

and

$$\sigma = 2a^3 k E \left(\frac{3x_0^2}{r_1^3} - \frac{1}{r_1^3} \right).$$

The charges distributed on the plane interact with the aerosol particle, and forces arise which cause movement of the latter.

It is interesting that the sum of all the additional charges induced on the conducting plane is zero. In fact, the charge induced on the plane is

$$Q = \int \sigma \cdot ds = 2a^3 \cdot k \cdot E \int \left(\frac{3x_0^2}{r_1^3} - \frac{1}{r_1^3} \right) ds,$$

(where the integration extends throughout an infinite plane) or, in the coordinates ρ , α on the boundary plane, it being borne in mind that $r_1^2 = \rho^2 + x_0^2$,

$$Q = 2a^3 \cdot k E \int_0^{2\pi} d\alpha \int_0^\infty \left(\frac{3x_0^2}{(\rho^2 + x_0^2)^{3/2}} - \frac{1}{(\rho^2 + x_0^2)^{3/2}} \right) \rho \cdot d\rho$$

and

$$\int_0^\infty \frac{3x_0^2 \cdot \rho}{(\rho^2 + x_0^2)^{3/2}} \cdot d\rho - \int_0^\infty \frac{\rho \cdot d\rho}{(\rho^2 + x_0^2)^{3/2}} = 0.$$

Hence $Q = 0$: i.e. changing the coordinates of the particle involves merely a redistribution of the additional induced charges.

To determine the forces acting on the particle, we write the field in the right-hand half-space, in view of Eqn. (7), in the form

$$\begin{aligned} \vec{E}_a = \vec{E} + \vec{E}_1' + \vec{E}_{add} = E \cos \theta_2 \frac{\vec{r}_2}{r_2} + \frac{2a^3}{r_1^3} k E \cos \theta_1 \frac{\vec{r}_1}{r_1} + \frac{2a^3}{r_2^3} k \cdot \gamma E \cos \theta_2 \frac{\vec{r}_2}{r_2} - \\ - E \sin \theta_2 \cdot \vec{\tau}_2 + \frac{a^3}{r_1^3} k E \sin \theta_1 \vec{\tau}_1 + \frac{a^3}{r_2^3} k \gamma E \sin \theta_2 \cdot \vec{\tau}_2, \end{aligned}$$

where $\vec{E}_1' = -\nabla \varphi_1$ and $\vec{E}_{add} = -\nabla \varphi_{add}$.

The energy of the aerosol particle will be determined by the field $\vec{E} + \vec{E}_1'$:

$$W = \frac{e_a - e_i}{2} \int_{V_i} (\vec{E} + \vec{E}_1') \cdot \vec{E}_i dV,$$

where $\vec{E}_i$ is the field strength within the particle, and V_i the volume of the latter; the force acting on the particle is

$$\vec{f} = -\nabla W = \frac{e_i - e_a}{2} \nabla \int_{V_i} (\vec{E} + \vec{E}_1') \cdot \vec{E}_i dV.$$

The dimensions of a real aerosol particle are extremely small, and we shall regard the field in the region occupied by the particle as quasi-uniform. The field inside the particle will then be

$$\vec{E}_i = \frac{3e_a}{e_i + 2e_a} (\vec{E} + \vec{E}_1')$$

and

$$\vec{f} = \frac{3}{2} e_a \cdot k \nabla (\vec{E} + \vec{E}_1')^2 \int_{V_i} dV = 2\pi a^3 \cdot e_a k \nabla (\vec{E} + \vec{E}_1')^2.$$

In the present case points A and B always lie on a normal to the boundary plane, independently of the position of the particle, so that $\theta_2 = 0$, and the equation for the force becomes

$$\vec{f} = -24\pi \frac{a^6}{r_2^4} \cdot \gamma \cdot k^2 E^2 \left(1 + \frac{2a^3}{r_2^3} \gamma \cdot k \right) \frac{\vec{r}_2}{r_2}.$$

or, since $r_2 = 2x_0$, we obtain

$$\vec{f} = \frac{3}{2} \pi \frac{a^6}{x_0^4} \cdot e_a \frac{e_a - e_i}{e_a + e_i} \cdot \left(\frac{e_i - e_a}{e_i + 2e_a} \right)^2 E^2 \left(1 - \frac{a^3}{4x_0^3} \frac{e_a - e_i}{e_a + e_i} \frac{e_i - e_a}{e_i + 2e_a} \right) \vec{i}.$$

