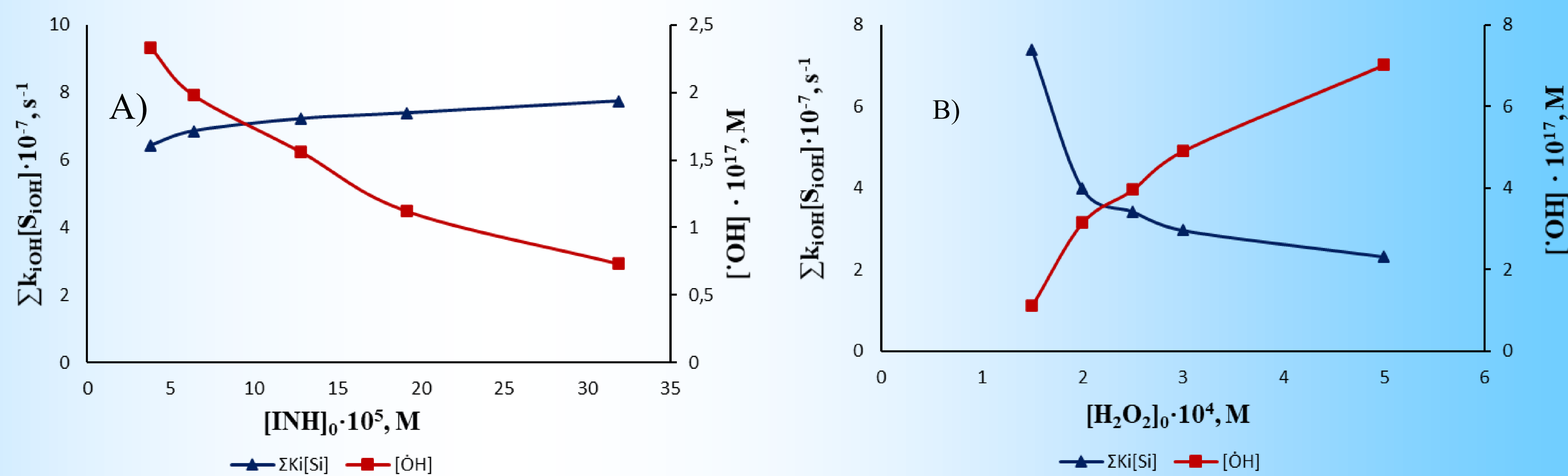


Fig. 1. Variation of inhibition capacity and concentrations of OH radicals generated in the system *INH-H₂O-H₂O₂-PNDMA-hv*: A) to the variation of the INH initial concentration; B) to the variation of the H₂O₂ initial concentration;
[PNDMA]₀=1.1·10⁻⁵ M, [H₂O₂]₀=1.0·10⁻⁴ M, [INH]₀=3.8·10⁻⁵ M, pH=6.7, t=22 °C

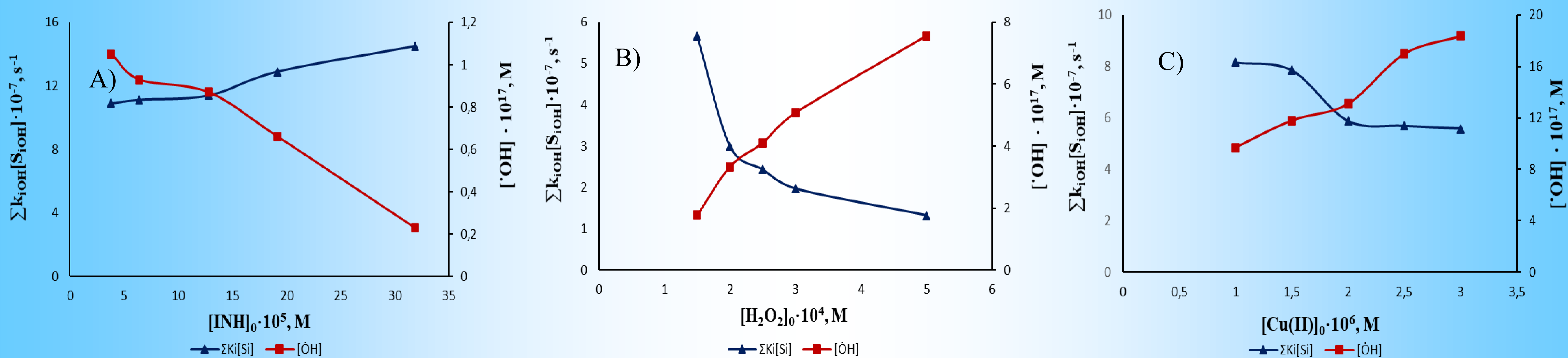


Fig. 2. Variation of inhibition capacity and concentrations of OH radicals generated in the system *INH-H₂O-H₂O₂-PNDMA-Cu(II)-hv*: A) to the variation of the INH initial concentration; B) to the variation of the H₂O₂ initial concentration; C) to the variation of the Cu(II) ions initial concentration
[PNDMA]₀=1.1·10⁻⁵ M, [H₂O₂]₀=1.0·10⁻⁴ M, [INH]₀=3.8·10⁻⁵ M, [CuSO₄]₀=1.2·10⁻⁶ M pH=6.7, t=22 °C

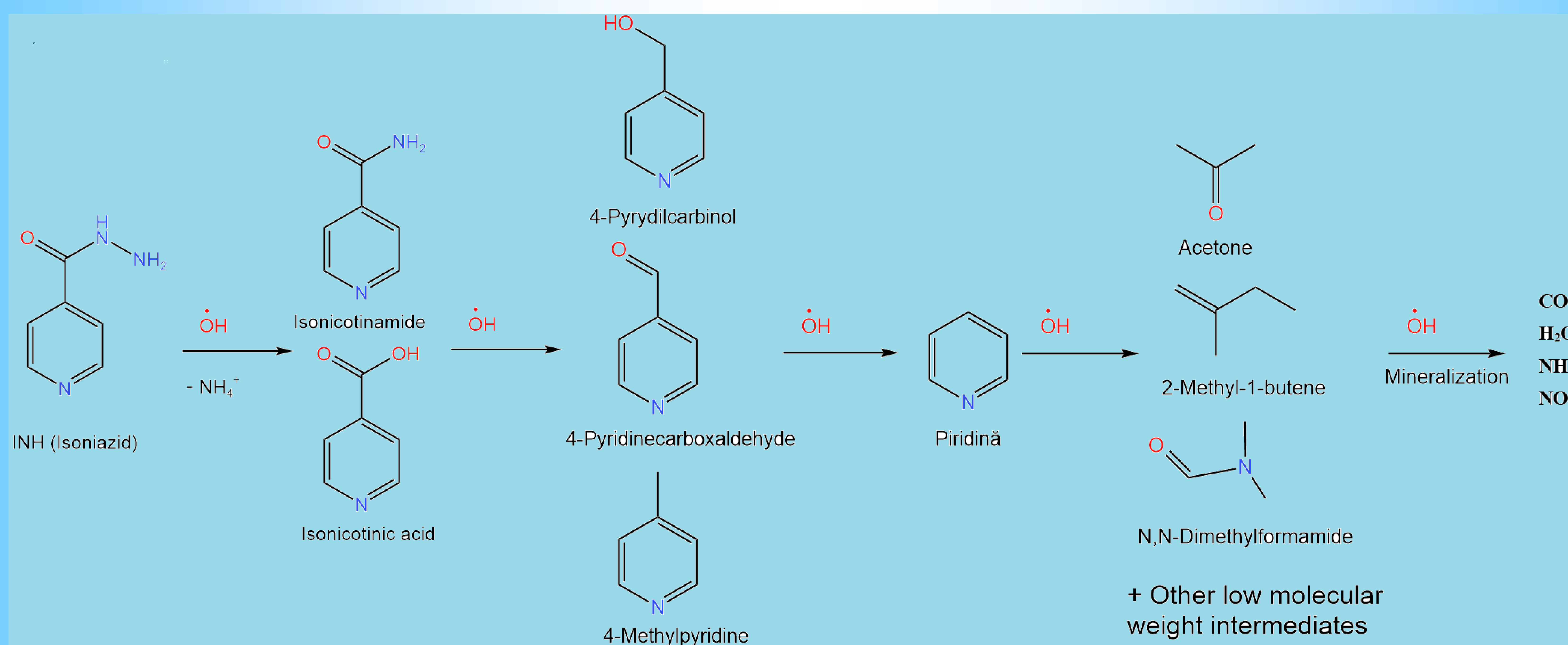


Fig. 3. Possible degradation mechanism of isoniazid in the presence of OH radicals (generated by the photodissociation of hydrogen peroxide)

Conclusions

From the obtained results, it was found that increasing the concentration of INH in the system leads to an increase in the inhibition capacity and a decrease in the OH radical concentration. The values for the inhibition capacity when INH was added at concentrations ranging from 3.8·10⁻⁵ M to 3.2·10⁻⁴ M were found to be on the order of 10⁶ to 10⁷ s⁻¹. According to the inhibition capacity parameter, the systems are classified as highly polluted waters. Self-purification processes decrease considerably in water systems with an increase in INH concentration. It was discovered that when the concentration of hydrogen peroxide in the system increased, the concentration of OH radicals increased and the inhibition capacity decreased. This proves that isoniazid effectively scavenges OH radicals, which are generated during hydrogen peroxide photodissociation, according to the mechanism presented in Fig. 3.

When Cu(II) ions are added to the system, the concentration of OH radicals rises 3–6 times and the inhibition capacity falls. This is explained by the fact that Cu(II) ions catalyze the photodissociation of hydrogen peroxide, producing a much greater quantity of OH radicals. So, in the presence of Cu(II) ions, according to the inhibition capacity parameter, the systems are classified as polluted waters. Based on this, it was shown that INH, which has a reducing character, consumes the oxidative equivalents in aquatic systems. Thus, INH leads to a reduction in the self-purification capacity of aquatic systems.

Acknowledgements. The research was carried out within the institutional project 20.8009.5007.27 "Physico-chemical mechanisms of redox processes with electron transfer involved in vital, technological and environmental systems".

