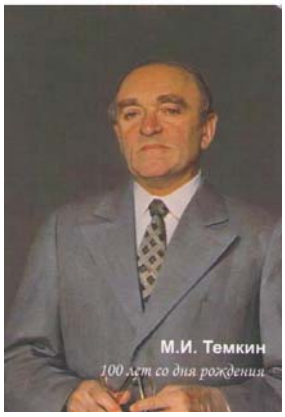
Mikhail Temkin



16.09.1908-1.10.1991

Family

With sister Roza

Parents: Isaak (1881-1938) and Gitel (1879-1947)

Father

Isaak Temkin was rector of Moscow State University of Geodesy and Cartography

Family

Wife Liya

Daughter Elena

Beginning

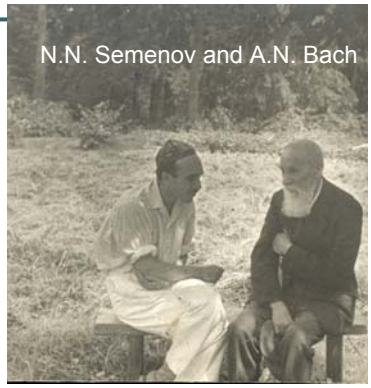
1932

Karpov Institute, architect B. Iofan

Teachers

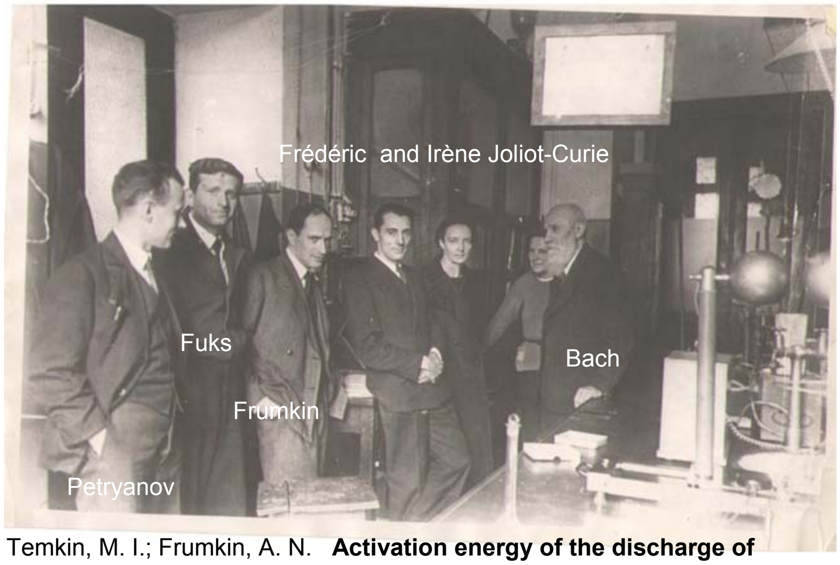
N. Kobozev (Moscow State University)

Kobozev, N. I.; Temkin, M.; Fraiberg, S. **Oxidation of nitric oxide to nitrogen pentoxide by means of ozone in the silent electric discharge.** Zhurnal Obshchei Khimii (1933), 3, 534



Temkin, M. I.; Bakh, A. N. **Adsorption of hydrogen by palladium in the presence and absence of water.** J. Phys. Chem. (USSR) (1934), 5, 809

Teachers



Temkin, M. I.; Frumkin, A. N. **Activation energy of the discharge of hydrogen ions.** Zhurnal Fizicheskoi Khimii (1955), 29 1513

Teachers

Michael Polanyi

My thanks are due to Prof. M. Polanyi for the use of the micropyknometer apparatus and for much valuable discussion.

M. TEMKIN.

Physical Chemistry Department,
University, Manchester.

552 NATURE OCTOBER 5, 1935

very favourably with the frequency 1230 cm.$^{-1}$ calculated from the theory of the molecular vibrations of three-particle systems put forward recently by Van Vleck and Cross[3]. It is interesting to note that a similar, but very feeble, band of frequency shift about 1650 cm.$^{-1}$ has been reported in the case of ordinary water[4].

3. A third band with a much lower frequency shift of 178 cm.$^{-1}$ is also noticed with both the 4358 A. and 4046 A. excitations. This frequency is far too low to be attributed to the internal vibrations of the D_2O molecule, and hence is presumably due to some sort of rotation or vibration of the molecule as a whole. The Raman spectrum of ordinary water also shows a band at approximately the same position. This band is evidently to be ascribed to the frequency of hindered rotation or oscillation of the liquid molecule, of which independent evidence is forthcoming from studies of dielectric constant[5], infra-red absorption[6], viscosity, etc.

A detailed paper on the subject will appear in the *Proceedings of the Indian Academy of Sciences*.

R. ANANTHAKRISHNAN.

Department of Physics,
Indian Institute of Science,
Bangalore.
Aug. 10.

Diffusion of Heavy Water into Ordinary Water

W. J. C. ORR and D. W. Thomson[1] have found the velocity of diffusion of HDO into H_2O to be abnormally large, the diffusion constant D being 9×10^{-4} cm.^{2} sec.$^{-1}$ at 13° C., whereas for all simple substances in water, diffusion constants are of the order of magnitude 10^{-5} cm.^{2} sec.$^{-1}$. Since this result, if it were true, would be of considerable significance for the theory of the structure of water, experiments were made to verify it.

The velocity of diffusion was measured with a micropyknometer of E. S. Gilfillan and M. Polanyi[2]; the orifice was made larger than usual (namely, about 0·1 mm.) to make noticeable the diffusion from the body of the pyknometer into the surrounding water.

The method of carrying out the experiments was as follows:

At the beginning the difference $(\Delta P)_0$ in equilibrium hydrostatic pressure for the solution and ordinary water was measured. Diffusion from the pyknometer was allowed to occur, in a separate vessel at constant temperature and for a given length of time t, and the measurement of the difference in the equilibrium hydrostatic pressure was repeated, giving $(\Delta P)_t$.

