



THERMO-ELECTRO CHEMICAL SURFACE ENERGY CONVERSION INFLUENCE ON AIRPOLLUTION

Vetreş Ion¹, Ioana Ionel¹ Milan Pavlović², Mirjana M. Ševaljević³

¹Faculty of Mechanics, University POLITEHNICA Timisoara
_monica@hotmail.com'

^{2, 3}Tehcnical faculty "Mihajlo Pupin" Zrenjanin, University in Novi
Sadmilanpavlovic50@gmail.com,
sevaljevic.mirjana@gmail.com

ABSTRACT

Water vapor condensation and crystallization active centers on gas exposed solid dust particle enable thermo-electrochemical energy catalytic storage and conversion. Thermodynamic diagnostic method is developed for determination of catalyst working function and thermo-electro chemical surface reaction kinetic. The diagnostic results of catalyst working function and hydrogen evolution rate constants justify the functional dependence obtained on the basis of monitoring data in six day period, in different seasons and location in Romania and Serbia. These indicate to relative electric permittivity dominant influence, depending on Helmholtz surface and Helmholtz outer and diffusion planes in catalyst electric double layer.

Indexing terms/Key words

Air pollutant monitoring, Pollutant diffusion/migration current, Thermo-electrochemical conversion kinetic, Catalyst work function, Double electric layer .

Academic Discipline And Sub-Discipline

Chemical Thermodynamic in Ecology

Subject Classification

Ecological Studies

Type (Method/Approach)

Theoretical Approach to Monitoring Data

Council for Innovative Research

Peer Review Research Publishing System

Journal: JOURNAL OF ADVANCES IN BIOTECHNOLOGY

Vol 3 , No 3.

www.cirjbt.org , jbteditor@gmail.com



INTRODUCTION

Aerosols play important role in photo-electrochemical energy conversion and in altering cloud properties. The troposphere (80 % mass of atmosphere is mostly heated by transfer of energy from the surface, so on average the lowest part of the troposphere is warmest and temperature decreases with altitude, 6 °C/km [1]. This promotes vertical mixing in troposphere. Some gases in the atmosphere which do not interact with sunlight in the visible spectrum absorb and emit infrared radiation CO₂ and H₂O cause green house effect, and can cause temperature inversion analogous to endoreversible solar driven sorption refrigeration system and relaxation plasma-chemical reactions [2, 3, 4].

Chemioptions water layer on mineral dust produce thermoelectric current intensity change, $i_0=C_i\eta_H/d\tau_p$ measured on the basis of alternating excitation temperature signals $T_{e,H+}=T_0+T_a\sin(\omega\tau)$ [5]. On inter-metallic surfaces of the deposited alloys and gas bubbles equal anode and cathode chemical exchange electron currents induce the stationary corrosion potentials [6]:

- on Fe with the small hydrogen over-potential, 0,08V and oxygen over-potential 0,25V
- on the inter-metals alloying and successive doping with the atoms which increase the hydrogen over-potential (Cu, Cd at

Where electron temperature mostly coincides with translational temperatures of heavy particles, then chemical relaxation processes control electron energy according to conservation equation: $d/dx(3/2N_eRT_e)=Q_{exc}-\Sigma Q_{rel}$ depending on pressure and temperature, tested in literature [8].

The objective of this work is to obtain a clear view of the influence of thermo-electrochemical energy conversion in irreversible heterogeneous processes and storage in reversible homogeneous processes, on air pollution. The understanding of connection between thermo-electrochemical energy conversion in mechanical work and storage as chemical free energy confirm the reasons:

- working functions can be measured as free energy change of mono-atomic layers in alloy inter-metallic surface of one metal upon the other, as catalyst Volta potential $E_{i(c_i=0)}=E_j^0$ in end titration point
- neutrals migration current can be diagnostified as equal diffusion mass transport rate constant, $k_m=k_d$ [9,10] .

MATERIAL AND METHODS

Diagnostics of air-pollution kinetic and catalyst workig functionjustify the functional dependences obtained on the basis of monitoring data in six day period, in different seasons and location in Romania and Serbia.