ADSORPTION OF TANNIC ACID ON ACTIVATED CARBONS WITH DIFFERENT SURFACE CHEMISTRY

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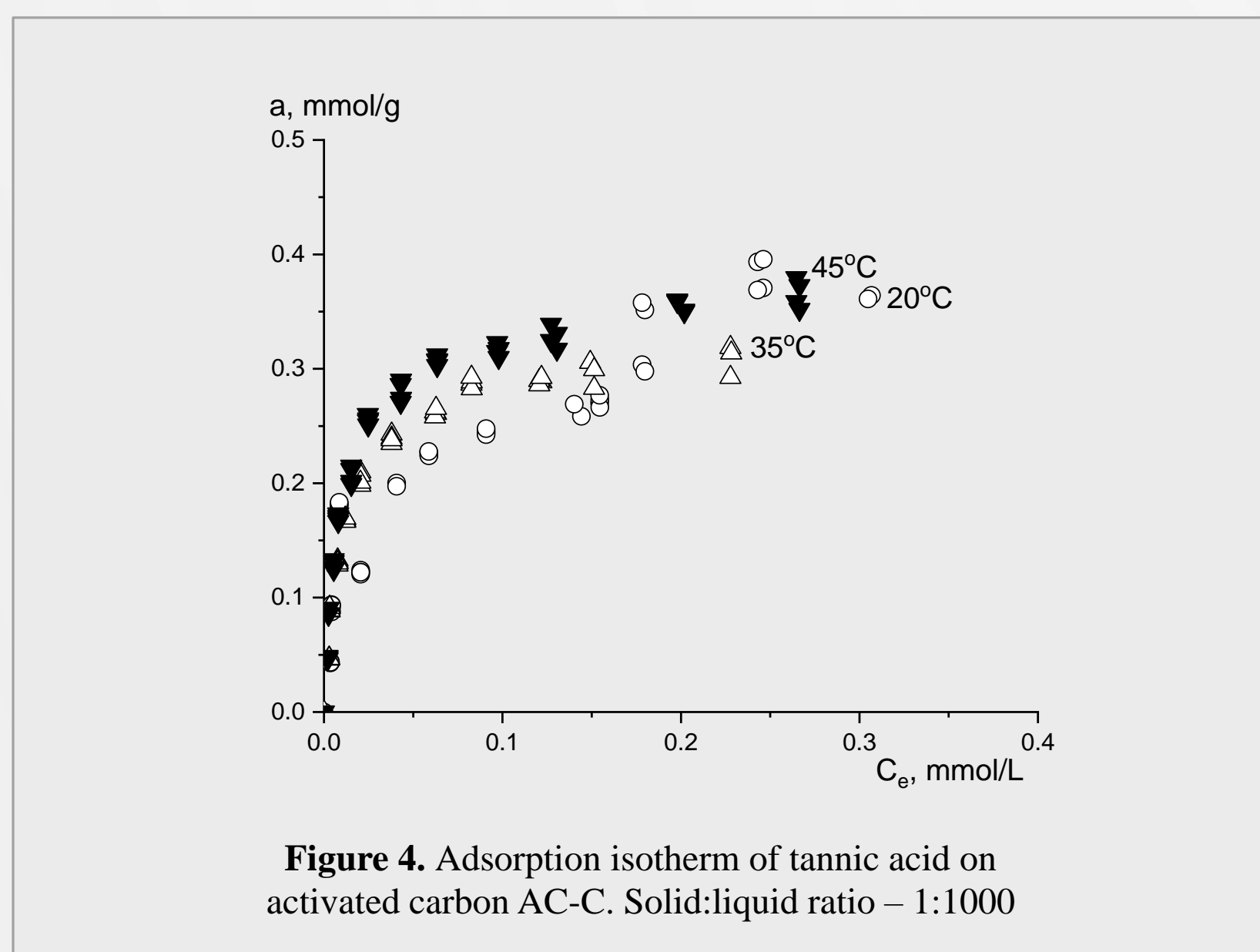
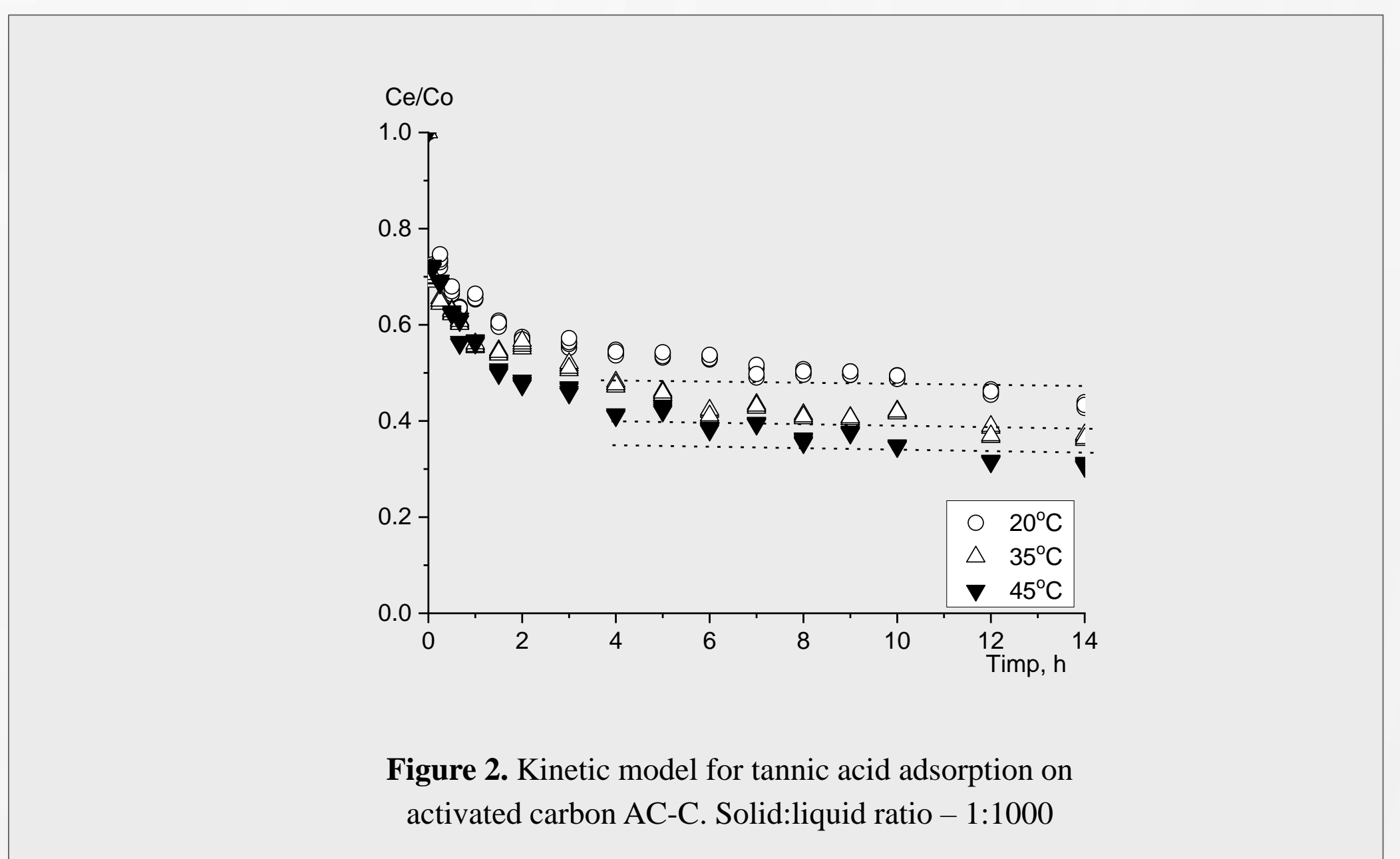
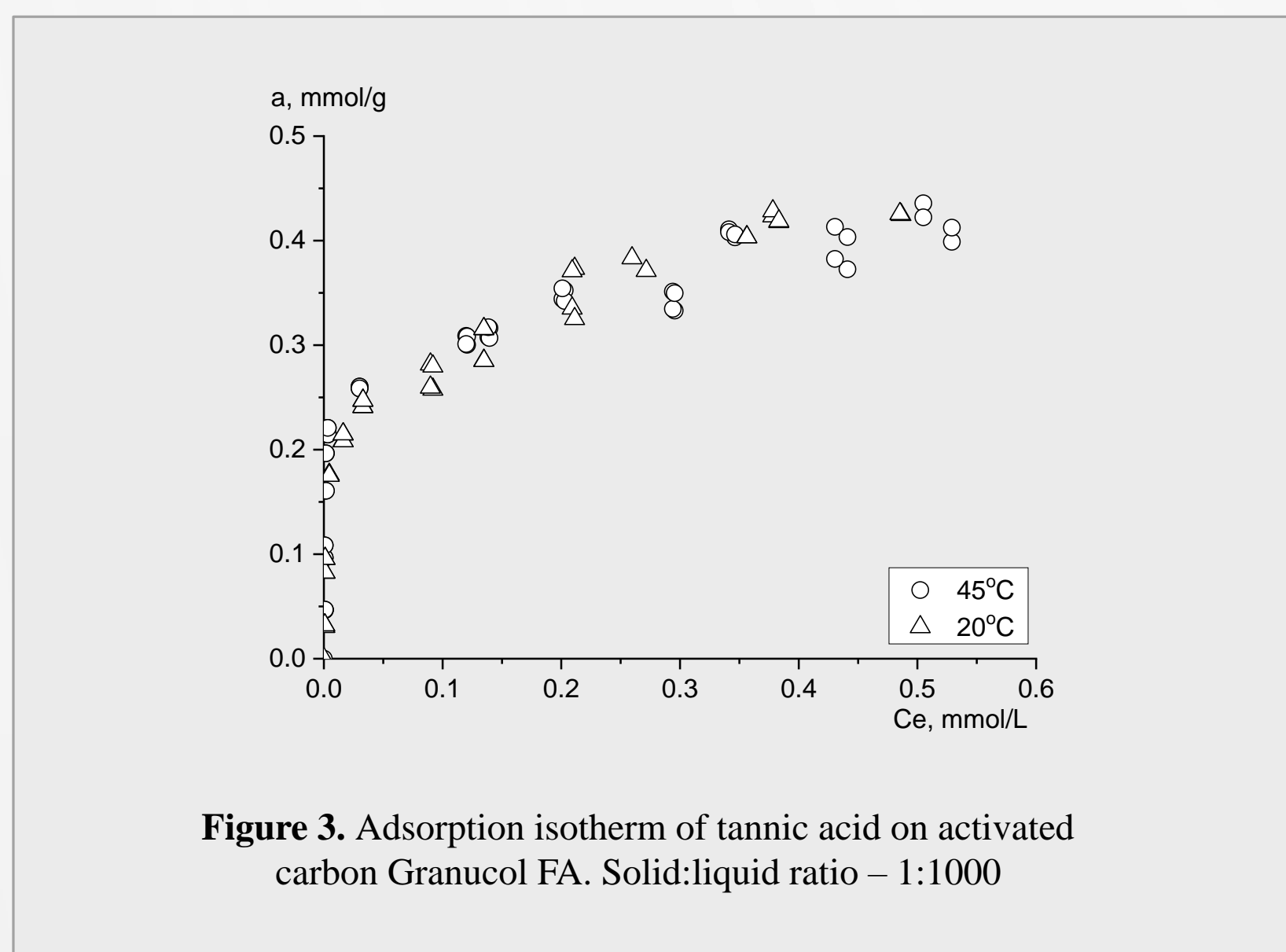
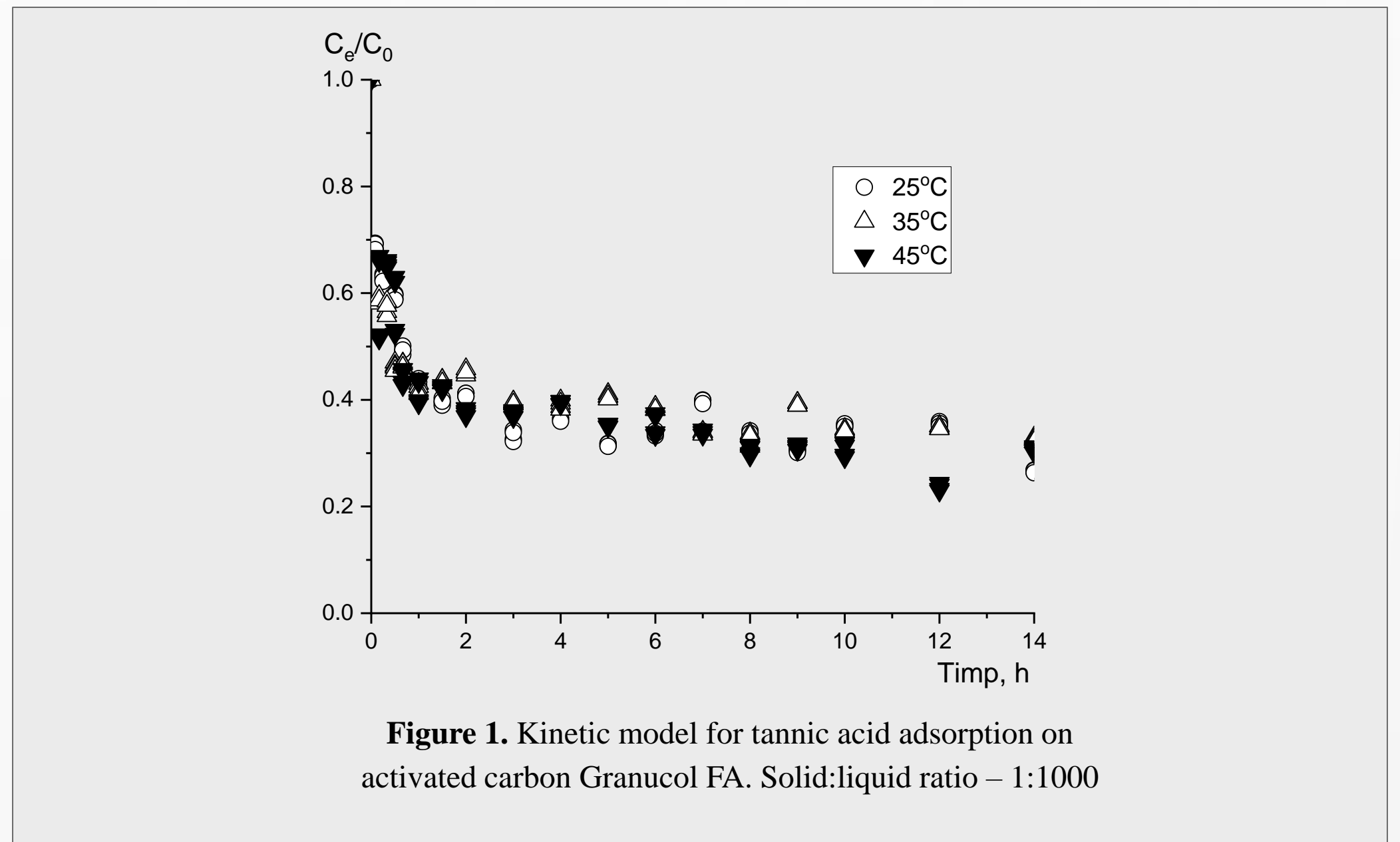
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Activated carbons are materials of major importance for industrial applications. This is due to their remarkably high surface area which gives them specific adsorption properties for the removal of pollutants in the liquid phase. Tannic acid (1,2,3,4,6-penta-O-galloyl-Dglucose) is a pentagalloylglucoside; the central part of the molecule esterified to the hydroxyl groups with gallic acid and is a hydrolyzable tannin [1], and this compound generally gives colour. One of the most promising ways to remove this compound from a liquid medium is adsorption on the activated carbons.