From Fick's law, the following equation can be easily obtained:

$$\lg\frac{(\Delta P)_t}{(\Delta P)_0} / Dt = K,$$

where K is a constant.

Constant K was obtained from observations of the diffusion of potassium chloride solution, employing data of the International Critical Tables for the diffusion constant. All experiments were duplicated, results agreeing within 5 per cent.

The following values of D were obtained for the diffusion of heavy water from ~ 3 mol. per cent solution into ordinary water.

$$D = 1{\cdot}1 \times 10^{-5}\ \text{cm.}^2\ \text{sec.}^{-1}\ \text{at}\ 0{\cdot}0°\ \text{C.}$$
$$D = 2{\cdot}5 \times 10^{-5}\ \text{cm.}^2\ \text{sec.}^{-1}\ \text{at}\ 28{\cdot}0°\ \text{C.}$$

Hence the constants are of the usual order of magnitude, contrary to the result of Orr and Thomson.

My thanks are due to Prof. M. Polanyi for the use of the micropyknometer apparatus and for much valuable discussion.

M. TEMKIN.

Physical Chemistry Department,
University, Manchester.

Identity of Natural Vitamin D from Different Species of Animals

BILLS, Massengale and Imboden[1] have found that one rat unit of blue-fin tunny liver oil in chicks has only 15 per cent of the antirachitic effect of one rat unit of cod liver oil, whence they conclude that the two forms of vitamin D are different. However, Dols[2] demonstrated that the antirachitic effect of those two forms of vitamin D in chicks is the same, the necessary dose being about 80 international D units a day for each chicken. Before the results of Dols were known to us, we had running a great number of tests to investigate whether there is any difference between the vitamin D of different species of animals. (The fact that there is another form of natural vitamin D found in green plants and accompanying the free fatty acids[3] is not discussed here.)

From the different fats under investigation the unsaponifiable fraction was first isolated, the vitamin A eliminated and the vitamin D to some degree concentrated by a method reported by us[4]. We have examined the liver fat as well as the body fat of the following species: coalfish (sei, *Gadus virens*), cod (torsk, *Gadus morrhua*), cusk (brosme, *Brosmius brosme*), dogfish (hå, *Squalus acanthias*), dorn (piggrokke, *Raja clavata*), Greenland shark (håkjerring, *Somniosus microcephalus*), haddock (kolje, *Gadus aeglefinus*), halibut (kveite, *Hippoglossus hippoglossus*), herring (sild, *Clupea harengus*), mackerel (makrel, *Scomber scombrus*), pollack (lyr, *Gadus pollachius*), redfish (uer, *Sebastes marinus*), salmon (laks, *Salmo salar*), shark (håbrand, *Lamna cornubica*), sprat (brisling, *Clupea sprattus*), tunny (makrelstörje, *Thunnus thynnus*), wrasse or 'Old Wife' (berggylte, *Labrus bergylta*), blue whale (blåhval, *Balaena musculus*); we also had specimens of vitamin D from the liver and body fat of a cow and of a human female. We found no difference between the antirachitic effect in chicks of all these fats, the daily dose required being in all cases 70–80 international D (rat) units per chicken.

We were thus able to confirm Dols's results but not the results of Bills *et al.* with tunny liver fat. None of the preparations investigated by us showed a maximum of absorption in the ultra-violet spectrum at 260–270 mμ nor any rotation of the plane of polarisation in alcoholic solution, and the degree of

Transition State Theory

Temkin, M. **Transition state in surface reactions.** Acta Physicochimica URSS (1938), 8, 141

Temkin, M. I. **The Arrhenius equation and the active complex method.** Acta Physicochimica URSS (1940), 13 733

- *each molecule one elementary space*
- *random distribution of molecules*
- *activated complexes occupy several adjacent elementary sites*
- *several possible positions of activated complexes*
- *number of activated complexes is small in comparison with total number of sites*

Surface Reactions

Reaction : $\nu_1 A_1 + \ldots + \gamma_1 B_1 + \ldots =$
$\nu'_1 A'_1 + \ldots + \gamma'_1 B'_1 + \ldots$

$$r_+ = \chi (kT/h) g L q_{t\neq} / (q_{A1}^{\nu 1} \ldots q_{B1}^{\gamma 1})\ \theta_{A1}^{\nu 1} \ldots \theta_o^{s-\Sigma \nu 1} c_{B1}^{\gamma 1} \exp(-\Delta \varepsilon_o^{\neq}/kT)$$

where $q_{t\neq}$ - modified partition function
L - total number of sites

Surface Reactions

$$r_+ = \chi(kT/h) g L q_{t\neq} / (q_{A1}^{\nu 1} \ldots q_{B1}^{\gamma 1}) \theta_{A1}^{\nu 1} \ldots \theta_o^{s-\Sigma\nu 1} c_{B1}^{\gamma 1} \exp(-\Delta\varepsilon_o^{\neq}/kT)$$

Consequences

1. Rate is proportional to the number of sites
2. Rate depends on the surface structure and configuration of activated complexes.