Air quality is performed by Polytechnic University of Timisoara mobile laboratory and LIDAR system. The equipments are part of the air quality monitoring mobile laboratory and procedures used are in full compliance with ISO/CEN 17025:2005 standard for quality assurance in analytic laboratories. The laboratory is the property of "Politehnica" University of Timisoara and more details and information's (including certifications) can be found on www.mediu.ro Linde and DKD (Deutsche Kalibrier dienst) calibrations gases (NO, SO₂, CO, CH₄ and N₂) were used.

Table 1.The average measured pollutant contents in six day period, for each examined location (published on ICCEM 07, Wien 2013)

Ečka,	3,93	0,70	48,72	34,01	10,10		0,44	4,37	392	7,2	26,815
Timis. 1	4,12	0,70	18,γ3	38,35	5,0γ	46,61	0,29	4,γ1	39γ,7	10,4	γ7,948
Elemir	4,06	1,01	31,55	28,86	3,55	43,75	0,3	4,35	366,6	11,3	17,738
Banats.	4,27	0,28	31,25	16,46	2,89	12,86	0,3	4,57	386	4,3	12,14
Pančevo	4,40	0,43	41,49	20,00	7,34	40,4	0,77	4,75	376	5,37	14,62
Vršac	4,60	2,11	35,21	76,63	3,57	47,04	0,44	5,04	380	28,54	48,09
Turn.S.	4,35	2,72	22,76	55,53	11,40	46,05	0,405	4,75	373	22	33,55
Resita	5,08	1,65	42,56	58,21	7,63	71,69	0,56	4,96	392	21	37,91
Timis. 2	4,95	1,16	15,02	49,32	20,87	51,45	0,84	5,79	396,7	21,8	27,535
c aver	4,40	1,18	32,36	41,35	8,12	49,57	0,48	4,78	384,33	14,66	27,37
±Δc_{max}	±0,6	±1,5	±16	±35	±12,7	±22	±0,36	±1	±12,7	±13,8	±21

Diffusion transport rate constants of neutral is determined on the basis of the monitoring results of pollutant daily mass concentrations γ (CH₄, CO, SO₂, O₃, NO_x, PM10, NMHC, CO₂, NO and NO₂) measured in sixth day period., on the basis of Lingane function



$$\ln \gamma_p = \pm k \cdot \tau - \ln \gamma_{p(\tau_0)} \quad (1)$$

Table 2. The pollutants diffusion rate constants $\pm k$, day⁻¹ obtained as the slope linear function on the basis of measured pollutant content and time which fit Eq.(1) in sixth day period, on examined location and season (published on ICCEM 07, Wien 2013)

	k_{dCH_4} day ⁻¹	k_{dCO} day ⁻¹	k_{dSO_2} day ⁻¹	k_{dO_3} day ⁻¹	k_{dNO_x} day ⁻¹	$k_{dPM_{10}}$ day ⁻¹	k_{dNMHC} day ⁻¹	k_{dTHC} day ⁻¹	k_{dCO_2} day ⁻¹	k_{dNO} day ⁻¹	k_{dNO_2} day ⁻¹
Ečka, April/Maj	0,0139	0,09	0,008	0,1917	0,1		-0,054	-0,0149	-0,0326	0,2853	0,0362
»	- 0,0159	-0,02	-0,009	-0,2755	0,031		-0,0106	-0,0106	-0,0187	-0,0673	-0,0267
Timisoara, June/July	0,027	-0,14	0,074	-0,0931	-0,0421	-0,23	0,1741	0,0306	-0,0187	0,0863	0,0451
“	- 0,0287	0,31	-0,057	0,1298	0,0431	0,064	-0,0923	-0,0753	-0,0139	-0,102	-0,0183
Elemir, August	-0,02	0,379	-0,039	0,1573	0,138	0,24	0,1458	0,034	-0,0139	0,1877	0,1954
“	0,0295	-0,10	0,114	-0,5313	-0,214	-0,15	-0,2226	-0,0645	-0,0619	-0,4652	-0,2525
Banatskov.s August	-0,034	- 0,1744	-0,052	0,0969	0,0189	0,15	0,3466	0,0568	0,0454	0,2728	0,0687
“	0,019	0,1385	-0,120	-0,1418	0,0523	-0,15	-0,336	-0,0383	-0,0465	-0,2082	
Pančevo, August	0,0663	0,1299	0,146	-0,0931	0,413	-0,1	0,3185	0,099	0,0458	0,3951	0,3408
“	- 0,0613	- 0,1222	-0,145	0,0672	-0,2897	0,034	-0,3697	-0,0132		-0,3401	-0,2343
Vršac, September	- 0,0635	-0,03	-0,232	0,0311	-0,138	-0,15	0,3185	0,0862		-0,3161	-0,526
“	0,0998	0,087	0,12	-0,2453	-0,263	-0,03	-0,3697	-0,0672			
Turn Sever. November	0,0213	0,314	0,211	-0,18	-0,4602	-0,18	0,1468	0,0368			0,1203
“	0,0343	0,022	-0,454	-0,25	0,1966	0,104	-0,1942	-0,0201	0,1163		-0,4322
Resita,Nov.	0,0294	0,2172	-0,152	0,1525	-0,2172	-0,17	0,1406	0,0373		0,4676	0,1683
“	-0,091	-0,12	-0,116	-0,0769	0,0539	0,165	-0,1942	-0,0632		-0,3018	-0,185
Timisoara, November	- 0,0091	- 0,1213	-0,052	0,0546	-0,0652	-0,11	0,1404	0,0373	0,0033	0,0708	0,3344
“	0,01	0,0606	0,049	-0,0753	0,0768	0,079	-0,1673	-0,0326	-0,0059	-0,0635	-0,1063



