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Results of Biophysical and Nano Technological Research of ZEOLITH Detox of LavaVitae Company

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Abstract

We studied the mathematical model of interaction with water of natural mineral and microporous crystalline mineral ZEOLITH detox of LavaVitae Company (Austria). In this report are submitted data about the interaction of ZEOLITH detox with water, obtained by non-equilibrium (NES) and differential-equilibrium energy spectrum (DNES) of water. The average energy ($\Delta E_{H\ldots O}$) of hydrogen H…O-bonds among individual molecules H_2O after treatment of ZEOLITH detox with water measured by NES- and DNES-methods is $\Delta E = -0.0034 \pm 0.0011$ eV for ZEOLITH detox. This result suggests the restructuring of $\Delta E_{H\ldots O}$ values among H_2O molecules with a statistically reliable increase of local extremums in DNES-spectra. The research is performed for ZEOLITH detox with study of pH and oxidative reduction potential (ORP).

Keywords: ZEOLITH detox, nanostructures, mathematical model, NES, DNES.

1. Introduction

The ZEOLITH detox is mineral refers to new generation of natural mineral sorbents (NMS). Zeolites are the alumosilicate members of the family of microporous solids known as "molecular sieves", named by their ability to selectively sort molecules based primarily on a size exclusion process. Natural zeolites form when volcanic rocks and ash layers react with alkaline groundwater. Zeolites also crystallize in post-depositional environments over periods ranging from thousands to millions of years in shallow marine basins. Naturally occurring zeolites are rarely pure and are contaminated to varying degrees by other minerals, metals, quarts, or other zeolites. For this reason, naturally occurring zeolites are excluded from many important commercial applications where uniformity and purity are essential.

As natural mineral zeolite has unusually broad scope of application in industry. Adsorption, catalytic, and reduction-oxidation Zeolites is widely used in industry as a desiccant of gases and liquids, for treatment of drinking and sewage water from heavy metals, ammonia, phosphorus, as catalyst in petrochemical industry for benzene extraction, for production of detergents and for extracting of radionuclides in nuclear reprocessing. It is also used in medicine as nutritional supplements having antioxidant properties. Some authors make qualifications of zeolites as nano materials.

A wide range of properties of zeolite defines the search for new areas of industrial application of these minerals in science and nano technology that contributes to a deeper study the mechanism of interaction of these minerals with water. This paper deals with evaluating of mathematical model of interaction of ZEOLITH detox with water.

2. Materials and Methods

2.1. Materials

The study is performed with samples of ZEOLITH detox from LavaVitae Company.

There are valid the following methods for research of zeolite.

2.2. Analytical Methods

The analytical methods were accredited by the Institute of Geology of Ore Deposits. Petrography, Mineralogy, and Geochemistry (Russian Academy of Sciences). Samples were treated by various methods as ICP-OES, GC, and SEM.

2.3. Gas-Chromatography

Gas-chromatography (GC) is performed at Main Testing Centre of Drinking Water (Moscow, the Russian Federation) on Kristall 4000 LUX M using Chromaton AW-DMCS and Inerton-DMCS columns (stationary phases 5% SE-30 and 5% OV-17), equipped with flame ionization detector (FID) and using helium (He) as a carrier gas.

2.4. Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)

The mineral composition is studied by inductively coupled plasma optical emission spectrometry (ICP-OES) on Agilent ICP 710-OES (Agilent Technologies, USA) spectrometer, equipped with plasma atomizer (under argon stream), MegaPixel CCD detector, and 40 MHz free-running, air-cooled RF generator, and Computer-optimized exhale system: the spectral range at 167–785 nm; plasma gas: 0–22.5 l/min in 1.5 l/min; power output: 700–1500 W in 50 W increments.

2.5. Transmission Electrom Microscopy (TEM)

The structural studies were carried out with using JSM 35 CF (JEOL Ltd., Korea) device, equiped with X-ray microanalyzer "Tracor Northern TN", SE detector, thermomolecular pump, and tungsten electron gun (Harpin type W filament, DC heating); working pressure: 10^{-4} Pa (10^{-6} Torr); magnification: 300.000, resolution: 3.0 nm, accelerating voltage: 1–30 kV; sample size: 60–130 mm.