The purpose of this work was to perform adsorption experiments of tannic acid from water solutions on activated carbons with different surface chemistry (AC-C obtained from apricot stones (Republic of Moldova) has a slightly basic surface - pH 8.8 and Granucol FA commercial activated carbon (Germany) has an acidic surface - pH 4.3).

To evaluate the adsorption process of tannic acid on activated carbons the adsorption kinetics at three temperatures (20, 35, 45°C) were determined. According to experimental data, the adsorption equilibrium is established after 8 hours and about 12 hours for activated carbons FA and AC-C, respectively. During the first 2 hours of contact, the adsorption speed of tannic acid on the activated carbon Granucol FA is higher by about 30% compared to the activated carbon AC-C. The adsorption capacity of the studied activated carbons for tannic acid was determined from the adsorption isotherms, being about 0.4 and 0.32 mmol/g for FA and AC-C, respectively.



The experimental data were described using mathematical models, such as the pseudofirst order, pseudo-second order and intraparticle diffusion kinetic models, and Langmuir, Freundlich, Temkin-Pyzhev and Dubinin-Radushkevich theoretical isotherms. The adsorption of tannic acid on the studied activated carbons is based on chemisorption because the experimental data are best described by the pseudo-second order kinetic and the Langmuir models.

Conclusion

The adsorption of tannic acid on the studied activated carbons is based on chemisorption because the experimental data are best described by the pseudo-second order kinetic model and the Langmuir model.

Acknowledgements. This research was performed with the financial support of the Project “Reducing the impact of toxic chemicals on the environment and health by using adsorbents and catalysts obtained from local raw materials”, DISTOX, 20.80009.7007.21, within Moldovan State Program 2020-2023.

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The catalytic activity of carbon catalysts impregnated with manganese, copper, and cobalt ions.

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În literatura de specialitate sunt mai multe brevete, care includ materiale compozite, obținute în baza adsorbantului carbonic, a hidrochiurului, ca suport catalitic, și a oxidului de mangan [1-9]. Analizând rezultatele brevetelor prezentate putem concluda că, materialele compozit de mangan pe bază de carbon în anumite condiții, posedă activitate catalitică și pot fi utilizate pentru degradarea unor poluanți organici. Scopul actualei lucrări este obținerea unui catalizator în bază de carbon, din materie primă locală, material compozit de mangan cu activitate catalitică mare.

Partea experimentală

În fig.1 și fig.2 sunt prezentate dependențele volumului O₂ de V_{KMnO₄} la diferite turații a malaxorului.

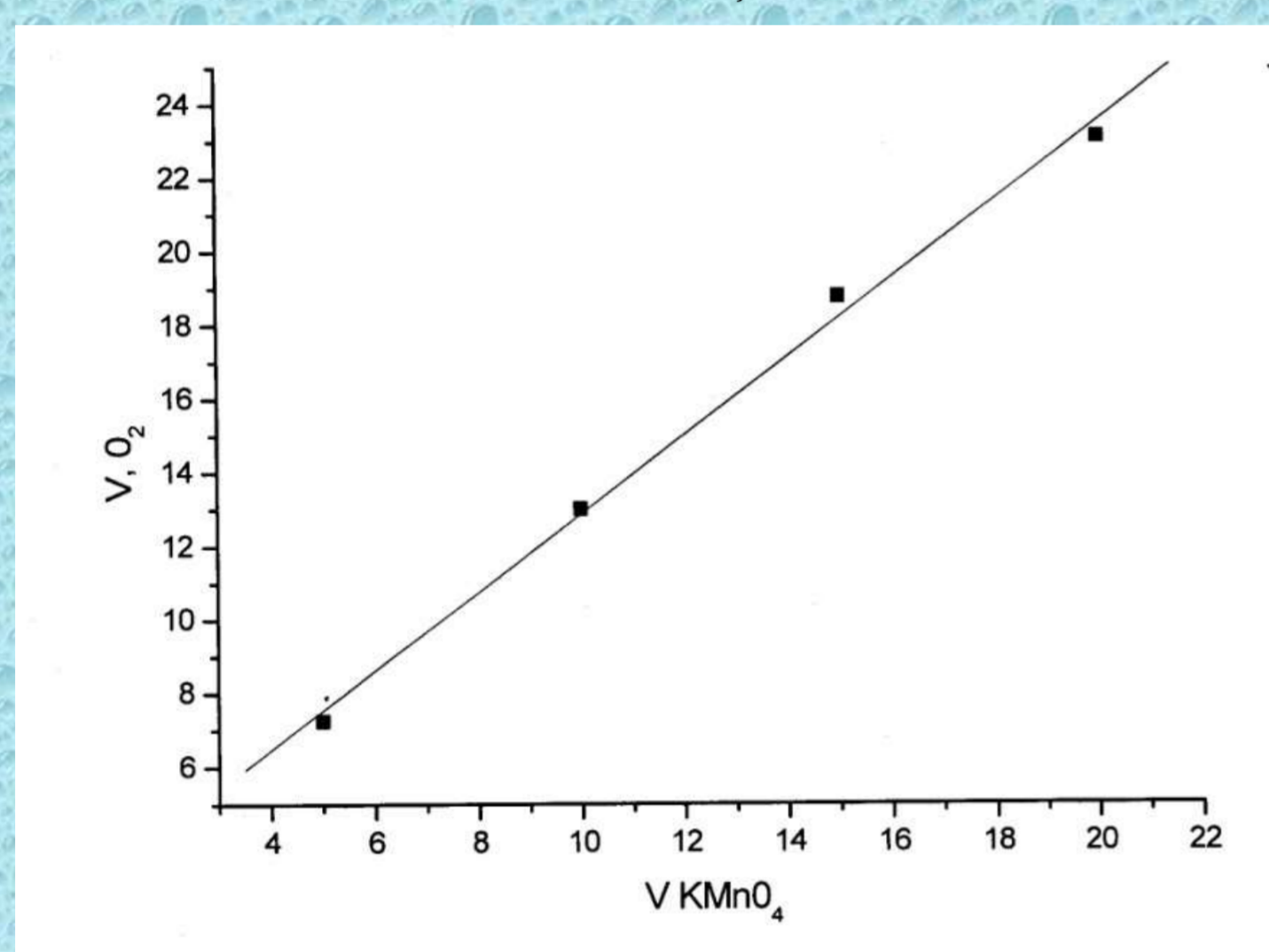


Figura 1 Dependenta V, O₂ de V_{KMnO₄}, t= 12 °C, 200 turații pe minut.

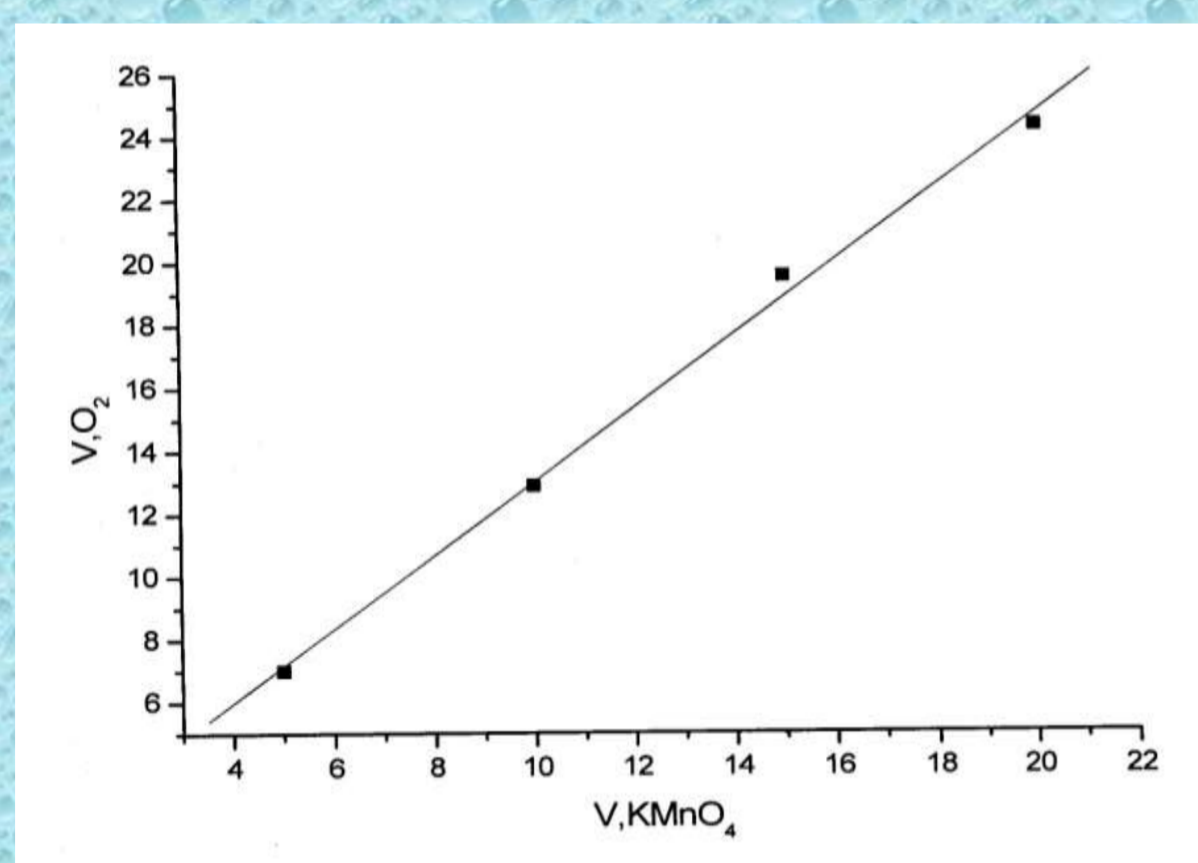


Figura 2 Dependenta V, O₂ de V_{KMnO₄}, t= 12 °C, 400 turații pe minut.

Dreptele prezentate în fig.1 și 2 practic coincid, ceea ce denotă că malaxorul cu 200 turații pe minut amestecă conținutul în colbă foarte bine, și demonstrează că instalația este foarte ermetică. În fig.3 sunt prezentate curbele cinetice măsurate pe mostrele de catalizatori Centaur 300 turații pe minut, quantum DM 1-65 la 300 turații pe minut, Centaur 600 turații pe minut, Centaur fărâmițat praf la 300 turații pe minut. t= 18 °C.