Lab of Chemical Kinetics

1939

Temkin, M.; Pyzhev, V. **Kinetics of the synthesis of ammonia on promoted iron catalysts.** J. Phys. Chem. (USSR) (1939), 13, 851

Theory applied to practical problems

Mechanism and kinetics

$$N_2 + 3H_2 \rightarrow 2NH_3$$

Mechanism (Fe-based catalyst):

$$N_2 + 2^* = 2N^* \quad (1)$$
$$H_2 + 2^* = 2H^* \quad (2)$$
$$N^* + H^* = NH^* + ^* \quad (3)$$
$$NH^* + H^* = NH_2^* + ^* \quad (4)$$
$$NH_2^* + H^* = NH_3^* + ^* \quad (5)$$
$$NH_3^* = NH_3 + ^* \quad (6)$$

Classical development (Temkin-Pyzhev):

- Dissociative adsorption ((1) & (2))
- Adsorption of N is rds
- N* dominates the surface
- Adsorbed N-atoms in "virtual equilibrium" with calculated equilibrium pressure of N_2 and H_2 in equilibrium with gas-phase NH_3

$$r = k_1' P_{N_2} \left(\frac{P_{H_2}^3}{P_{NH_3}^2} \right)^{\alpha} - k_2' \left(\frac{P_{NH_3}^2}{P_{H_2}^3} \right)^{1-\alpha}$$

$\alpha \approx 0.4 - 0.5$

k_i' contains rate and equilib. constant

at zero conversion : $r = k'' P_{H_2}^{\alpha} P_{N_2}^{1-\alpha}$

Kinetics and mechanism of the ammonia synthesis

By A. Ozaki and Sir Hugh Taylor, F.R.S.
Department of Chemistry, Princeton University
and M. Boudart
Department of Chemical Engineering, Princeton University

Hugh Taylor

new kinetic investigations. The additional postulate introduced by Temkin & Pyzhev is that nitrogen is the only species covering the surface in appreciable amounts and that the surface coverage is determined uniquely by the partial pressures of hydrogen and ammonia above the catalyst. The theory further assumes a special model of surface heterogeneity characterized by an empirical parameter α related to a linear change with coverage of activation energies and heats of adsorption.

Temkin, M. **Fugacities in gas mixtures.** Acta Physicochimica URSS (1944), 19, 163

Catalysis Letters 3 (1989) 111–116

PERSPECTIVES IN CATALYSIS

VIRTUAL PRESSURE AND VIRTUAL FUGACITY IN CATALYSIS AND ELECTROCATALYSIS

M. BOUDART

Department of Chemical Engineering, Stanford University, Stanford, California 94305, U.S.A.

In catalytic reactions, the concept of *virtual pressure* or *virtual fugacity* of a reactant or product was first conceived fifty years ago by Temkin and Pyzhev in connection with ammonia synthesis and decomposition [2]. If we write the

$$v_d/v_a = [N_2]_v/[N_2]_{ss} \quad (5)$$

where $[N_2]_{ss}$ is the actual pressure (or fugacity) of N_2 in the reacting system at the steady state and $[N_2]_v$ is the *virtual pressure* (*or fugacity*) of N_2 *defined* as the pressure or fugacity of N_2 that would be necessary to reach a surface concentration $[N^*]_{ss}$ prevailing during the steady-state of the reaction, if N_2 were in equilibrium with the surface.

Gas mixtures

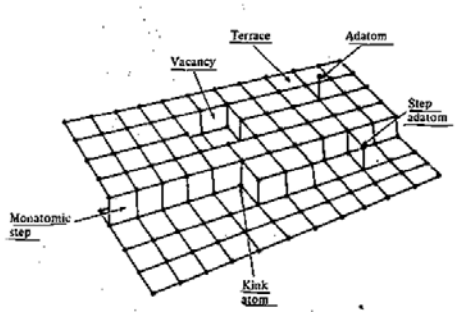
Temkin, M. **The Krichevskii - Kazarnovskii equation of state for gaseous mixtures.** J. Phys. Chem. (U. S. S. R.) (1943), 17

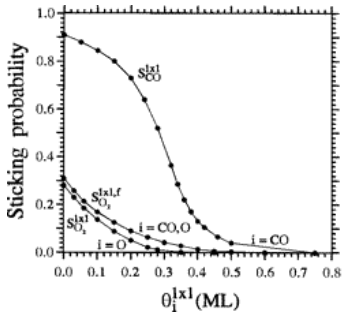
Temkin, M. **Volatility in gaseous mixtures.** J. Phys. Chem. (U. S. S. R.) (1943), 17, 414

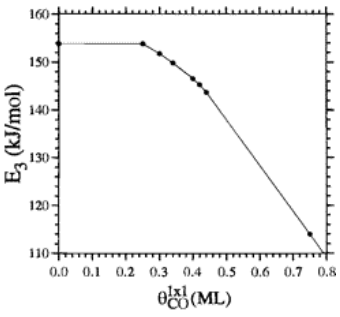
Temkin, M. **Partial pressures in real gaseous mixtures.** Acta Physicochimica URSS (1945), 20 713

Prof. I. Kazarnovskii
Father-in-law of M. Temkin

Surfaces are not uniform



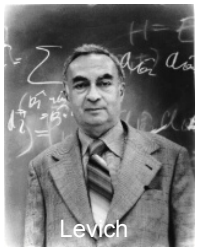




Surfaces are not uniform

Temkin, M. I. **Kinetics of heterogeneous catalysis.** J. Phys. Chem. (U. S. S. R.) (1940), 14, 1153

Temkin, M.; Levich, V. **Adsorption equilibrium on heterogeneous surfaces.** J. Phys. Chem. (U.S.S.R.) (1946), 20, 1441



$$\theta = \sum_s \frac{a_s p}{1 + a_s p} \qquad \theta = \int_0^1 \frac{a_s p}{1 + a_s p} ds$$

$$\theta = \frac{1}{f} \ln \frac{1 + a_0 p}{1 + a_1 p}$$

Quasi-logarithmic isotherm

$$\theta = \frac{1}{f} \ln \frac{1 + a_0 p}{1 + a_1 p}$$

a_0=a at s=0 (highest a)

where a_1=a at s=1 (lowest a)

The number of sites with the same adsorption strength

Strongly nonuniform surfaces

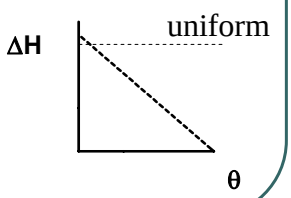
$$\theta = \frac{1}{f} \ln \frac{1 + a_0 p}{1 + a_1 p}$$

$a_0 >> a_1$ $\quad$ $a_0 p >> 1$, $a_1 p << 1$,

For the most strongly adsorbing sites the probability of being occupied is almost 1 and for the weakly adsorbing sites – almost 0 (**medium coverage**)

Logarithmic (Temkin) isotherm

$$\theta = \frac{1}{f} \ln(a_0 p)$$



Temkin isotherm

$$\theta = \frac{1}{f}\ln(a_0 p)$$

Explaining to I. Langmuir and A. Frumkin that surfaces are nonuniform

Frumkin-Shlygin isotherm was in fact derived by Temkin in a footnote of Frumkin, A.N. and Shlygin, A.I., **On Platinum Electrode**, *Dokl Akad. Nauk SSSR*, 1934, 2, 173.