2.6. IR-Spectrospopy

IR-spectra of water samples, obtained after being contacted 3 days with shungite and zeolite, are registered on Fourier-IR spectrometer Brucker Vertex ("Brucker", Germany) (a spectral range: average IR – 370–7800 cm^{-1}; visible – 2500–8000 cm^{-1}; the permission – 0.5 cm^{-1}; accuracy of wave number – 0.1 cm^{-1} on 2000 cm^{-1});

For the research of ZEOLITH detox the methods are:

2.8. Non-equilibrium Spectrum (NES) and Differential Non-equilibrium Spectrum (DNES)

The energy spectrum of water is characterized by a non-equilibrium process of water droplets evaporation, therefore, the term non-equilibrium spectrum (NES) of water is used. The difference Δ*f(E) = f (samples of water) – f (control sample of water)* – is called the "differential non-equilibrium energy spectrum of water" (DNES).

2.9. Measurement of pH and ORP (oxidative-redox potential)

The research is perform from Georgi Gluhchev with device from Hanna Instruments.

3. Results and Discussion

In comparison with zeolite comprises a microporous crystalline aluminosilicate mineral commonly used as commercial adsorbents, three-dimensional framework of which is formed by linking via the vertices the tetrahedral $[AlO_4]^{2-}$ and $[SiO_4]^{2-}$ (Panayotova & Velikov, 2002). Each tetrahedron $[AlO_4]^{2-}$ creates a negative charge of the carcasses compensated by cations (H^+, Na^+, K^+, Ca^{2+}, NH_4^+, etc.), in most cases, capable of cation exchange in solutions. Tetrahedrons formed the secondary structural units, such as six-membered rings, five-membered rings, truncated octahedra, etc. Zeolites framework comprise interacting channels and cavities forming a porous structure with a pore size of 0.3–1.0 nm. Average crystal size of the zeolites may range from 0.5 to 30 μm.

By the measurement of IR spectra in the range of vibrations in the crystal mineral framework one can obtain the information: a) on the structure of the framework, particularly type lattice ratio SiO_2/Al_2O_3, nature and location of cations and changes in the structure in the process of the thermal treatment; b) on the nature of the surface of the structural groups, which often serve as adsorption and catalytically active sites.

Other method for obtaining information about the average energy of hydrogen bonds in an aqueous sample is measuring of the spectrum of the water state. It was established experimentally that at evaporation of water droplet the contact angle θ decreases discretely to zero, whereas the diameter of the droplet changes insignificantly (Antonov, 2005). By measuring this angle within a regular time intervals a functional dependence f(θ) can be determined, which is designated by the spectrum of the water state (Ignatov, 2005; Ignatov, 2012; Ignatov & Mosin, 2013). For practical purposes by registering the spectrum of water state it is possible to obtain information about the averaged energy of hydrogen bonds in an aqueous sample. For this purpose the model of W. Luck was used, which consider water as an associated liquid, consisted of O–H…O–H groups (Luck *et al.*, 1980). The major part of these groups is designated by the energy of hydrogen bonds (-E), while the others are free (E = 0). The energy distribution function f(E) is measured in electron-volts (eV^{-1}) and may be varied under the influence of various external factors on water as temperature and pressure.

For calculation of the function f(E) experimental dependence between the water surface tension measured by the wetting angle (θ) and the energy of hydrogen bonds (E) is established:

$$f(E) = b\,f(\theta) / 1 - (1 + b\,E)^2)^{1/2},$$

where $b = 14.33\ eV^{-1}$; $\theta = \arccos(-1 - b\,E)$

The energy of hydrogen bonds (E) measured in electron-volts (eV) is designated by the spectrum of energy distribution. This spectrum is characterized by non-equilibrium process of water droplets evaporation, thus the term "non-equilibrium energy spectrum of water" (NES) is applied.