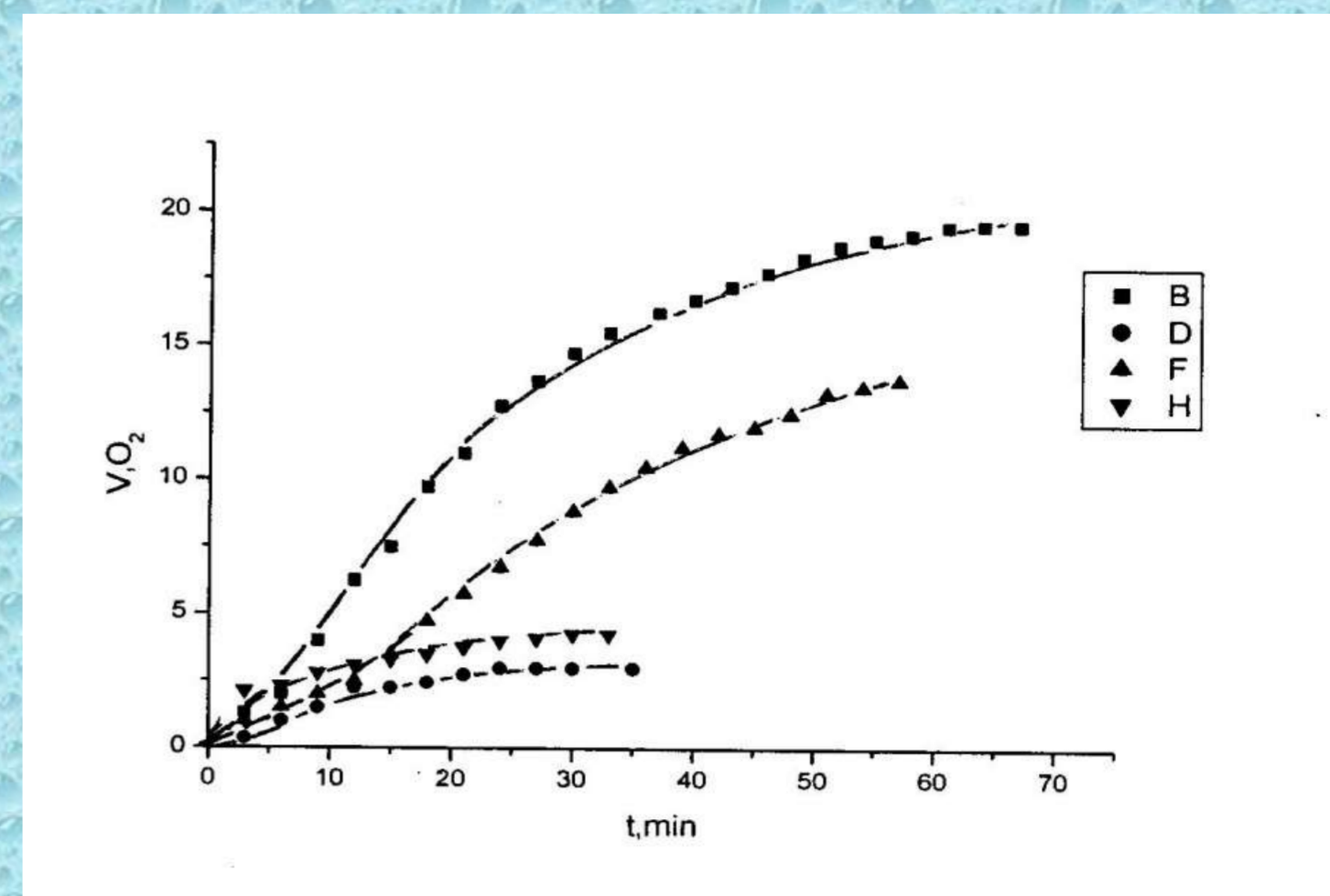


Figura 3 Cinetica procesului de descompunere a peroxidului de hidrogen în prezența catalizatorilor Centaur (•) 300 turații pe minut, quantum DM 1-65 (●) 300 turații pe minut, Centaur (▲) 600 turații pe minut, Centaur fărâmițat praf (▼) 300 turații pe minut. t= 14 °C, P= 747 mm.c.m.

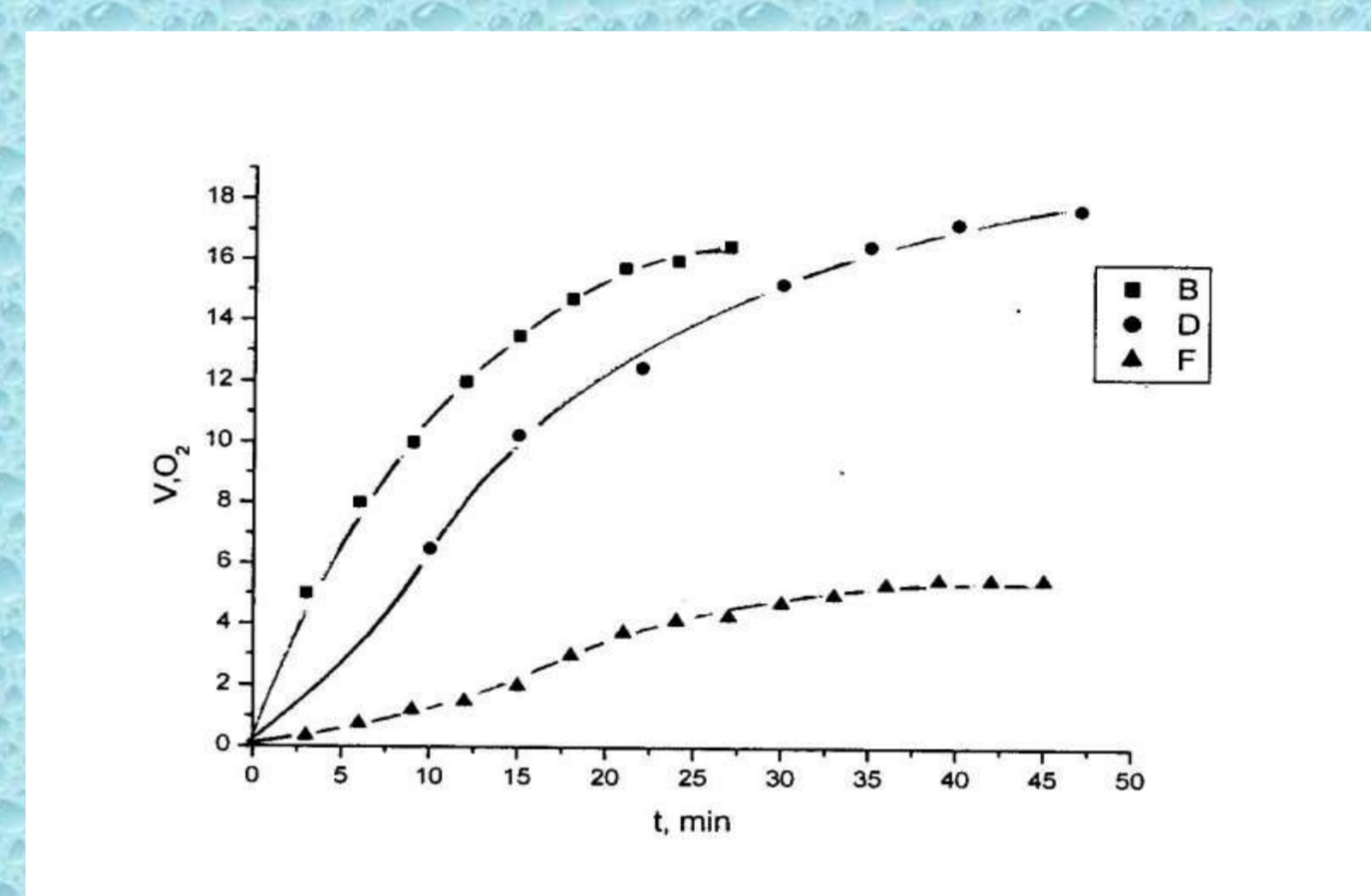


Figura 4 Cinetica procesului de descompunere a peroxidului de hidrogen în prezența catalizatorilor AC-Cu1 (•) la 200 turații pe minut, AC-Co1 (●) la 200 turații pe minut, AC-Mn2 la 200 turații pe minut. t= 14 °C (▲).

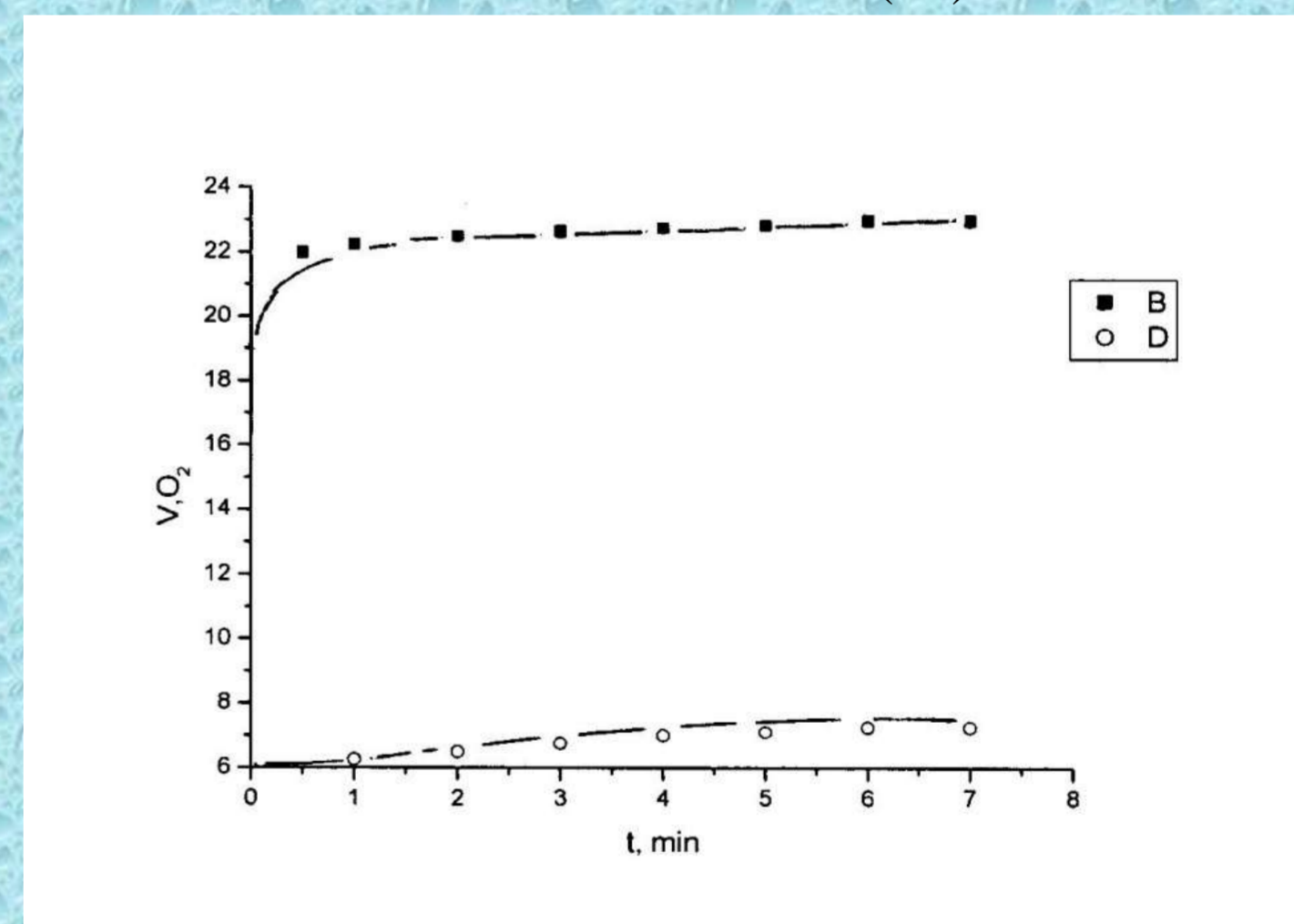


Figura 5 Cinetica procesului de descompunere a peroxidului de hidrogen în prezența catalizatorilor CA-Mn1+KMnO₄, la 200 turații pe minut (•), CA-Mn1 fiert la 95°C, spălat la 200 turații pe minut, t= 14 °C (○).