Name	Isotherm equation	Applicability
Langmuir[b]	$\frac{V}{V_m} = \theta = \frac{bp}{1+bp}$	Chemisorption and physical adsorption
Henry[c]	$V = k'p$	Chemisorption and physical adsorption at low coverages
Freundlich	$V = kp^{1/n} (n > 1)$	Chemisorption and physical adsorption at low coverages
Temkin	$\frac{V}{V_m} = \theta = A \ln Bp$	Chemisorption
Brunauer–Emmett–Teller (BET)	$\frac{p}{V(p_0 - p)} = \frac{1}{V_m c} + \frac{c}{V_m c} \cdot \frac{p}{p_0}$	Multilayer, physical adsorption
Polanyi[c]	$\varepsilon = RT \ln(p_0/p)$	Physical adsorption
Dubinin–Radushkevich[c]	$\ln x = \ln(W_0 \rho) - D[\ln(p_0/p)]^2$	Multilayer formation in microporous solids
Dubinin–Kaganer–Radushkevich (DKR)	$x = x_m \exp(-B\varepsilon^2)$	Physical adsorption up to a monolayer
Virial	$\frac{p}{RT} = x(1 + a_1 x + a_2 x^2 + \ldots)$	Multilayer formation in micropores

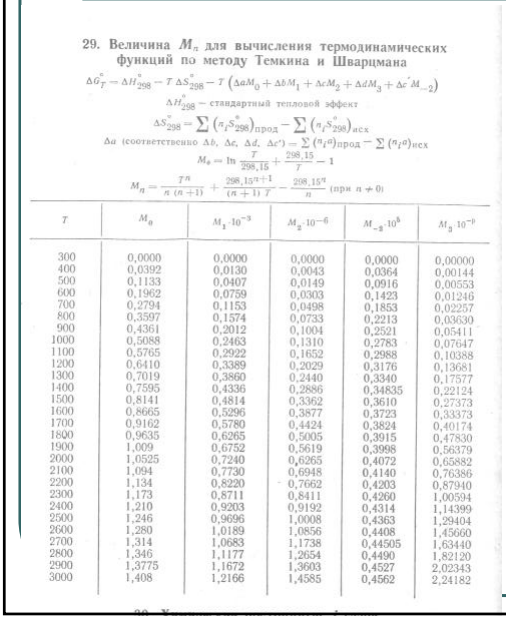
1945

Kiperman Romanushkina

Romanushkina, A. E.; Kiperman, S. L.; Temkin, M. I. **Equilibrium in the reaction of hydrogen with nitrogen adsorbed on iron.** J. Phys. Chem. USSR (1953), 27, 1181

Kul'kova, N. V.; Temkin, M. I. **Kinetics of the reaction of conversion of carbon monoxide by water vapor.** Zhurnal Fizicheskoi Khimii (1949), 23, 695

Temkin, M. I.; Shvartsman, L. A. **Auxiliary table for chemical-thermodynamic calculations.** Uspekhi Khimii (1948), 17, 259



29. Величина M_n для вычисления термодинамических функций по методу Темкина и Шварцмана

$$\Delta G^\circ_T = \Delta H^\circ_{298} - T\Delta S^\circ_{298} - T\left(\Delta a M_0 + \Delta b M_1 + \Delta c M_2 + \Delta d M_3 + \Delta c' M_{-2}\right)$$

ΔH°_{298} — стандартный тепловой эффект

$$\Delta S^\circ_{298} = \sum \left(n_i S^\circ_{298}\right)_{\text{прод}} - \sum \left(n_i S^\circ_{298}\right)_{\text{исх}}$$

Δa (соответственно Δb, Δc, Δd, $\Delta c'$) $= \sum (n_i a)_{\text{прод}} - \sum (n_i a)_{\text{исх}}$

$$M_0 = \ln\frac{T}{298{,}15} + \frac{298{,}15}{T} - 1$$

$$M_n = \frac{T^n}{n(n+1)} + \frac{298{,}15^{n+1}}{(n+1)T} - \frac{298{,}15^n}{n} \quad (\text{при } n \neq 0)$$

T	M_0	$M_1 \cdot 10^{-3}$	$M_2 \cdot 10^{-6}$	$M_{-2} \cdot 10^{5}$	$M_3 \cdot 10^{-9}$
300	0,0000	0,0000	0,0000	0,0000	0,00000
400	0,0392	0,0130	0,0043	0,0364	0,00144
500	0,1133	0,0407	0,0149	0,0916	0,00553
600	0,1962	0,0759	0,0303	0,1423	0,01246
700	0,2794	0,1153	0,0498	0,1853	0,02257
800	0,3597	0,1574	0,0733	0,2213	0,03630
900	0,4361	0,2012	0,1004	0,2521	0,05411
1000	0,5088	0,2463	0,1310	0,2783	0,07647
1100	0,5765	0,2922	0,1652	0,2988	0,10388
1200	0,6410	0,3389	0,2029	0,3176	0,13681
1300	0,7019	0,3860	0,2440	0,3340	0,17577
1400	0,7595	0,4336	0,2886	0,34835	0,22124
1500	0,8141	0,4814	0,3362	0,3610	0,27373
1600	0,8665	0,5296	0,3877	0,3723	0,33373
1700	0,9162	0,5780	0,4424	0,3824	0,40174
1800	0,9635	0,6265	0,5005	0,3915	0,47830
1900	1,009	0,6752	0,5619	0,3998	0,56379
2000	1,0525	0,7240	0,6265	0,4072	0,65882
2100	1,094	0,7730	0,6948	0,4140	0,76386
2200	1,134	0,8220	0,7662	0,4203	0,87940
2300	1,173	0,8711	0,8411	0,4260	1,00594
2400	1,210	0,9203	0,9192	0,4314	1,14399
2500	1,246	0,9696	1,0008	0,4363	1,29404
2600	1,280	1,0189	1,0856	0,4408	1,45660
2700	1,314	1,0683	1,1738	0,44505	1,63440
2800	1,346	1,1177	1,2654	0,4490	1,82120
2900	1,3775	1,1672	1,3603	0,4527	2,02343
3000	1,408	1,2166	1,4585	0,4562	2,24182