The difference Δf(E) = f (samples of water) – f (control sample of water)

– is designated the "differential non-equilibrium energy spectrum of water" (DNES).

DNES is calculated in milli-electron volts (0.001 eV or meV) is a measure of changes in the structure of water as a result of external factors. The cumulative effect of all other factors is the same for the control sample of water and the water sample, which is under the influence of this impact.

The research with NES method of water drops received after 3 days stay with zeolite in deionized water may also give valuable information on the possible number of hydrogen bonds as percent of water molecules with different values of distribution of energies. These distributions are basically connected with restructuring of H_2O molecules with the same energies.

The average energy ($E_{H...O}$) of hydrogen H…O-bonds among individual H_2O molecules in 1% solution of ZEOLITH detox is measured at E=-0.1219 eV. The result for the control sample (deionized water) is E=-0.1185 eV. The results obtained with the NES method are recalculated with the DNES method as a difference of the NES (1% solution of ZEOLITH detox) minus the NES (control sample with deionized water) equaled the DNES spectrum of 1% solution of ZEOLITH detox. Thus, the result for 1% solution of Zeolite detox recalculated with the DNES method is ΔE=-0.0034±0.0011 eV. The result shows the increasing of the values of the energy of hydrogen bonds in 1% solution of ZEOLITH detox regarding the deionized water. The result is effect of stimulation on human body. This shows restructuring of water molecules in configurations of clusters, which influence usefully on human health on molecular and cellular level. The effects are describing with mathematical model of 1% solution of ZEOLITH detox.

The research with the NES method of water drops is received with 1% solution ZEOLITH detox, and deionized water as control sample. The mathematical models of 1% solution ZEOLITH detox gives the valuable information for the possible number of hydrogen bonds as percent of H_2O molecules with different values of distribution of energies (Table 1 and Fig. 1). These distributions are basically connected with the restructuring of H_2O molecules having the same energies.

Table 1: The distribution (%, $(-E_{value})/(-E_{total\ value})$ of H_2O molecules in 1% water solution of ZEOLITH detox (product of LavaVitae, Austria) and control deionized water

-E(eV) x-axis	1% water solution ZEOLITH detox (LavaVitae) y-axis (%($(-E_{value})$ */ $(-E_{total\ value})$**	Control Sample Deionized water y-axis (%($(-E_{value})$*/ $(-E_{total\ value})$**	-E(eV) x-axis	1% water solution ZEOLITH detox (LavaVitae) y-axis (%($(-E_{value})$ */ $(-E_{total\ value})$**	Control Sample Deionized water y-axis (%($(-E_{value})$*/ $(-E_{total\ value})$**
0.0937	0	6.7	0.1187	0	15.5
0.0962	0	6.7	0.1212	**18.9**[2]	0
0.0987	0	6.7	0.1237	0	6.7
0.1012	6.0	15.5	0.1262	0	6.7
0.1037	12.5	6.7	0.1287	0	0
0.1062	0	6.7	0.1312	0	3.3
0.1087	3.1	0	0.1337	12.5	0
0.1112	**3.1**[1]	0	0.1362	12.5	3.3
0.1137	0	15.5	0.1387	**18.9**[3]	0
0.1162	12.5	0	–	–	–

Notes:

E=-0.1212 eV is the local extremum for anti inflammatory effect

E= -0.1387 eV is the local extremum for inhabitation of development of tumor cells of molecular level

Notes:

* The result $(-E_{value})$ is the result of hydrogen bonds energy for one parameter of (-E)

** The result $(-E_{value})$ is the total result of hydrogen bonds energy

Figure 1 shows the distribution (%, $(-E_{value})/(-E_{total\ value})$ of H_2O molecules in and 1% of water solution of ZEOLITH detox (product of LavaVitae, Austria) (red line) and control sample deionized water (blue line).