Diagnostics free energy, ΔG_p , of pollutant is carried out on the basis of equilibrium constant, calculated as the ratio between pollutant increasing diffusion rate constant ($k_d=k_1$) and decreasing content diffusion rate constants, ($-k_d=k_{-1}$) measured in the same period sixth day monitoring period:

$$\Delta G_p = -RT \ln \frac{k_1}{k_{-1}} \quad (2)$$

The obtained linear functional dependence with average pollutant content on the examined location and season enable:

- the determination of gaseous pollutant content, $\Delta \gamma_{pol(\Delta G_p=0)}$ with minimal free energy state ($k_1=k_{-1}$):

$$\Delta G_{p,k}^\theta = tg \cdot \gamma_{pol} + \Delta G_0^\theta \quad (3)$$

$$\Delta \gamma_{pol(\Delta G_p=0)} = -\frac{\Delta G_0^\theta}{tg} \quad (4)$$

-the determination of catalyst working function in the gaseous pollutant mono-atomic layer end titration point in alloy inter-metallic surface:

$$\Delta G_c^\theta(\gamma_p = 0) = FE_0^\theta = (F\phi)_c \quad (5)$$

Adsorbed dipole activate photo chemical relaxation in entropy driven relaxation processes in inner Helmholtz plane of electric double layer [11] at equal surface temperature where:

- T_e temperature of gas electron, defined according to molecular kinetic theory
- and T_{H+} temperature of gas hydrogen ion, defined according to molecular kinetic theory
- at equal exchanged heat, $-q_{res}/T_e = q_{em}/T_{H+}$, components emit plasmon in a small time interval and volume [12] at equal electron-hydrogen ion density and electron-hydrogen temperature which increase coefficient of ambipolar diffusion diffusion, $D_{amb} = D_{H+}(1 + T_e/T_{H+})$ and diffusion rate constant, $k_{amb} = 2k_d$. Kinetic energy equalisation, $T_e = T_{H+}$ enable electron and hydrogen velocity ratio, i.e its rate constants ratio, $\frac{k_{H+}}{k_e}$ controlled with relatio:

$$\frac{k_{H+}}{k_e} = \sqrt{\frac{m_e}{m_H}} \quad (6)$$

Isobaric surface energy thermo-electrochemical conversion enable oxygen-hydrogen electrochemical equilibrium achieved at equal hydrogen pressure with oxygen atmospheric partial pressure [13]. Then migration current control electric power for hydrogen evolution $k_{H_2} F \eta_{H_2}$ equal gaseous pollutant diffusion power controlled with its kinetic energy, $k_{d,p} \frac{3RT}{2F}$:

$$k_{H_2} F \eta_{H_2} = k_{d,p} \frac{3RT}{2F} \quad (7)$$

where:

$$\eta_{H_2, th} = \frac{k_{d,p} 3RT}{k_{H_2} 2F} \quad (8)$$

Hydrogen evolution over-potential in chemisorptions waterlayer on mineral dust produce thermoelectric current intensity change: $i_0 = C_i \eta_H / dt_p$ in electric double layer [5]. Then active surface capacity, $C_{catalyst} = \epsilon_r \frac{F}{E_w^\theta}$ control catalyst



work function, FE^\ominus_c and relative electric permittivity of chemisorbed dipole and Ohm resistance, $R_\Omega = \frac{\eta_{H2}}{k_{H+}F}$. Then current intensity relaxation time:

$$\tau_e = R_\Omega \cdot C \quad (9)$$

$$\tau_e = R_\Omega \cdot C = \frac{\eta_{H2}}{k_{H+}F} \cdot \epsilon_r \frac{F}{E_w^\ominus} \quad (10)$$

control hydrogen overpotential depending on catalyst work function and adsorbed dipole electric permittivity:

$$\eta_{H2ech} = \frac{k_{H+} E_w^\ominus}{k_e \epsilon_r} \quad (11)$$

Equal evolved hydrogen over-potential in thermo chemical reaction (Eq. 8) and in electrochemical reaction due to the reacting contact surfaces separation with adsorbed dipole (Eq. 11), after the combining with Eq. 6 gives linear functional dependence between ratio of air pollutant diffusion rate constant and hydrogen evolution rate constant, on catalyst working function:

$$\frac{k_{d,p}}{k_{H2}} = \frac{2}{3} \cdot \frac{F}{\epsilon_r RT} \sqrt{\frac{m_e}{m_H}} E_w^\ominus \quad (12)$$

The re-written form:

$$\frac{k_{H2}}{(m_H / m_e)^{1/2}} \cdot \frac{FE_w^\ominus}{\epsilon_{dip}} = k_{d,p} \frac{RT}{\epsilon_0} \quad (13)$$

indicate to enhanced hydrogen evolution rate constant, $(m_H / m_e)^{1/2}$ times:

$$\frac{k_{H2}}{(m_H / m_e)^{1/2}} \cdot = k_{d,p} \quad (14)$$

where: $\frac{FE_w^\ominus}{\epsilon_{dip}} = \frac{RT}{\epsilon_0}$

Pollutant stationary homogeneous state control equal diffusion velocity and surface reaction velocity:

$$j_m = v_{d,p} F$$

$$v_{d,p} = k_{H2} (\gamma_p - \gamma_{kdp=0}) \gamma_{H2} \quad (15)$$

Then diagnostic of hydrogen evolution rate constant, k_{H2} enable pseudo first process rate constant:

$$k_{d,p} = k_{H2} (\gamma_p - \gamma_{kdp=0}) \quad (16)$$

on the basis of the slope or the re-written form of the linear functional dependence which fit experimental data for pollutant mass content, γ and its diffusion rate constant k_d :

$$\gamma_p = \frac{k_{d,p}}{k_{H2}} + \gamma_{kdp=0} \quad (17)$$



RESULTS AND DISCUSSION

The monitoring results (Table 1) are used to calculate the pollutant diffusion rate constants (Table 2), as well as in diagnostics of parameters dominant in pollutant thermoelectric surface energy conversion influence on air pollution (Table 3).

Table 3. Diagnostics of the parameters which control thermo-electric conversion and air pollution

$\Delta E_p^\ominus = \gamma \cdot \gamma_p + \Delta E_{0,0}^\ominus$ - linear functional dependences between air pollutant content, γ and its polarization $\Delta E_p^\ominus = \Delta G_p^\ominus / F$, according to Eq. (3a)

$\gamma_p, (\Delta G=0)$ - air pollutant content for the pollutant minimal free energy state calculated acc to Eq. (4)

$k_p(\Delta G_p=0) = k_d = -k_d$ - equal increasing and decreasing pollutant diffusion rate constant (Table 1 and Table 2)

$\Delta G_{0,0}^\ominus = FE_{0,0}^\ominus$ - catalyst working function, calculated as free term (at $\gamma_p=0$) in Eq. (5)

$\gamma_{p=0} = \gamma \cdot k_d \Delta E_{p=0} + \gamma_{p,kd=0}$ functional dependence on the basis of Eq. (17),

$k_{H_2} = 1/T_{H_2}$ - hydrogen evolution rate constant calculated on the basis of the slope of Eq.(17)