$$\ln K^0 = -\frac{\Delta H^0_{298}}{RT} + \frac{\Delta S^0_{298}}{R} + \frac{I}{R}$$

$$I = -\frac{1}{T}\int_{298}^{T}\Delta C_p dT + \int_{298}^{T}\frac{\Delta C_p}{T}dT$$

$$I = \Delta a M_0 + \Delta b M_1 + \Delta c M_2 + \Delta c' M_{-2}$$

$$M_0 = \frac{298}{T} - 1 + \ln\frac{T}{298}$$

$$M_n = \frac{298^{n+1}}{(n+1)T} - \frac{298^n}{nT} + \frac{T^n}{n(n+1)}$$

Temkin, M. **Mixtures of fused salts as ionic solutions.**
Acta Physicochimica URSS (1945), 20, 411

H.A. ØYE

A useful first approximation structural model for molten ionic systems is the so-called ideal Temkin model. Due to Coulombic forces, ionic crystals are ordered in a way that cations are only surrounded by anions and *vice versa*. An interchange of an anion and a cation in the lattice is energetically highly unfavorable. The Temkin model for molten salt mixtures transfers the ideas for a solid mixed crystal to the liquid. The molten salt has a "cation lattice" and an "anion lattice" so that

$$S = S^{+} + S^{-} \qquad [1]$$

NaCl :

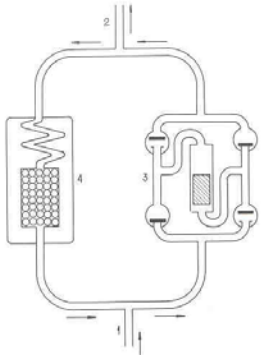
$$a^{id}_{NaCl} = (X_{Na^+})(X_{Cl^-})$$

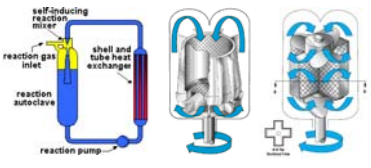
KCl-$MgCl_2$

$$a_{KCl} = (X_{K^+})\,(X_{Cl^-}) = 1 \cdot \frac{n_{K^+}}{n_{K^+} + n_{Mg^{2+}}}$$

METALLURGICAL AND MATERIALS TRANSACTIONS B
VOLUME 31B, AUGUST 2000—641

Temkin, M. I.; Kiperman, S. L.; Luk'yanova, L. I. **Flow-circulation method of investigation of the kinetics of heterogeneous catalytic reactions.**
Doklady Akademii Nauk SSSR (1950), 74, 763





Buss Berty Carberry

- The pressure in the system is constant
- Gas (liquid) composition does not change with time or in space
- Each single pass of reactants through the bed results in very small conversion as the circulation rate is very high.
- The system is free from concentration gradients along the catalyst bed, concentration gradients due to axial dispersion and temperature gradients.
- The treatment of data is simplified as the rate is extracted directly in the differential form

1954

Temkin, M. I. **Calculation of surface area from data of vapor adsorption.** Zhurnal Fizicheskoi Khimii (1955), 29 1610

Cherednichenko, V. M.; Temkin, M. I. **The effect of internal diffusion on the course of a heterogeneous catalytic reaction retarded by the reaction product.** Zhurnal Fizicheskoi Khimii (1957), 31, 157.

Cherednichenko, V. M.; Temkin, M. I. **Kinetics of catalytic synthesis of methanol.** Zhurnal Fizicheskoi Khimii (1957), 31, 107

Cherednichenko, Slinko, Boreskov, Kul'kova, Lukyanova

1956

Temkin, M. I. **Reaction kinetics on the surface of solids and the problems of the highest catalyst activity.** Zhurnal Fizicheskoi Khimii (1957), 31 3

Kurilenko, A. I.; Kul'kova, N. V.; Rybakova, N. A.; Temkin, M. I.. **Oxidation of ethylene to ethylene oxide on a silver catalyst. II. The reaction kinetics.** Zhurnal Fizicheskoi Khimii (1958), 32, 1043

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Gel'bshtein, A. I.; Temkin, M. I., **Determination of the reaction order from the acidity.** Proc. Akad. Sci. Phys. Chem. Sect. (1958), 118, 57

Temkin, M. I. **Kinetics of stationary reactions.** Doklady Akademii Nauk SSSR (1963), 152, 156

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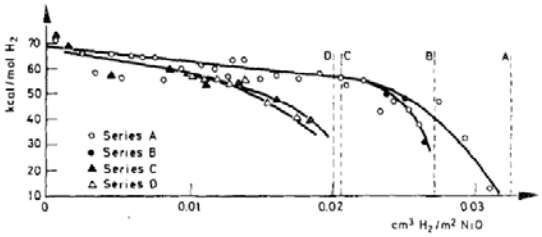