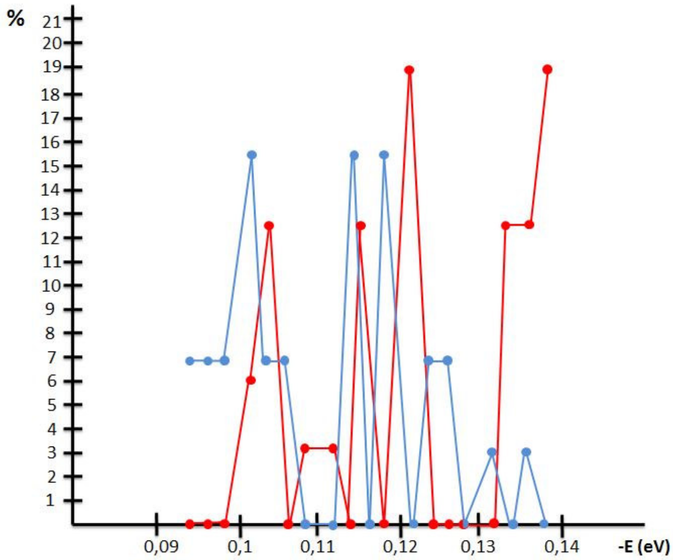

Fig. 1. Mathematical model (Ignatov, Mosin, 2013) of 1% water solution of ZEOLITH detox (product of LavaVitae, Austria).

Notes:

E=-0.1212 eV is the local extremum for anti inflammatory effect

E= -0.1387 eV is the local extremum for inhabitation of development of tumor cells of molecular level

The experimental data obtained testified the following conclusions from the mathematical model of in 1% water solution of ZEOLITH detox (product of LavaVitae, Austria) and control deionized water. The distribution (%, ($-E_{value}$)/($-E_{total\ value}$) of water molecules in mathematical model of in 1% water solution of ZEOLITH detox (product of LavaVitae, Austria) and control deionized water. The distribution (%, ($-E_{value}$)/($-E_{total\ value}$) of water molecules in ZEOLITH detox (product of LavaVitae, Austria) according control sample is different. However, for the value E = -0.1387 eV or λ = 8.95 μm there is the biggest local extremum (18.9 (%, ($-E_{value}$)/($-E_{total\ value}$)) corresponding to the re-structuring of hydrogen bonds among H_2O molecules for inhabitation of development of tumor cells of molecular level. This difference may indicate on the different number of hydrogen bonds in water samples, as well as their physical parameters **(pH, ORP),** resulting in different distribution of H_2O molecules and different values of H_2O molecules with ratios of ($-E_{value}$)/($-E_{total\ value}$). Particularly it was observed the statistical re-structuring of H_2O molecules in water samples according to the energies. The experimental data may prove that stipulates the restructuring of H_2O molecules on molecular level and may be used for the prophylaxis of development of tumor cells. For the valueE=-0.1212 eV or λ=10.23 μm there is the bigger local extremum (18.9 (%, ($-E_{value}$)/($-E_{total\ value}$)) corresponding to the re-structuring of hydrogen bonds among H_2O molecules for anti inflammatory effect.. The experimental data for ZEOLITH detox may prove that stipulates the restructuring of H_2O molecules on molecular level and the biophysical effects are:

E=-0.1212 eV is the local extremum for anti inflammatory effect

E= -0.1387 eV is the local extremum for inhabitation of development of tumor cells of molecular level

5. Results with pH and ORP

There are valid the following results of pH as indicator for acid alkaline medium of the products of Lava Vitae. There are the results also of ORP or Oxidation-reduction potential.

The results are for 1% of solutions of products, which are made from deionized water. This research is performed with Georgi Gluhchev from Bulgarian Academy of Science. The results of pH of deionized water is 6.05 and of ORP is 119.7. Table 2 shows the results of pH and ORP.