$E_{cat. process}^\ominus = \Delta G_{0,0}^\ominus / F$ - the possible catalyst reversible process identified by comparison of $\Delta E_{0,0}^\ominus = \Delta G_{0,0}^\ominus / F$ with electrochemical potentials from table data





Sample $\Delta G_p=0$	$\Delta E_p^0 = \frac{t \cdot g \cdot \gamma_p}{\Delta E_0^0} +$ [ICEEM 007]	γ_p , ($\Delta G=0$) g/m ³	k_d p($\Delta G=0$) s ⁻¹	ΔG_0^0 kJ/mol	$\gamma_{p=0} = \frac{t \cdot g \cdot k_d \cdot \Delta E_{p=0}}{\gamma_{p,kd=0}}$	k_{H_2} s ⁻¹	T K	E^0 cat process V
Nb, poll, loc., month								
1. CH ₄ Tim, VI, VII	-0,0233γ + 0,0895 R ² = 0,8886	3,85E-03	3,36E-07	8,64	γ = -4163,2x + 0,0061 R ² =0,7645	-0,00024	295,2	+0,09(2S ₂ O ₃ ./ S ₄ O ₆ ²⁻ +2e)
2.CO PančVIII	0,0595γ - 0,02 R ² = 0,7821	0,34 E-3	1,39E-06	-1,93	»	-0,00388	296,6	0,01(NO ₃ ⁻ +H ₂ O+2e/ NO ₂ ⁻ +2OH ⁻)
3.CO Resita Nov	0,0519γ - 0,0763 R ² = 0,9789	1,47 E-3	1,85E-06	-7,36	γ = -209,03x + 0,0012 R ² =0,8929	-0,00478	296,6	-0,12(CO ₂ +2H ₃ O ⁺ +2e/CO+3H ₂ O)
4.NMHC Ban. A.VIII	γ = -0,114x+0,053 R ² = 0,9949	0,47 E-3	3,94E-06	5,13	»	-0,00478	296,6	-0,07(Cu(NH ₃) ₄ ²⁺ +2e/ Cu+4NH ₃)
5.NMHC Tim, XI	γ = -0,0934γ+0,077 R ² = 0,9238	0,83 E-3	1,78E-06	7,47	»	-0,00478	286,2	-0,07(Cu(NH ₃) ₄ ²⁺ +2e/ Cu+4NH ₃)
6. THC Vršac IX	γ = 0,01γ-0,0378 R ² = 1	3,78 E-3	8,68E-07	-3,65	»	-0,00024	294,2	-0,036(Fe/Fe ³⁺ +3e ⁻)
7. PM10 Resita XI	γ = 0,0005γ - 0,03 R ² = 0,9027	6,63E-05	1,93E-06	-3,21	»	0,023648	276,6	-0,07(Cu(NH ₃) ₄ ²⁺ +2e/ Cu+4NH ₃)
8. O ₃ Tim., XI	-0,0021γ + 0,0301 R ² = 0,8213	1,43E-05	7,29E-07	2,90	γ = 42,286x - 2E-05 R ² =0,9983	0,023648	276,6	-0,07(Cu(NH ₃) ₄ ²⁺ +2e/ Cu+4NH ₃)
9. CH ₄ Tim, VI, VII	-0,0233γ + 0,0895 R ² = 0,8886	3,85E-03	3,36E-07	8,64	γ = -4163,2x + 0,0061 R ² =0,7645	-0,00024	295,2	+0,09(2S ₂ O ₃ ./ S ₄ O ₆ ²⁻ +2e)
10.NO Ban A.VIII	γ = -0,0099γ+0,042 R ² = 0,8042	4,23E-06	2,78E-06	4,03	γ = -257,61 x + 0,0007 R ² =0,9565	-0,00388	296,6	-0,036(Fe/Fe ³⁺ +3e ⁻) -0,048(O ₂ /HO ₂ ⁻ on C)
11. NO Tim. XI	γ = -0,0027γ + 0,05 R ² = 0,8392	1,87E-05	7,75E-07	4,86	»	0,023648	276,6	-0,07(Cu(NH ₃) ₄ ²⁺ +2e/ Cu+4NH ₃)
12. NO Tim VI,VII	γ = -0,0054γ + 0,07 R ² = 0,9104	1,29E-05	1,09E-06	6,74	»	-0,0004	295,1	-0,07(Cu(NH ₃) ₄ ²⁺ +2e/Cu+4NH ₃)
13. SO ₂ Tim XI	-0,0054γ + 0,0396 R ² = 0,9038	7,31E-06	1,55E-06	3,82	»	-0,00024	276,6	-0,036(Fe/Fe ³⁺ +3e ⁻) -0,048(O ₂ /HO ₂ ⁻ on C)
14. CO ₂ Ban A. VIII	γ = -0,0061γ+2,277 R ² = 0,9981	3,73E-01	5,32E-07	219,70	»	-5,92E-06	296,6	-2,25(H ₂ +2e=2H ⁻) 2,07(O ₃ +2H ₂ O+2e/O ₂ +2OH ⁻)
15. PM10 Ban A. VIII	-0,001γ + 0,0128 R ² = 0,9987	12,8 E-3	1,74E-06	1,24	»	-5,92E-06	296,6	0,01(NO ₃ ⁻ +H ₂ O+2e/ NO ₂ ⁻ +2OH ⁻)