Fig. 5. Differential heats of H_2 sorption by NiO at 190° as a function of the volume of sorbed H_2. In series *A*, *B*, *C* and *D* the catalyst contained different quantities of O_2. Dotted lines indicate maximum sorbed volumes in each series

Journal of Thermal Analysis, Vol. 14 (1978) 27—43

COMBINED USE OF CALORIMETRIC AND ADSORPTION KINETIC METHODS FOR THE STUDY OF THE MECHANISMS OF CATALYTIC PROCESSES

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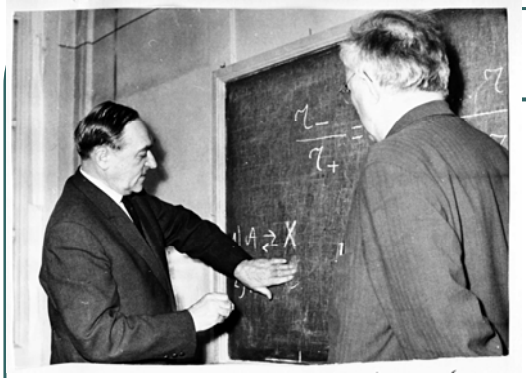

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Theory of complex reactions

		σ	
		$N^{(1)}$	$N^{(2)}$
1.	$O_2 + 2^* \leftrightarrow 2O^*$	1	1
2.	$H_2 + 2^* \leftrightarrow 2H^*$	2	0
3.	$H^* + O^* \leftrightarrow OH^* + *$	2	0
4.	$OH^* + H^* \leftrightarrow H_2O + 2^*$	2	0
5.	$H_2 + O^* \leftrightarrow H_2O + *$	0	2
	$2H_2 + O_2 \leftrightarrow 2H_2O$		

$N^{(i)}$: routes

***: active center**

σ : stoichiometric number

α : stoichiometric coefficient

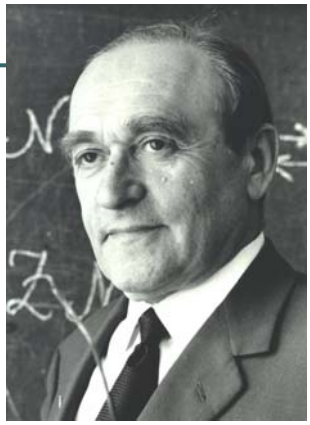
Horiuti - Temkin equation

P=S+W-J

P – number of routes, W – number of balance equations, J – number of intermediates, S – number of steps

$$r = \frac{\prod_{i=1}^{s} r_{+i} - \prod_{i=1}^{s} r_{-i}}{\sigma_1 r_{+2} \ldots r_{+s} + r_{-1}\sigma_2 r_{+3} \ldots r_{+s} + r_{-1} r_{-2} \ldots \sigma_s}$$

Two-step sequence



1. $Z+A_1 \leftrightarrow ZI+B_1$
2. $\underline{ZI+A_2 \leftrightarrow Z+B_2}$

   $A_1+A_2 \leftrightarrow B_1+B_2$

$$r = \frac{k_1 P_{A_1} k_2 P_{A_2} - k_{-1} P_{B_1} k_{-2} P_{B_2}}{k_1 P_{A_1} + k_2 P_{A_2} + k_{-1} P_{B_1} + k_{-2} P_{B_2}}$$

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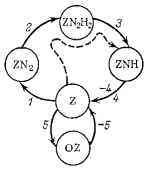
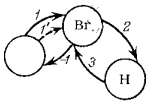


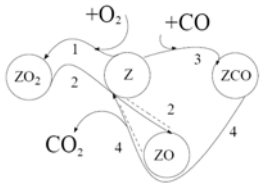
Hanging vertex

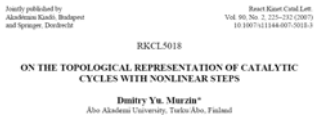
1. $N_2+Z=ZN_2$	1
2. $ZN_2+H_2= ZN_2H_2$	1
3. $ZN_2H_2+Z= 2ZNH$	1
4. $ZNH+H_2 =NH_3+Z$	2
5. $Z+H_2O=ZO+H_2$	0

Graph with an empty circle



Graph for the Langmuir-Hinshelwood CO oxidation mechanism with dissociative oxygen adsorption



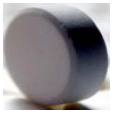

RKCL5018

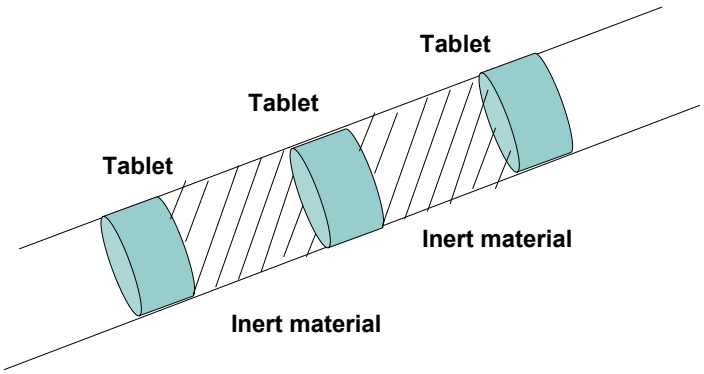
ON THE TOPOLOGICAL REPRESENTATION OF CATALYTIC CYCLES WITH NONLINEAR STEPS

Dmitry Yu. Murzin*

Temkin, M. I.; Kul'kova, N. V. **Ideal-displacement laboratory reactor.** Kinetika i Kataliz (1969), 10, 461

Catalyst granules or pellets are placed into the tubes, divided with an inert material





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Mass transfer

Temkin, M. I. **Transfer of dissolved matter between a turbulently moving liquid and particles suspended in it.** Kinetika i Kataliz (1977), 18 493.