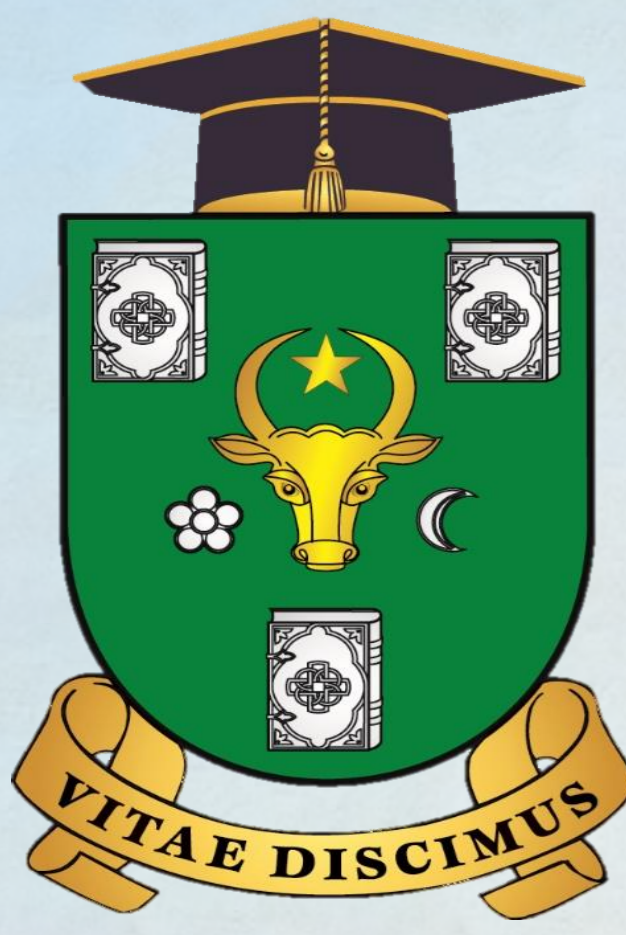
REZULTATE

Din datele prezentate observăm că cea mai mare activitate, în vederea descompunerii peroxidului de hidrogen, o are catalizatorul Centaur, obținut în SUA, la 300 turații pe minut a malaxorului. Fărâmițarea catalizatorului până la praf, la 600 turații pe minut după cum se vede din fig.3, activitatea catalitică a acestei mostre de catalizator se diminuează semnificativ. Catalizatorii DM 1-65 și Centaur fărâmițat praf la 300 turații pe minut au o activitate catalitică foarte mică. În fig.4. este prezentată cinetica procesului de descompunere a peroxidului de hidrogen în prezența catalizatorilor AC-Cu1 (•) la 200 turații pe minut, AC-Co1 (●) la 200 turații pe minut, AC-Mn2 la 200 turații pe minut. t= 14 °C (▲). În fig.5 este prezentată cinetica procesului de descompunere a peroxidului de hidrogen în prezența catalizatorului CA-Mn1+KMnO₄, la 200 turații pe minut, CA-Mn1 fiert la 95°C, spălat, la 200 turații pe minut, t= 14 °C. Dacă facem comparație dintre cinetica procesului de descompunere a peroxidului de hidrogen pe mostrele AC-Mn1+KMnO₄ cu AC-Mn1+KMnO₄ ținut 2 ore în etuvă la 95 °C, fiind adăugată apa demineralizată, constatăm o diminuare semnificativă a activității catalitice a mostrei ținute 2 ore în etuvă la 95 °C, fiind adăugată apa demineralizată. Probabil, la încălzire manganul, în forma în care se află, pur și simplu o parte din el se spală.

În urma creșterii turațiilor malaxorului are loc modificarea compoziției granulometrice a catalizatorului (el se mărunțește), diminuând semnificativ activitatea catalitică a acestuia. Aceeași legitate se observă atunci când se evaluează activitatea catalitică a catalizatorului inițial mărunțit. Acest rezultat poate fi explicat prin modificarea structurii catalizatorului obținut la o anumită presiune și temperatură.

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MONONUCLEAR NICKEL(II) AND COPPER(II) COMPLEXES WITH SCHIFF BASE LIGANDS DERIVED FROM QUINOLINE-8-ALDEHYDE AND S-METHYLISOTHIOSEMICARBAZONES



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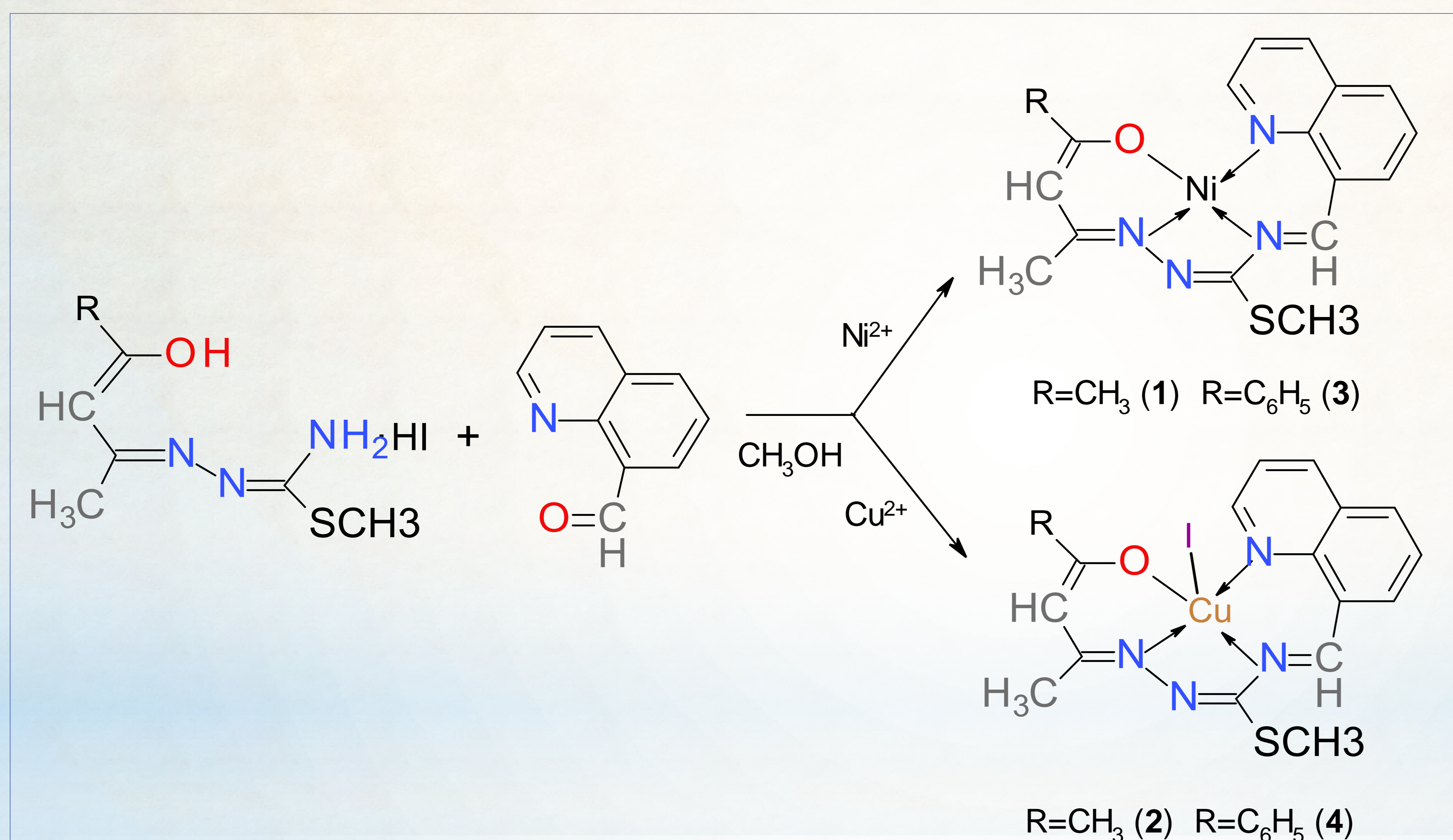


Complexes of Schiff bases with some transition metals show significant biological notification including antimicrobial, antibacterial, antifungal and anticancer activities. Azocompounds have been studied widely because of their excellent thermal, antibacterial activity and optical properties in applications such as optical recording medium, toner, ink-jet printing and oil-soluble lightfast dyes.

Metal complexes of thiosemicarbazone are well known for their pharmacological applications, while quinoline derivatives (in particular, quinoline carbaldehydes) display bactericidal, insecticidal and fungicidal properties. The combination of both active moieties in one molecular entity appears promising for the preparation of biologically active compounds.

In this paper, we report new four mononuclear Ni(II) and Cu(II) complexes: NiL¹I (1), [CuL¹I] (2), [NiL²I] (3) and [CuL²I] (4) with N₃O binding system obtained by metal-directed condensation of quinoline-8-aldehyde with acetyl or benzoylacetone mono-S-methylisothiosemicarbazone (H₂L¹ and H₂L²) (Scheme).

The compounds were characterized by elemental analysis, ESI MS and IR-spectroscopy. The molecular structures of 1 and 2 were established by X-ray diffraction method (Fig.).



Scheme. Method of obtaining of complexes 1 - 4.

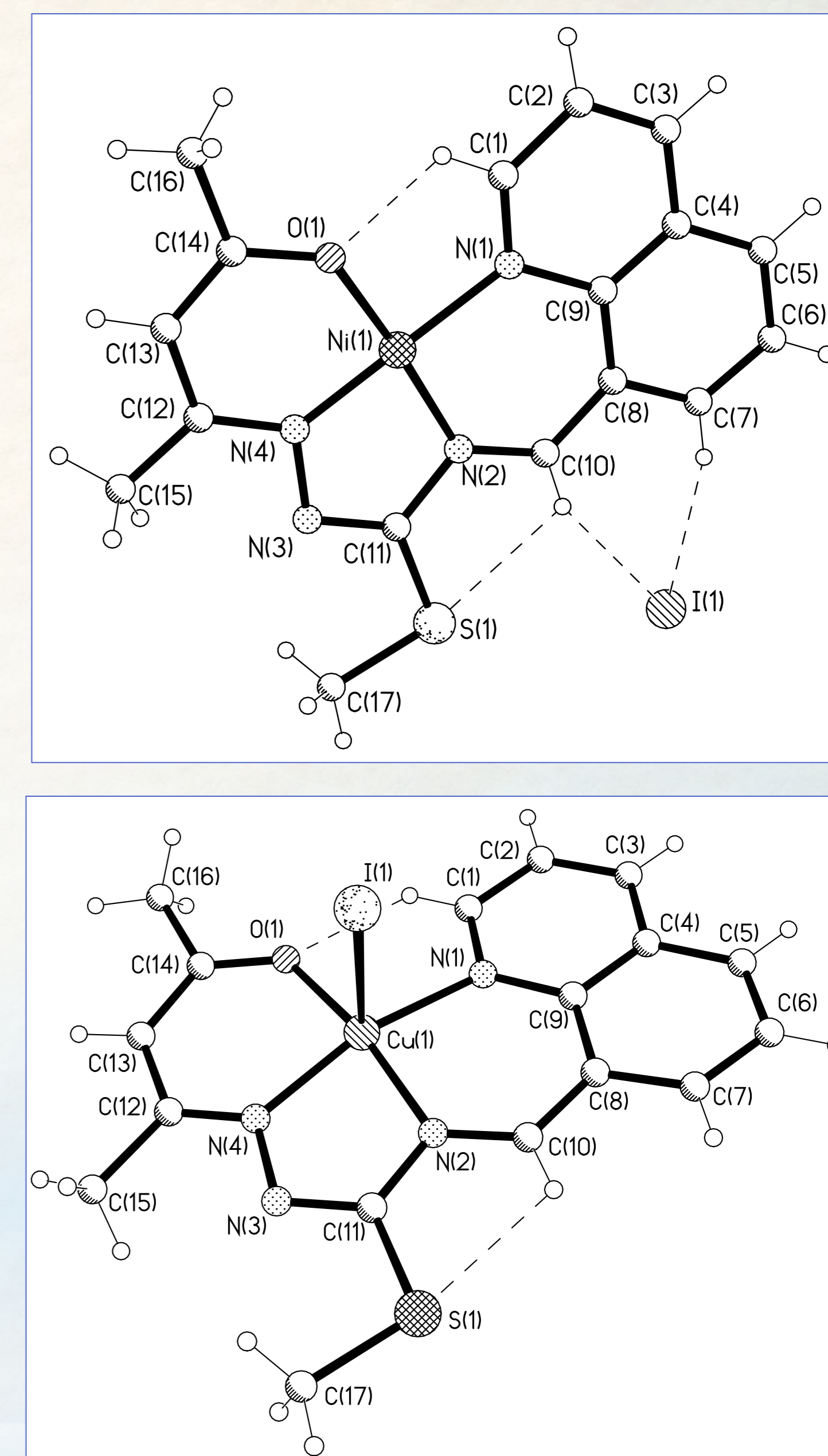


Fig. The molecular structures of 1 and 2.