16. PM10 Turn Sev XI	-0,0155y + 0,6933 R ² = 0,9506	4,48E-05	2,26E-06	66,90	»	-5,92E-06	276,6	0,69(O ₂ +2H ₃ O ⁺ +2e/ H ₂ O ₂ +2H ₂ O)
17. NO₂ ResitaXI	y=0,0027y - 0,09 R ² = 0,8827	3,34E-05	2,03E-06	-8,70	»	-5,92E-06	276,6	-0,12(NO ₃ ⁻ +7H ₂ O+8e/ NH ₄ OH+9OH ⁻)
18. CO₂ Tim VI,VII	y=0,0086y- 3,348 R ² = 0,8019	2,39E-01	1,89E-07	- 323,12	y = -160302x + 0,3536 R ² =0,8142	-5,92E-06	295,2	-3,1(3N ₂ +2H ₃ O ⁺ +2e/ 2NH ₃ +2H ₂ O)
19. SO₂ Ečka IV, V	0,0026y - 0,0272 R ² = 0,9832	1,04E-05	9,84E-08	-2,62	»	3,88E-06	288,1	0,01(NO ₃ ⁻ +H ₂ O+2e/ NO ₂ ⁻ +2OH ⁻)
20. THC Ečka IV, V	y=-0,2062y+ 0,92 R ² = 0,9249	4,48 E-3	1,16E-07	89,09	y = 257442x - 0,0253	3,88E-06	286,2	-0,92 (SO ₄ ²⁻ + H ₂ O+2e/ SO ₃ ²⁻ +2OH ⁻)
21.NMHC _{PančVIII}	y =1,4592x - 0,44 R ² = 0,9438	0,29 E-3	3,94E-06	-42,13	»	-0,00478	296,6	-0,44(Fe ²⁺ +2e)=Fe