$$Sh \Rightarrow \mathrm{Re}^{1/2}\, Sc^{1/3}$$

$Sh = \frac{\beta d}{D}$ — **Sherwood Number**

$\mathrm{Re} = \frac{Vd}{\nu}$ — **Reynolds Number**

$Sc = \frac{\nu}{D}$ — **Schmidt Number**

Kolmogorov theory of turbulence

Critical eddies responsible for energy dissipation

$$\mathrm{Re} = \frac{V_\lambda \lambda}{\nu} \qquad V_\lambda \propto (\varepsilon\lambda)^{\frac{1}{3}}$$

Kolmogorov equation can be applied to bubbles / solid particles with characteristic length d (Temkin, 1977; Baldi et.al., 1978)

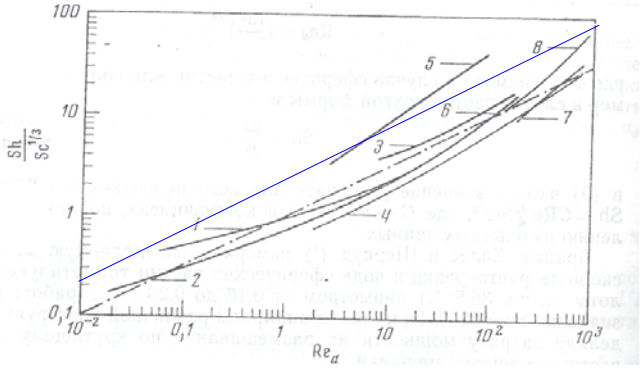
$$\mathrm{Re}_d \propto \left(\frac{\varepsilon d}{\nu^3}\right)^{\frac{1}{3}}$$

ε power input per kg of liquid; energy dissipation

d diameter of bubbles / solid particles

Remember $$Sh \propto \mathrm{Re}_d^{0.5}\, Sc^{0.33}$$

Analysis of experimental data:



Temkin, 1977

$$Sh = 1.0\,\mathrm{Re}_d^{0.5}\, Sc^{0.33}$$

Mass transfer coefficient

Gas-liquid

Temkin, 1990

$$\beta_{gL} = 1.0\left(\frac{\varepsilon D^4}{\nu d_b^{\,2}}\right)^{1/6}$$

diameter of bubbles

Liquid-solid

$$\beta_{Ls} = 1.0\left(\frac{\varepsilon D^4}{\nu d_{cat}^{\,2}}\right)^{1/6}$$

diameter of particles

Temkin, 1977

State Prize!

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Chemreactor in 1981

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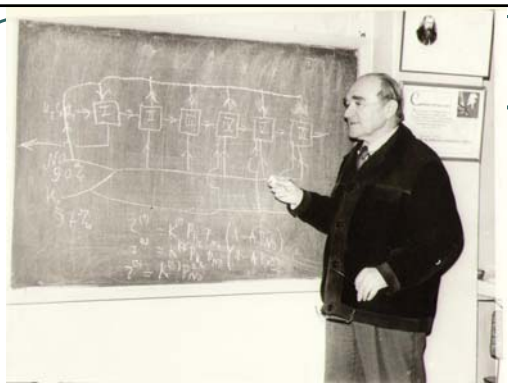

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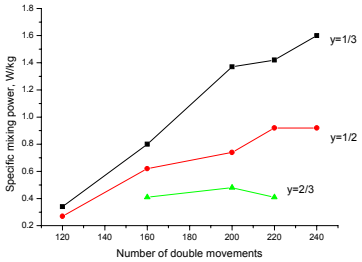
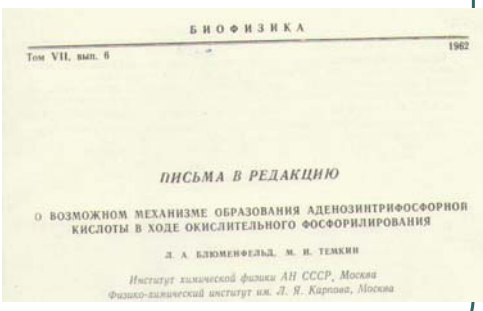
Specific mixing power in a shaked reactor : measuring of heat release



Пусть нам завидуют потомки:
Сам Михаил Исаакович Темкин.
В аспирантуре нас учил
И *Cherry brandy* с нами пил!

Л. А. Блюменфельд

Blumenfel'd L A; Temkin M I. **On the possible mechanism of formation of adenosine triphosphate in the course of oxidative phosphorylation**. Biofizika (1962), 7, 731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Том VII, вып. 6 1962