The investigations confirmed that the Ni(II) compounds are ionic with an iodide anion in the external sphere and the Cu(II) complexes are molecular, the iodide anion being coordinated to the metal atom. The X-ray diffraction studies revealed a square-planar structure of the Ni(II) ionic complex and a square-pyramidal structure of the Cu(II) molecular complex.

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CHEMICAL SYNERGISM DEFINED INSIGHTS INTO COMPLEX INTERACTIONS

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Rezumat: The authors have proved, for all chemical processes used in different physico-chemical methods of analysis and research and in various fields of applications, that the common feature of the synergism phenomenon is the formation of a mixed compound. A prior knowledge of this common feature offers the possibility of a deeper understanding of this phenomenon and of the directed search or prediction of the necessary or pre-planned synergistic effects. For a better understanding of the synergism phenomenon, examples of synergistic processes in other disciplines have been given. The authors have formulated the following rule: the formation of mixed complexes is a necessary, but not sufficient condition to explain the occurrence of the chemical synergism. To prove the synergistic effect, it is necessary to measure a certain physicochemical or physical quantity, which proves the superiority of the non-additivity phenomenon over a simple summation of the properties of individual components. In other words, the theory of chemical equilibrium cannot serve as a basis for predicting synergy, but it can be post-proof of this phenomenon.

Rezultate:

It has been proven that some chemical processes exhibit a common characteristic: the formation of a mixed compound [1]. In reference [1], the nature of the synergistic effect of total buffering action in heterogeneous mixtures was explained. For instance, the authors have found that when hexanoic acid (HA) and decanoic acid (HB) combine in benzene (the organic phase) to create the mixed complex HAHB, this compound enhances the overall buffering effect. This notion is supported by other researchers who propose that in solvent extraction processes, the synergistic effect primarily arises from the formation of mixed metal complex compounds involving all extracting molecules.

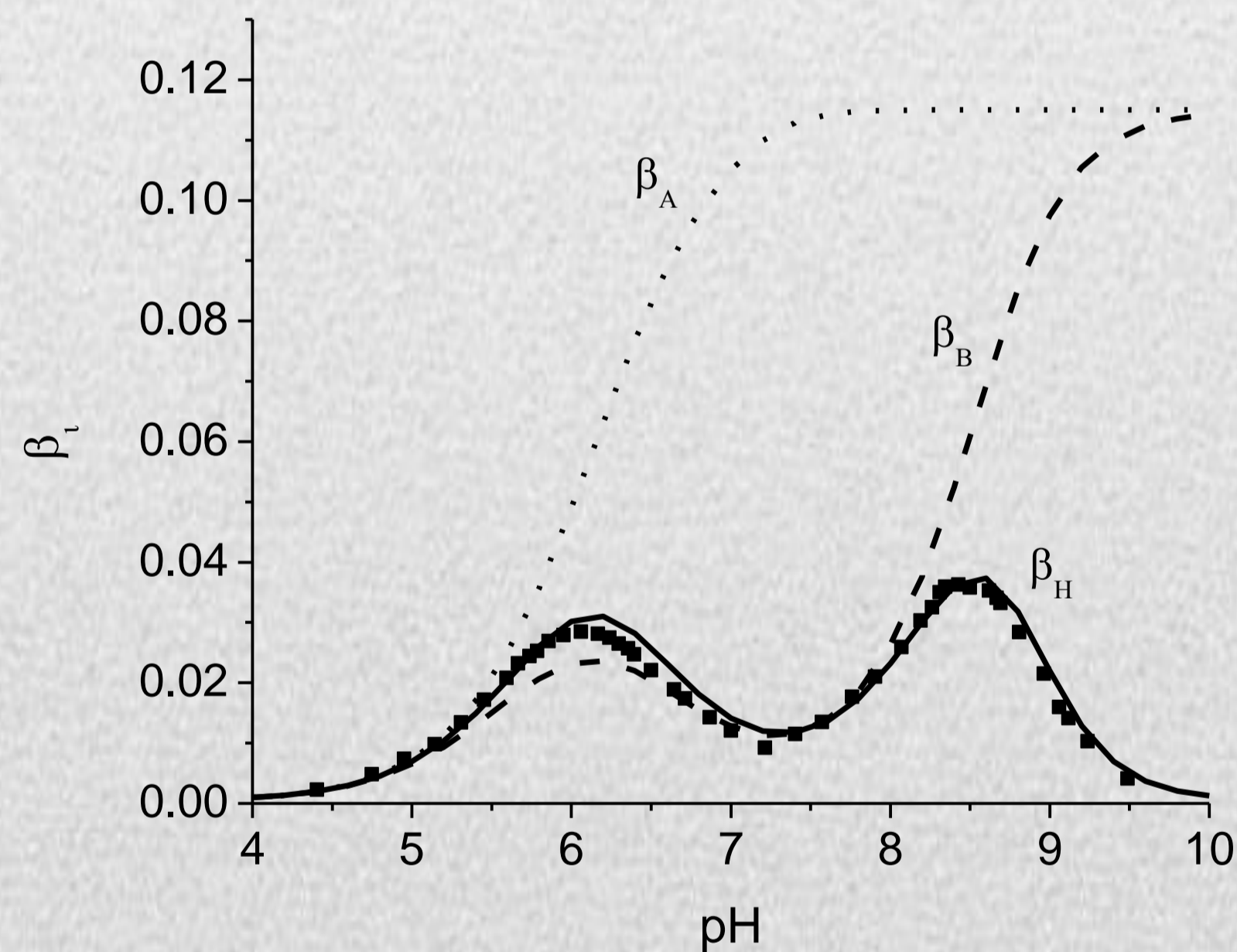


Fig. 1. Curves $\beta_H = f(\text{pH})$, $\beta_A = f(\text{pH})$ and $\beta_B = f(\text{pH})$ for the two-component two-phase buffer system, containing hexanoic and decanoic acids. $C_A^0 = C_B^0 = 0.05 \text{ mol L}^{-1}$, $I = 0.1$, $t = 25^\circ\text{C}$.

$$V(\text{C}_6\text{H}_6) \div V(\text{H}_2\text{O}) = 1 \div 1$$

Conclusions

The knowledge and the application of the ideas and general patterns of synergy described can be useful for specialists using the simultaneous action of various agents to optimize combined technological schemes. It was also concluded that the overall universal pattern of the manifestation of synergy is its dependence on the intensity of the agents used. The existence of universal patterns of synergy indicates the need to develop a new paradigm and theoretical concept of chemical synergy, which should take into account the identified patterns. A prior knowledge of this common feature gives the possibility of a deeper understanding of this phenomenon and of target search or prediction of required or pre-planned synergistic effects. Subsequent research on chemical synergism in order to predict this phenomenon should focus on finding sufficient conditions for synergistic systems, in which the formation of the mixed compound is well known and their comparison with other non-synergistic analogous systems, in which a mixed compound is formed.

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In reference [2], the formation of mixed complex compounds with precious metals was found to significantly accelerate their dissolution rates (see Fig. 2). Consequently, the process of forming mixed complex compounds could be applied for the oxidative dissolution of gold. For example, the addition of small amounts of ammonium thiosulfate to ammonium solutions has a synergistic effect on the dissolution of gold. This results in a higher dissolution rate compared to using thiosulfate or ammonium solutions separately at the same concentrations as those in the mixture.

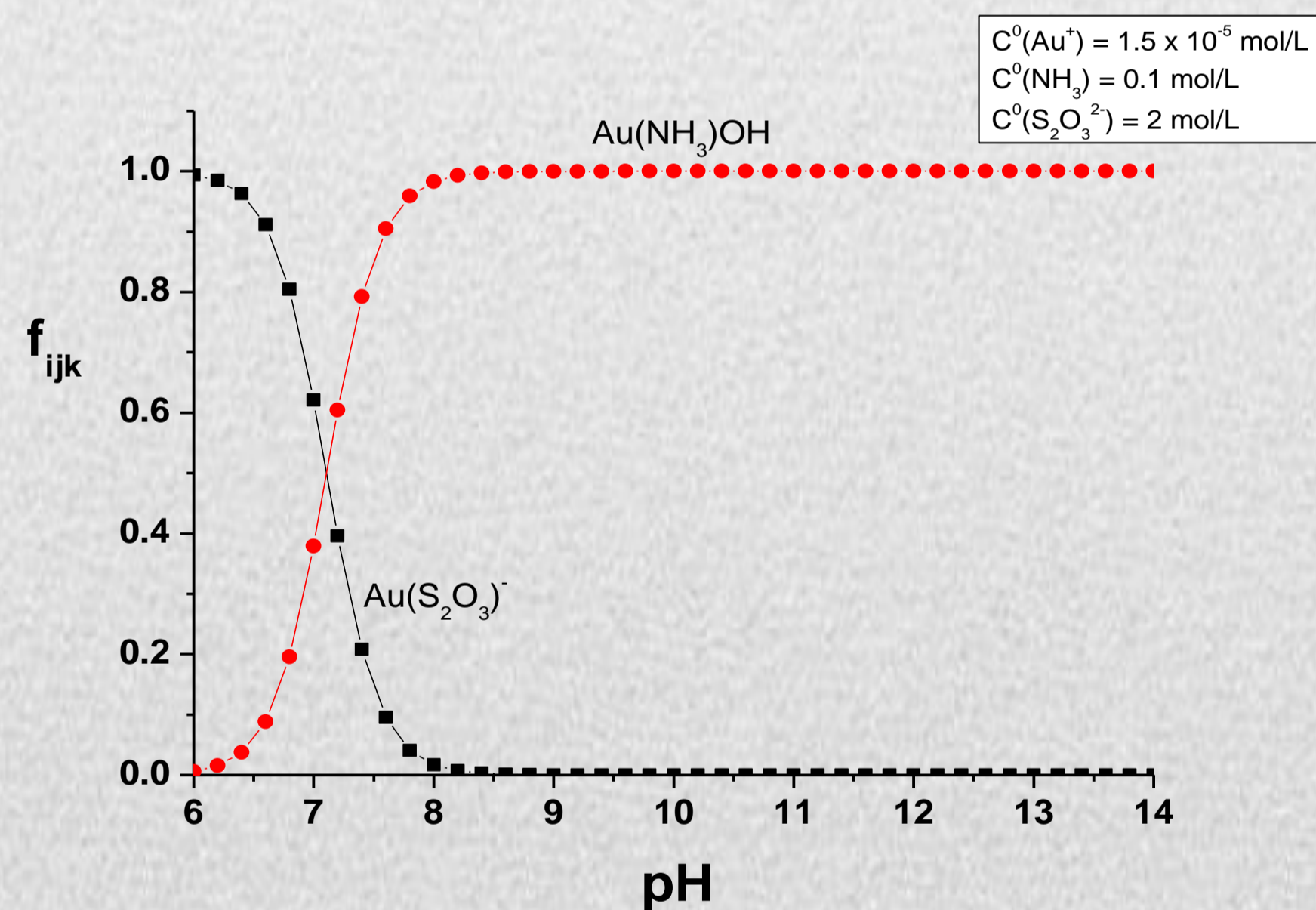


Fig.2. Curves of distribution of the Au(I) species versus pH in homogeneous system $\text{Au(I)} - \text{NH}_3 - \text{S}_2\text{O}_3^{2-} - \text{H}_2\text{O}$.