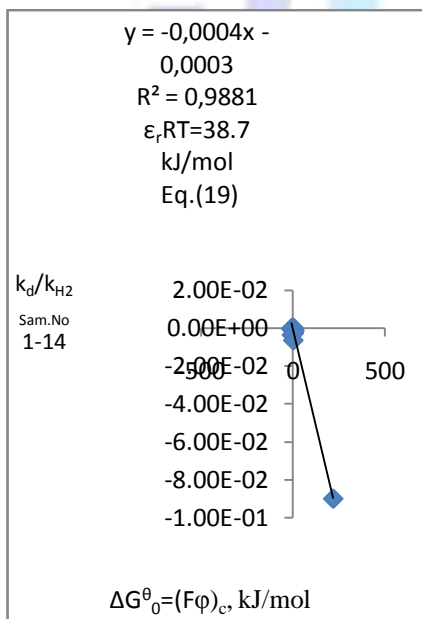


Figure 1a

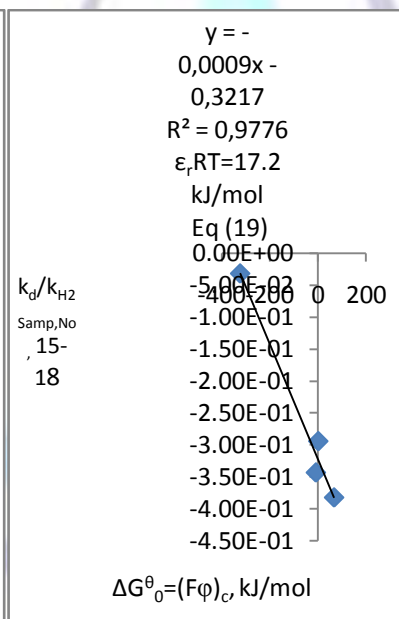


Figure 1b

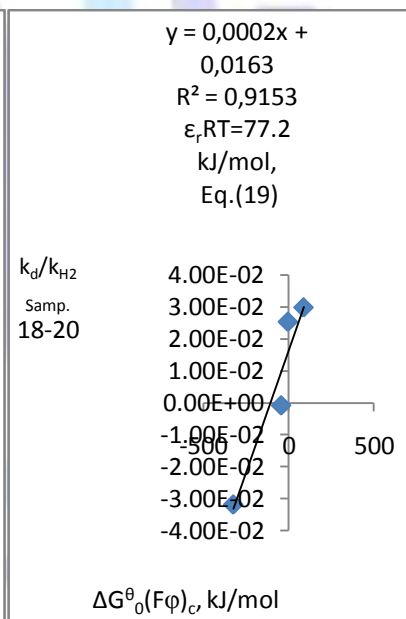


Figure 1c

Figure 1. The linear functional dependences acc. to Eq. (12) which fit $y = k_d/k_{H_2}$ and $x = \Delta G^0_0 = (F\phi)_c$, kJ/mol, according to data in Table 3

The slope of obtained linear functions (Fig. 1) enable diagnostic of double electric layer surface electric permittivity effective in thermo-electric energy conversion influence on air pollution:

$$tg = \frac{2}{3\epsilon_r (m_H / m_e)^{1/2} RT} \quad (18)$$

$$\epsilon_r RT = \frac{2}{3(m_H / m_e)^{1/2} tg} \quad (19)$$



According to obtained results (Table 3, Fig.1) , inner Helmholtz plane in double electric layer ($\epsilon_r=6$) [11] is not effective in examined thermo-electric energy conversion influence on air pollution.

However pollutant vertical transport can activate water vertical transport in term chemical electric energy conversion processes at stationary chemical potential in surface Helmholtz plane ($\epsilon_r=17$), and stationary isobaric work in outer Helmholtz plane ($\epsilon_r=38$), as well as in diffusion layer ($\epsilon_r=77.2$). It can influence to exchanging water sensible heat corresponding to relative electric permittivity value of hydration layer in double electric layer, above boiling temperature where $\epsilon_r<55$ and under water boiling temperature, $\epsilon_r>55$, for liquid water $\epsilon_r=77$ at 25 °C on condensation active centers, up to water crystallization temperature, where $\epsilon_r=88$ [10] .

CONCLUSION

The conclusion remarks are as follows:

The monitoring results of air pollution fit the obtained functional dependences for thermo chemical pollutant transport

The article was originated **on the Romania-Serbia Cross-Border Co-operation Programme:** "Sustainable development for Banat Region by means of Education and Scientific Research and Development in Transboundary air Quality Monitoring Issues" IPA CBC Programme Romania-Serbia. 2010-2011 <http://banatair.mec.upt.ro>, and based also on research developed in the frame of the the project AirQ, financed by the Romanian national authority UEFISCDI (2012-2014) <http://airq.mec.upt.ro> .

kinetic effective in thermoelectric current intensity change in double electric layer depending on catalyst working function, with strong correlation coefficient, $R^2=0,91-0,98$.

1. Diagram in Fig. 1a indicate to relative electric permittivity of surface Helmholtz plane ($\epsilon_{r\text{samples } 1-14} = 38,75/RT$) influence on decreasing rate constant of pollutant stationary chemical potential, with positive catalyst working function couple with endothermic relaxation processes, from -2,25 V (H/H) with 2,07 ($2O_3/3O_2$) up to -0,12 (CO_2/CO) and -0,07 V ($Cu(NH_3)^{2+}/Cu+NH_3$ with 0,09 V($3RT_{H_2O,b}$)
2. Diagram in Fig. 1b, indicate to relative electric permittivity of inner Helmholtz plane ($\epsilon_{r\text{samples, } 15-18} = 17,2/RT$) influence on decreasing rate constant of pollutant stationary entropy driven relaxation processes, with negative working functions relaxation from -3,1 V(N_2/NH_3) to 0,69 V (O_2/H_2O_2)
3. Diagram in Fig. 1c indicate to relative electric permittivity ($\epsilon_{r\text{ sample, } 15-18} = 77,2/RT$) influence on increasing rate constant of pollutant isobaric vertical transport work, CO_2 , SO_2 , THC and NHC from April to August with the negative working functions from -3,1 V (N_2/NH_3) to -0,44 V(Fe^{2+}/Fe) up to 0,01 V (NO_3^-/NO_2^-).