Table 2. Results of products of company LavaVitae for pH and ORP

Product	pH	ORP (mV)	Coordinates Fig. 5
VITA Intense	4.07±0.02	- 104.5	Point 1 (4,07; -104.5)
BOOST	3.60±0.02	+113.6	Point 2 (3,90;113.6)
ZEOLITH detox	8.01±0.02	+109.5	Point 3 (8,01;103.3)
Deionized water	6.05±0.02	+119.7	

Figure 2 shows the dependence between the acidity and basicity (pH) of electrochemically activated solutions and the oxidation-reduction potential (ORP). The pH value within the interval from 3 to 10 units and the ORP within the interval from -400 mV to +900 mV characterize the area of the biosphere of microorganisms. Outside these ranges of pH and ORP the microorganisms will hardly survive.

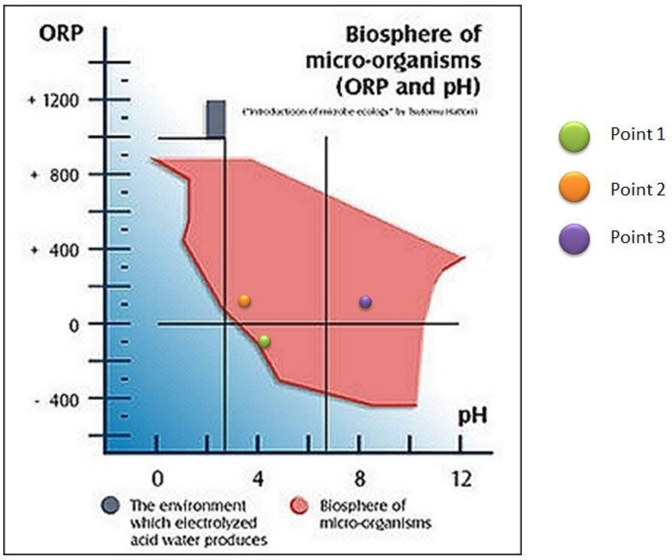

Figure 2. The dependence between acidity and basicity (pH) of solutions and the ORP on the biosphere of micro-organisms (point 1; Vita Intense), (point 2; BOOST), point 3; ZEOLITH detox).

Owing to the unique porous structure the mineral Zeolites are ideal absorbents and fillers (Gorshteyn *et al.*, 1979), and as sorbents have a number of positive characteristics:

- High adsorption capacity, characterized by low resistance to water pressure;
- Mechanical strength and low abrasion resistance;
- Corrosion-resistance;
- Absorption capacity felative to many substances, both organic (oil, benzene, phenol, pesticides, etc.) and inorganic (chlorine, ammonia, heavy metals);
- Catalytic activity;
- Relatively low cost;
- Environmental friendliness and ecological safety.

4. Conclusions

The interaction of ZEOLITH detox with water is quiet complex and results the restructuring of energy values among H_2O molecules with a statistically reliable increase of local extremums in DNES-spectra after treatment of ZEOLITH detox with water. These values are measured at -0.1219 eV for ZEOLITH detox. The result for control sample (deionized water) is -0.1185 eV. The results with NES method were recalculated by the DNES method. The result of ZEOLITH detox with DNES method is 0.0034±0.0011 eV.

From the NES and DNES spectrum and mathematical model of 1% solution of ZEOLITH detox and deionized water as control sample are valid the following conclusions for biophysical effects for ZEOLITH detox (LavaVitae Company)

- anti inflammatory effect;
- inhabitation of development of tumor cells of molecular level;

Naturally occurring zeolites are rarely pure and are contaminated to varying degrees by other minerals, metals, quarts, or other zeolites. For this reason, naturally occurring zeolites are excluded from many important commercial applications where uniformity and purity are essential. In comparison with zeolite comprises a microporous crystalline aluminosilicate mineral commonly used as adsorbent. Zeolite$^-$ creates a negative charge of the carcasses compensated by cations (H^+, Na^+, K^+, Ca^{2+}, NH_4^+, etc.), in most cases, capable of cations exchange in solutions. Efficiency of using zeolite is stipulated by the high range of valuable properties (absorption, catalytic, antioxidant, regenerative, antibacterial). There is permanent antioxidant activity of zeolite on enzymes (Dogliotti et al., 2012; Ignatov, Mosin, 2015).

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