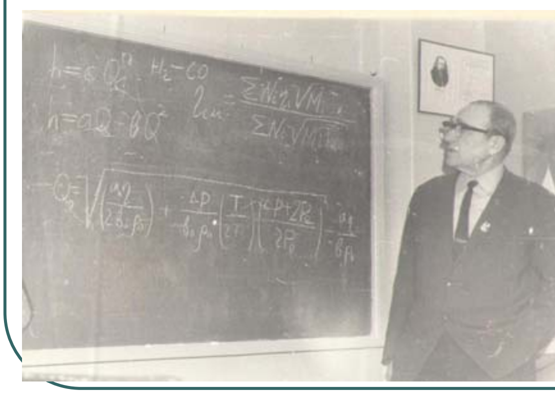
ПИСЬМА В РЕДАКЦИЮ

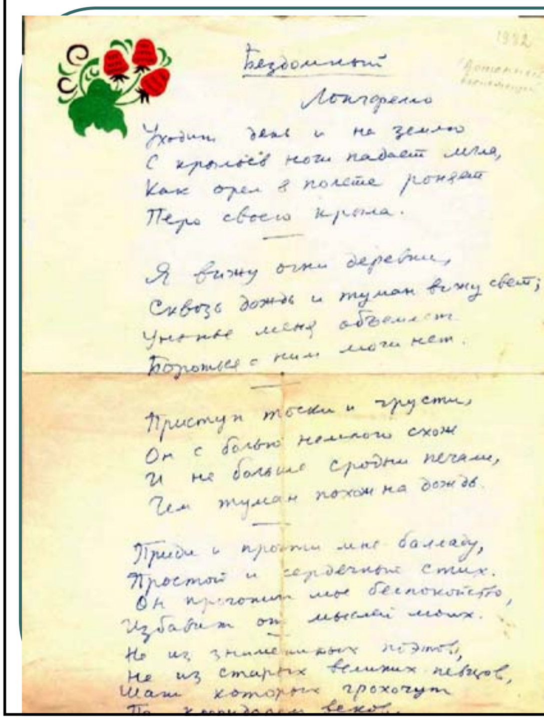
О ВОЗМОЖНОМ МЕХАНИЗМЕ ОБРАЗОВАНИЯ АДЕНОЗИНТРИФОСФОРНОЙ КИСЛОТЫ В ХОДЕ ОКИСЛИТЕЛЬНОГО ФОСФОРИЛИРОВАНИЯ

Д. А. БЛЮМЕНФЕЛЬД, М. И. ТЕМКИН

Институт химической физики АН СССР, Москва
Физико-химический институт им. Л. Я. Карпова, Москва

Throughout the years: Science





Бездомный

Лонгфелло

Уходит день и на землю
С крыльев ночи падает мгла,
Как орел в полете роняет
Перо своего крыла.

Я вижу огни деревни,
Сквозь дождь и туман вижу свет;
Уныние меня объемлет
Бороться с ним мочи нет.

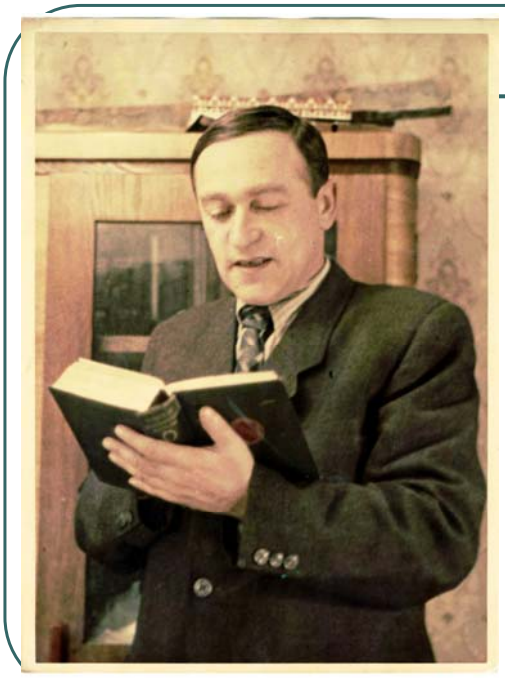
Приступ тоски и грусти,
Он с болью немного схож
И не больше сродни печали,
Чем туман похож на дождь.

Приди и прочти мне балладу,
Простой и сердечный стих.
Он прогонит мое беспокойство,
Избавит от мыслей моих.

Не из знаменитых поэтов,
Не из старых великих певцов,
Шаги которых грохочут
По коридорам веков.

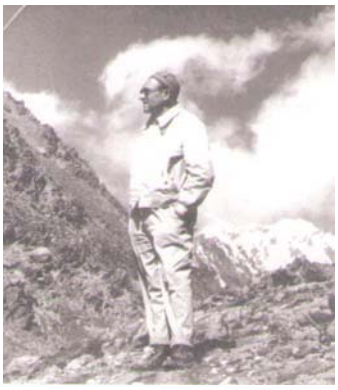
…and not only

..and not only



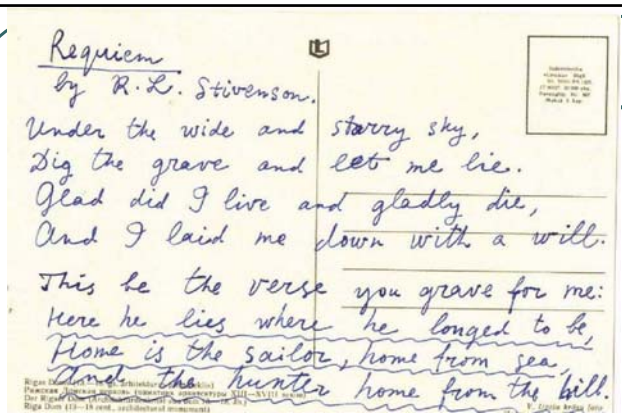
Reading Shakespeare

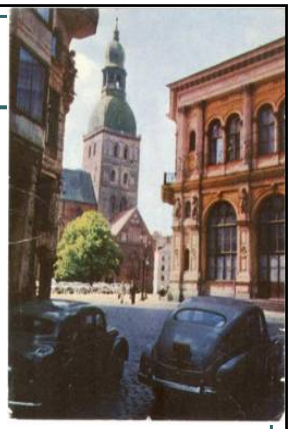
..and not only



Mountain climbing

Hiking





Завещание

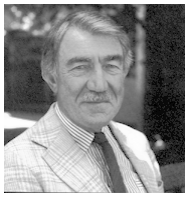
Р.Л. Стивенсон (перевод М.Темкина)

К широкому небу лицом ввечеру
Положите меня, и я умру
Я радостно жил и легко умру
И вам завещаю одно –
Напишите на моей плите гробовой:
«Моряк из морей вернется домой,
Охотник с гор вернется домой
Он там, куда шел давно».

More personal memories

http://temkin-76.ucoz.ru/

D. Yu. Murzin, The man behind the name: Mikhail Temkin, *Journal of Molecular Catalysis .A. Chemical* (accepted)



Jean-Paul Sartre is reported to have said ”I shall die twice, the first time physically and the second time when no one shall read my works””. Mikhail Temkin will live a long, long second life, as his name will remain known by new generation of kineticists, who will not even need to read the original writings, since the main ideas of Temkin are already in all textbooks and monographs on heterogeneous catalysis

M. Boudart