Concentrations, mol L^{-1} : $C_{\text{Au}^+}^0 = 1.5 \cdot 10^{-5}$; $C_{\text{NH}_3}^0 = 0.1$; $C_{\text{S}_2\text{O}_3^{2-}}^0 = 2$

ACKNOWLEDGMENTS: This work was carried out within the Moldovan State Program (2020–2023) “Study and management of pollution sources to develop recommendations for implementing measures to mitigate the negative impact on environment and human health”. Project number: 20.80009.7007.20.

CORRELATION BETWEEN RAINWATER CHEMICAL COMPOSITION AND ITS EROSION PROPERTIES

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The purpose of the works. The pollution of the atmosphere through the release of significant quantities of gaseous industrial pollutants leads to rainwater contamination, rendering it corrosive to terrestrial rocks and soils. Furthermore, the trend of aridification in the Republic of Moldova is altering the dynamics of rainfall patterns. This trend is characterized by a reduction in the duration of rainfall events and an escalation in their intensity, resulting in a higher rate of rainwater flow per unit of time. In such circumstances, despite a roughly similar volume of rainwater, the consequences are markedly different, as the potential for soil erosion is on the rise. The objective of this research was to assess the influence of rainwater chemical composition and specific conditions on the process of soil particle washing. The action of rainwater washing soil not only depletes the soil itself but also results in the sedimentation of lakes and ponds, leading to the clogging of surrounding areas. Consequently, this phenomenon can cause natural lakes and, particularly, man-made reservoirs (such as dam lakes) to become murky and silt-laden..

Research results. Following the analysis of the results of a series of rainwater samples collected on the territory of the Republic of Moldova and other regions presented in scientific publications, three types of rainwater were modeled: “*Moderate*” in which HCO_3^- ions predominate along with $\text{CO}_2 \cdot \text{H}_2\text{O}$, $\text{NH}_3 \cdot \text{H}_2\text{O}$; “*Acid*” (in which strong acid anions Cl^- , NO_3^- , SO_4^{2-} predominate along with HCO_3^- , $\text{CO}_2 \cdot \text{H}_2\text{O}$, $\text{NH}_3 \cdot \text{H}_2\text{O}$, etc.; and “*Ammoniacal*” (in which the

Table 1. Concentration (mg/L) of total calcium ion (soluble and in suspension) washed by rainwater and retained over time (in bold in samples kept for 3 days in rainwater)

	The type of rainwater								
	Acid			Moderate			Ammoniacal		
Dilution	1	2	4	1	2	4	1	2	4
Time	Ca ²⁺ mg/L								
10 min.	196	84(98)	60(49)	163	92	72	188	121	82
30 min.	150	84(75)	56(37.5)	132	88	59	148	100	72
60 min.	124	80(62)	56(31)	125	80	51	144	100	64
27 hre	88	29(44)	24(22)	88	52	22	110	64	43

ammonium ion predominates along with HCO_3^- , $\text{CO}_2 \cdot \text{H}_2\text{O}$ and the anions

of strong acids). Diluted versions (by 2, 4, 8 times) of these three rainwater types were as well modeled. In all types of rainwater CO_2 was obtained supersaturated. To get the pH titration curves, the automatic titrator 848 Titrio plus was used. COD, Ca^{2+} , Mg^{2+} et al. were carried out according to the accepted methodology. For the soil washing research, three types of soils, well known in the Republic of Moldova (*Typical Chernozium*, *Clay Carbonate Chernozium* and *Argiloiluvial Chernozium*) and the most aggressive types of rainwater (*Acid* and *Ammoniacal*) were used in models.

Table 2. Value of $[\text{Ca}^{2+}]$ of the sum of $[\text{Ca}^{2+} + \text{Mg}^{2+}]$ and COD for washing rainwater of typical soils after one freeze and after 10 freezes.

Types of soils	Typical chernoziom				Carb. clayey chernoziom				Argiloiluvial chernoziom			
	Type of water	Amon.	Acid	Amon. /4	Dist.	Amon.	Acid	Amon. /4	Dist.	Amon.	Acid	Amon. /4
After a frost												
$\Sigma \text{Ca}^{2+} + \text{Mg}^{2+}$, mgEc/L	1.44	1.52	0.96	1.12	4	2.32	2.56	1.88	2.6	1.92	2.08	2.0
Ca^{2+} , mg/L	26.4	17.6	17.6	14.4	63.2	44.8	45.6	15.2	40	33.6	33.6	14.4
CCO_{Cr} , mgO/L	165	156	148	255	189	197	222	148	559	535	666	518
After 10 freezes												
$\Sigma \text{Ca}^{2+} + \text{Mg}^{2+}$, mgEc/L	1.12	1.2	0.96	0.92	2.32	2.0	1.72	1.44	1.2	1.8	1.6	1.44
Ca^{2+} , mg/L	16	18.4	17.6	16	33.6	40	34.4	25.6	328	33.6	27.2	27.2
CCO_{Cr} , mgO/L	132	74	140	86	99	91	140	86	387	346	304	197

The multiple freeze/thaw cycle was practiced in order to understand the effect of the winter period. The following important conclusions were obtained: 1) strong *Acid* rainwater solubilizes calcareous rock most strongly; 2) CO_2 and NH_3 are the main components that retain the washing/hydrating properties of limestone particles; 3) by the dilution of the mineral component of rainwater, the limestone washing activity is best preserved in *Ammoniacal* rainwater; 4) *Typical Chernoziom* soil is the most resistant to the aggressiveness of the rains; 5) the vulnerability of the soils gradually increases in the *Typical Chernozium*, *Clay-Carbonate Chernozium* and *Argiloiluvial Chernozium* consequence; 6) the study of changes in soils at low temperatures demonstrates the strengthening of their stability after multiple freezes.

SORPTIVE PROPERTIES OF SUBAQUATIC SEDIMENT FRACTIONS IN A EUTROPHICATED LAKE

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The purpose of the works. The researches aimed to elucidate the composition and properties of sedimented matter from the water of Lake Ghidighici - a typical example of a eutrophic lake in the geographical area. Samples of mineral and organomineral sediments extracted from the lake bottom were investigated using for this purpose different chemical and physico-chemical research methods - elemental composition analysis, automatic acid-base titration, infrared and UV-VIS spectroscopy, Roentgen analysis, etc. The research was performed using the Metrohm 848 Titrino plus titrator, Perkin Elmer Lambda 25 and Lomo SFD-46 spectrophotometers, Dron 3 diffractometer.

Research results. Automatic acid-base titration of dispersed systems - solid particles from underwater sediments showed a relatively high buffer capacity for acidic agents and relatively low in the case of basic solutions.

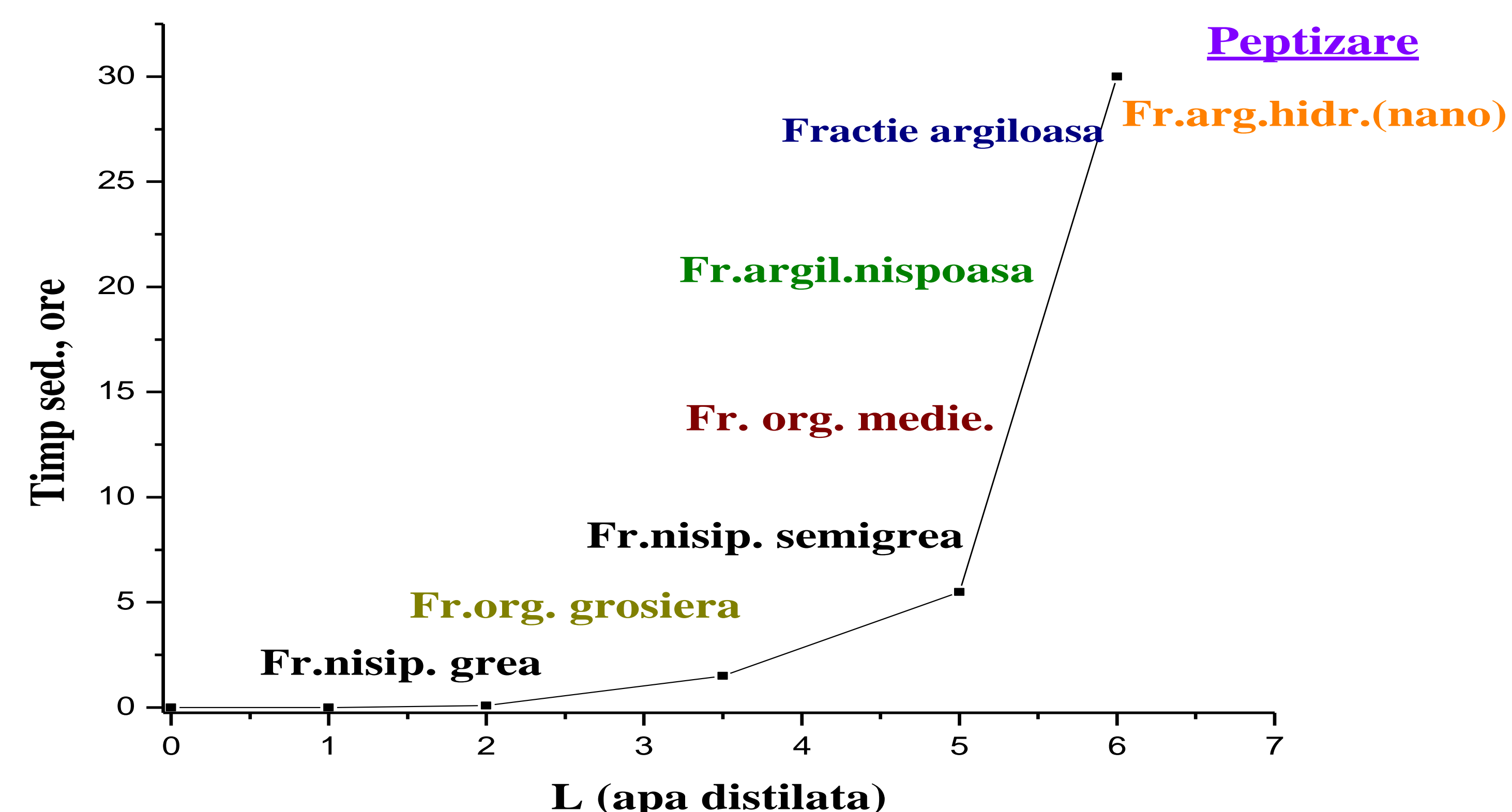


Fig. 1. The dynamics of the separation of the fractions from the underwater sediment, Lake Ghidighici.

The separation of the fractions in the clearing processes were performed by subsequent agitation and sedimentation following the specificity of the sedimentation process over time of the fractions of the dispersed system (Fig. 1). A total of seven fractions were separated. Acid-base titrations allow to evaluate the resistance capacity of the underwater sediment to the action of aggressive agents of acidic or basic nature (Fig. 2). Knowing the laws of acid-base influence on underwater sediments allows the creation of stability conditions in the aquatic environment. Carrying out the clearing of water basins makes it possible to use underwater sediments as a material to strengthen the durability of soils against erosion and improve the physico-chemical and mechanical properties of soils. The phenomenon of cetyltrimethylammonium adsorption on underwater sediment particles demonstrates that the highest adsorption value has the fine fraction.