Consequently the particle is subject to a force causing it to drift always along the normal, towards or away from the plane depending on the relation between ϵ_a and ϵ_i . Thus when $\epsilon_a > \epsilon_i$ the particle will recede from the plane; whereas when $\epsilon_a < \epsilon_i$ it will approach the plane. When the plane is electrically conducting, a particle having any value of ϵ_i ($\epsilon_i \neq \epsilon_a$) will tend to settle on the plane under the action of a force

$$\vec{f} = \frac{3}{2} \pi \frac{a^6}{x_0^4} \cdot e_a \left(\frac{e_i - e_a}{e_i + 2e_a} \right)^2 E^2 \left(1 + \frac{a^3}{4x_0^3} \frac{e_i - e_a}{e_i + 2e_a} \right) \vec{i}.$$

Thus when an aerosol particle is located in a uniform electric field near the boundary between two media, forces are produced which tend to deposit the particle on the plane or to remove it. With actual aerosols the time occupied by a particle in reaching the conducting plane from an initial distance of $x_0 = 50a$, when $E = 10 \text{ kV cm}^{-1}$, may be of the order of a few seconds, as is shown by a numerical estimate.

SUMMARY

1. Neutral aerosol particles located in a uniform electric field near the boundary plane between two media are subject to forces tending to repel them from the plane or attract them to it. The magnitude of these forces depends on the electrical parameters of the media and of the aerosol particles, as well as on the strength of the electric field.
2. The time taken by a particle in approaching the plane in real aerosols may be several seconds for $x_0 \approx 50a$.

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Received 28th May 1964

U.D.C. 620.191/193

EFFECT OF SULPHUR-CONTAINING COMPOUNDS ON THE CORROSION OF IRON IN ACID SOLUTION

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It has been shown previously^{1,2} that the tendency of hydrogen sulphide to promote the corrosion of iron in acid solutions (in the absence of oxygen) disappears on addition of organic cations, which then acquire a strong inhibiting effect.

The action of inhibitors of cationic type, if they are adsorbed on the metal surface, is associated with the appearance of a positive adsorption Ψ_1 potential, a function of the surface coverage θ of the metal with inhibitor, which can be found from the relative decrease in the differential capacitance of the double layer ΔC . The positive Ψ_1 potential slows down the cathodic discharge of hydrogen ions and

the anodic ionisation of the metal^{3,4}, in conformity with the equations — for the cathodic reaction

$$i_c = k' [H^+] \exp \left\{ -\frac{F}{RT} [\alpha \varphi_k + (1 - \alpha) \Psi_1] \right\} \quad (1)$$

and for the anodic reaction

$$i_a = k'' \exp \left\{ \frac{F}{RT} 2\beta (\varphi_a - \Psi_1) \right\} \quad (2)$$

where i_c and i_a are the rates of these reactions expressed in electrical units, and α and β are constants.

Because of the positive charge on an iron surface, these inhibitors are feebly adsorbed from sulphuric-acid solutions, and are therefore ineffective^{2,5}, as is evident from the values of the spontaneous iron-dissolution currents i_c and i_a and of ΔC resulting from the addition to 1N H₂SO₄ of tetrabutylammonium sulphate [(C₄H₉)₄N]₂SO₄ or of tribenzylamine (C₆H₅CH₂)₃N (see Table and Fig. 1)†.

The action of hydrogen sulphide on the adsorption of inhibitors is probably associated with the chemisorption of HS⁻ ions and the formation of dipoles comprising HS⁻ and iron atoms, the negative ends of which are directed towards the solution. These chemisorbed structures have been shown⁶ to catalyse the anodic ionisation of iron while promoting the adsorption of organic bases, which block the catalyst dipoles and thus eliminate their stimulating effect. The resulting positive Ψ_1 potential slows down the electrochemical reactions. Even very small concentrations of hydrogen sulphide promote adsorption of the inhibitors^{1,2},

TABLE.

Addition to 1 N H ₂ SO ₄	φ_c , mV at $i = 0.01$ A cm ⁻²	φ_a , mV at $i = 0.01$ A cm ⁻²	φ_{sp} , mV	i_{sp} , A cm ⁻²	ΔC at $\varphi = 0.4$ V, μF cm ⁻²
No addition	-300	-177	-220	2.5 · 10 ⁸	0
[(C ₄ H ₉) ₄ N] ₂ SO ₄ , 2 × 10 ⁻³ N	-300	-175	-220	2.5 · 10 ⁸	2
Na ₂ S, 10 ⁻⁴ N	-315	-230	-270	4 · 10 ⁸	5
10 ⁻⁴ N Na ₂ S + 2 × 10 ⁻³ N [(C ₄ H ₉) ₄ N] ₂ SO ₄	-535	-100	-220	1.8 · 10 ⁸	30
(C ₆ H ₅ CH ₂) ₃ N, 10 ⁻³ M	-300	-180	-220	2.5 · 10 ⁸	2-3
C ₆ H ₅ (OH)(COOH)SO ₃ H, 0.01 M	-225	-180	-230	1.5 · 10 ⁸	12
0.01 M C ₆ H ₅ (OH)(COOH)SO ₃ H + + 0.001 M (C ₆ H ₅ CH ₂) ₃ N	-500	-90	-205	2.5 · 10 ⁴	21