The thermo-electrochemical energy conversion in mechanical work and storage as chemical free energy justify :

- working functions measured as free energy change of monatomic layers in alloy inter-metallic surface of one metal upon the other can be diagnosed in end titration point , as catalyst reversible cell voltage at zero current
- and that migration current of neutral is equal to diffusion mass transport rate constant, $k_m = k_d$

The obtained results of thermodynamic study of air thermo-electrochemically pollutant transport could be useful in the planning of a way to achieve better efficiency of a cold plasma processes to remove and oxidize different kinds of pollutants, with increased performance in eco-efficient electrical and innovative technology development, as well as indoor and gas exhaust treatment in industry.

ACKNOWLEDGMENTS

This paper is partially supported by the Sectoral Operational Programme Human Resources Development (SOP HRD), financed from the European Social Fund and by the Romanian Government under the project number POSDRU/159/1.5/S/134378.

REFERENCES

- [1] Chang , I.C., Hana, S.R., 2005 Air quality model performance evaluation, Meteorology and Atmospheric Physics 87, 167-196
- [2] Alam, K.C.A., Saha, B.B., Akisawa, A., and Kashiwagi, T., 2001 Optimization of solar driven adsorption refrigeration system, Energy Conversion and Management 42, 741-753.
- [3] Vlachos, D. G. 1998 Stochastic modeling of chemical micro reactors with detailed kinetics –induction times and ignitions of H_2 in air, Chemical engineering Science 53, 157-168.



- [4] G.Weick, D.Weinmann, G.-L.Ingold and R.A.Jalabert, 2007 Anomaly in the relaxation dynamic close to the surface plasmon resonance, *Europhys. Lett.*, **78**, 2700
- [5] Rotenberg, Z.A. 1997 Thermochemical impedance, *Electrochimica Acta*, 42(5), 793-799
- [6] Jelena M. Jakšić, Nedeljko Krstajić, Bane N. Grgur, and Milan M. Jakšić, 1998 Hydridic and electro-catalytic properties of hypo-hyper d -electronic combinations of transition metal intermetallic phases, *Int. J. Hydrogen Energy* 23667-681
- [7] Ševaljević, M.M., 2000. Development of the Galvanostatic method for gaseous arsenic hydride generation and successive lead and cadmium pre-concentration for increasing AAS Determination Sensitivity, Ph.D. Thesis, Faculty of Technology, Novi Sad.,
- [8] Gorelov V.A. , Gladyshev M.C., Kireev, A. Yu et al. 1998 Experimental and numerical study of non-equilibrium UV-emission in NO and N_2^+ in shock layer, *J. of Thermophysics and heat transfer* **12** , 172 -179
- [9] M. M. Ševaljević, M. Stanojević, S. N. Simić, and M. Pavlović, 2009 Thermodynamic study of aeration kinetic in treatment of refinery wastewater in bio-aeration tanks, *Desalination*, 248 , 941-960
- [10] Slavko Mentus, 2001 *Electrochemistry*, University in Belgrade, Faculty for Physical Chemistry,
- [11] Mark H. B. 1990 Electrocatalysis and its application to analysis, *Analyst* **115**, 667
- [12] T. V. Shabzyan, I.E. Perakis and J.Y. Bigot, 1998 Size dependent surface Plasmon dynamic in metal nano-particles, *Phys. Rev.Lett.* 81, 3120
- [13] Ševaljević, M. M., Simić, S. N. and Ševaljević, P. V. 2012 Thermodynamic diagnostic of electron densities in gas bubbles in aerated saturated refinery waste water, *Desal. Wat. Treat.* 42 144-154.