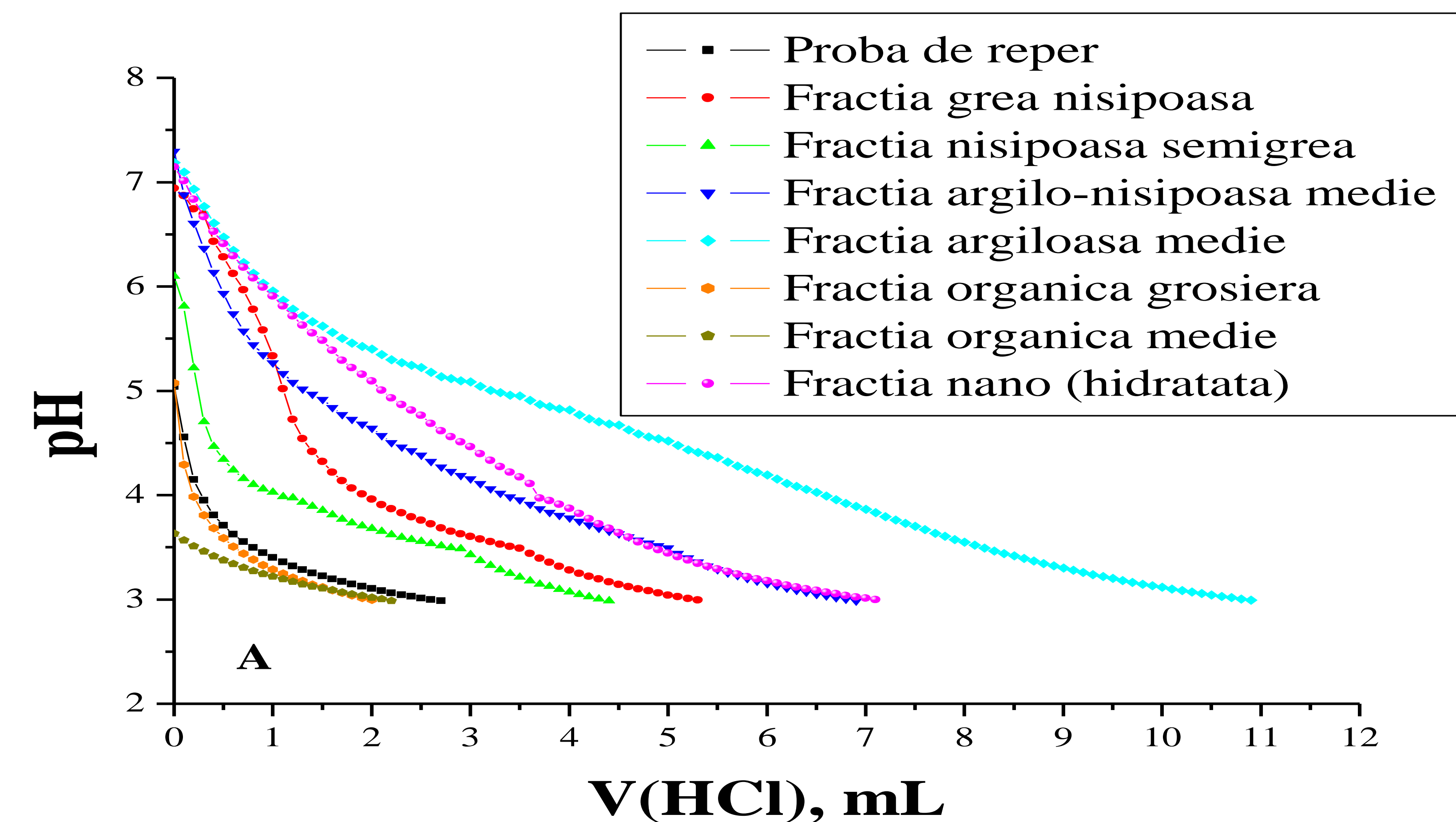


Fig. 2. Acid titration curves (A) of 7 fractions of underwater sediment.


The decrease of this characteristic is observed in the case of fractions with medium and coarse dispersion. The study of underwater sediments with modern physico-chemical methods allowed the identification in them of a series of minerals (silicates, aluminosilicates, carbonates and others) characteristic of the soil in the area, their quantitative assessment and their role in nature, and the prospect of using their specific properties. The determination of the structural-sorbational characteristics and the surface chemistry of solid particles in underwater sediments prove the possibility of obtaining new filter materials and allow the development of original methods for purification of natural and wastewater, and the evaluation of acid-base durability and adsorbent properties of sludge develop soil fortification procedures against erosion processes.

The most hydrated, finest fraction was chosen from the obtained fractions and named "peptizing". A solution of cetylpyridinium chloride (CPir) $C_{21}H_{38}ClN$ at a level of 6 - 10 mol/L was used in the model. The experiment demonstrated a very efficient separation of this surface-active substance. Upon fixation of CPir on the hydrated fraction, significant sedimentation properties were acquired, leading to complete separation within five hours. The capture efficiency of this fraction exceeded 2.6 $\mu\text{mol/g}$ of CPir. This process helps to understand the self-purification process in the water-particle (hydrated clay) suspension system. A similar fixation and purification effect is presumed to occur in WWTP.

THERE IS AN OPPORTUNITY TO REDUCE EMISSION OF NOX AND GHG ON ANY THERMAL POWER PLANT IF THEY USE NATURAL GAS AS FUEL.

Author: Iurie Panfil

Organization: *UIR Inovatorul*;



Cleaner and Cheaper Energy by Using

REAEGR
„Replace Excess Air through Exhaust Gases Reduction”

http://www.reae.gr

This is a low cost measure to reduce emissions of CO₂, NO_x and save fuel at any thermal power installation
(Patents: EA 030025; MD 4270).

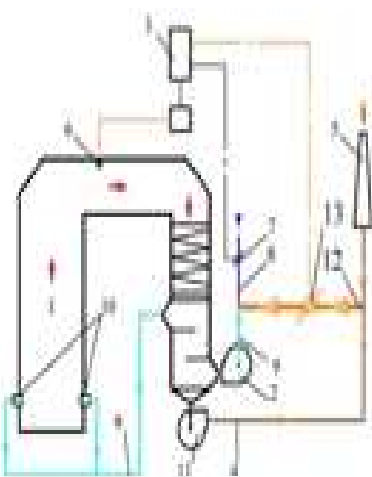
Implementation of it at Termoelectrica S.A. (the Republic of Moldova) will give an annual:

Emissions reduction: CO₂ 20.0 Kt
NO_x 0.3 Kt

Savings of natural gas: 6.0 Mln. m³

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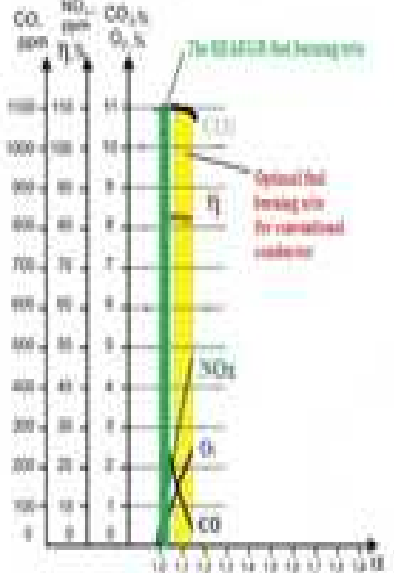
Scheme of the REAEGR for the boilers with capacity more than 30.0 MW



Explication:
1 - boiler;
2 - air supply fan;
3 - control panel;
4 - flue gas duct;
5 - stack;
6 - sensor for O₂ and CO probes;
7 - valve on air duct;
8 - air duct;
9 - mixture duct;
10 - burner;
11 - exhauster;
12 - recirculation duct;
13 - valve on recirculation duct.

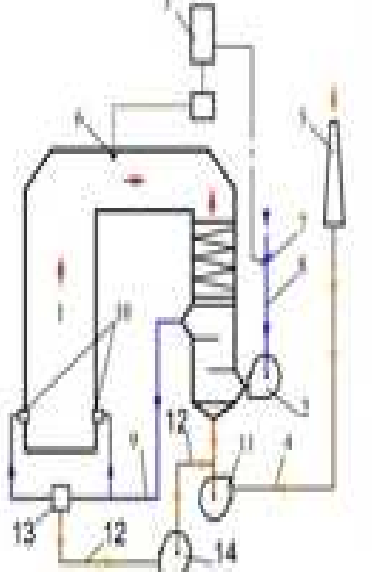
The REAEGR device

Diagram of parameters of exhaust gas from boilers using the REAEGR



The REAEGR fuel burning area is highlighted in green, showing a significantly narrower range of CO₂ and O₂ concentrations compared to conventional boilers, indicating more precise fuel control and lower emissions of CO and NO_x.

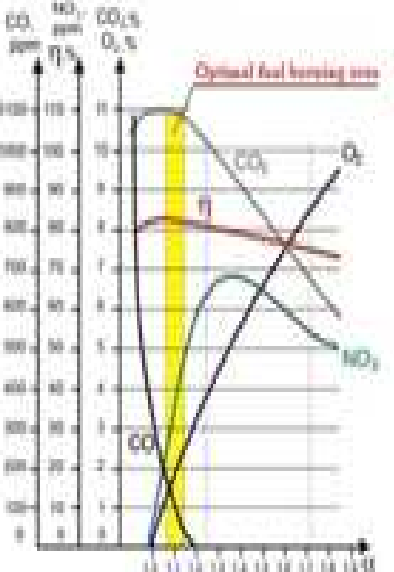
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7 - valve on air duct;
8 - air duct;
10 - burner;
11 - exhauster;
12 - recirculation duct;
13 - mixing chamber;
14 - recirculation exhaust fan.

The EGR technology

Diagram of parameters of exhaust gas from conventional boilers



The conventional boiler fuel burning area is highlighted in red, showing a much wider range of CO₂ and O₂ concentrations, indicating less precise fuel control and higher emissions of CO and NO_x.

NATIONAL STRATEGY ON EDUCATION FOR THE ENVIRONMENT AND CLIMATE CHANGE 2023-2030

CONTEXT

- * The world is facing two major crises - climate change and environmental degradation - which generate devastating effects on people's lives and well-being. Therefore, systemic solutions and multi-level action are needed: international cooperation, the involvement of all state institutions, but also the private, academic environment, and citizens.
- * In this context, the education of young people plays a fundamental role in behavioral and mental adaptation, in the formation of transversal skills, necessary to cultivate sensitivity towards moral-civic values and respect for nature, its resources, and the natural, social and cultural environment.

NATIONAL STRATEGY – A FIRST FOR ROMANIA

- * The adoption at government level of the “National Strategy on Education for the Environment and Climate Change 2023-2030”, a programmatic document that will include eco-social skills among the key skills starting from the 2023-2024 school year, represents a moment of utmost importance, being a first for Romania to adopt this national strategy.
- * The strategy is based on the Report of the Presidential Administration “Education on climate change and the environment in sustainable schools”, a continuation of the “Educated Romania” Project, young people being both bearers of a message to their families and communities, as well as directly involved in actions to stop the degradation of the environment and to develop public policies for its protection.



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“Carol Davila” Post-Secondary Healthy School
Bioterra University from Bucharest

OBJECTIVES

- * Students will acquire competencies, skills and attitudes: to develop systems thinking and understand “green” energy, responsible exploitation of natural resources, pollution, extractive industry, energy industry, social justice, food waste, natural disasters, etc.; to relate to environmental factors and living environments; to make decisions and start relevant actions, through behavior to protect and improve the quality of the environment and reduce the impact of negative factors; to protect, restore and promote the sustainable use of terrestrial ecosystems, flowing waters, lakes, seas and marine resources and halt the loss of biodiversity; understand environmental legislation and the roles of relevant actors in the area of environmental protection; to participate, in the future, in the development of public environmental policies and of new technologies for combating environmental degradation.
- * The objectives assumed by our country until 2030 are: improving education, awareness and human and institutional capacity on adaptation, reducing the impact of factors affecting the environment; intensifying Romania's efforts to achieve the transition to a “green” economy, for the integration of measures to combat environmental degradation in vulnerable economic, social and environmental sectors, in accordance with EU policies.

CONCLUSIONS

- * The implementation of the strategy and the action plan assumes that the legal and the strategic framework will evolve in accordance with the proposed objectives, taking into account the European and national legislative context in the field of environmental protection.

REFERENCES: <https://www.edu.ro/sites/default/files/SNEM.pdf>