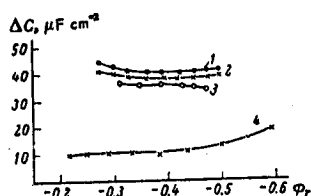


Fig. 1. Curves showing dependence of differential capacitance on potential of iron in 1 N H₂SO₄ containing:

- 1) no addition; 2) 0.002 N [(C₄H₉)₄N]₂SO₄;
- 3) 0.0001 N H₂S; 4) 0.002 N [(C₄H₉)₄N]₂SO₄ + 0.0001 N H₂S.

† Values of the differential capacitance, measured on pure zone-melted iron by means of an 800 c/s a.c. series circuit, were converted to a parallel circuit. The φ_r potential is given relative to a hydrogen electrode in the same 1 N H₂SO₄ solution.

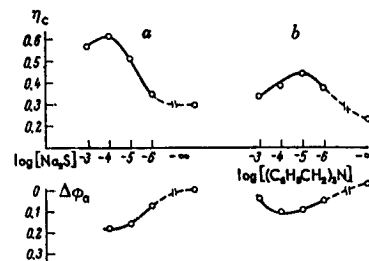


Fig. 2. Variation in hydrogen overpotential and potential for the ionisation of zone-melted iron with relative concentrations of (C₆H₅CH₂)₃N and Na₂S (at $i = 0.01$ A cm⁻²):

- a) dependence on Na₂S concentration in the presence of 10⁻³ M (C₆H₅CH₂)₃N; b) dependence on (C₆H₅CH₂)₃N concentration in the presence of 10⁻⁶ N Na₂S.

the inhibiting effect depending on the relative concentrations of hydrogen sulphide and inhibitor in the acid solution. Fig. 2 gives values of the hydrogen overpotential η_c and the change in potential of the anodic process $\Delta\varphi_a$ for pure iron resulting from the addition of various concentrations of Na₂S and of tribenzylamine to 1N H₂SO₄. The overpotential decreases at high or very low concentrations of one of the additives. It is seen from Fig. 2 that with 0.001M tribenzylamine the optimum is observed at 0.0001N Na₂S; with an Na₂S concentration of 10⁻⁶N, the optimum lies at a tribenzylamine concentration of 10⁻⁵M.

Organic sulphonic acids must be considered among the stimulators of the acid corrosion of iron. Being present as anions in solutions, they are quite well adsorbed from H₂SO₄ solution on a positively charged iron are quite well adsorbed from H₂SO₄ solutions on a positively charged iron surface. The adsorption of anions produces a negative adsorption Ψ_1 potential, and therefore sulphonic acids, in conformity with Eqns. (1) and (2), stimulate the corrosion of iron†.

It can be seen from the Table that the addition of, for example, sulphosalicylic acid to 1N H₂SO₄ results in a substantial decrease in hydrogen overpotential, whereas it has no appreciable effect on the anodic reaction.

It is interesting that the presence together of a sulphonic acid and an organic base results in the latter exerting a strong inhibiting effect, and of course in disappearance of the stimulating action of the sulphonic acid, as occurs in the presence of hydrogen sulphide and an organic base. The last column in the Table shows that, when both sulphosalicylic acid and tribenzylamine are present in the solution, ΔC considerably exceeds the sum of the decreases in capacitance produced by each additive alone.

The above combined effect is associated with the polar character of the bond between the sulphonic acid molecules and the metal and with increased adsorption of cations of the organic base on the negative ends of the above dipoles.

† It must be noted that the stimulating action of sulphonic acids decreases with increase in molecular mass and in length of the hydrocarbon chain, and may pass into an inhibiting effect because of the screening influence of the long hydrocarbon chain on ions undergoing discharge in the double layer.

This hypothesis is supported by the fact that the action of the sulphonate anions and the organic cations depends on their relative concentrations, as shown for another system in Fig. 2. The maximum effect on the hydrogen overpotential is observed, for example, at concentration of $0.01N$ $[(C_4H_9)_4N]_2SO_4 + 10^{-5}M$ $C_6H_5(OH)(COOH)SO_3H$ with $\Delta\eta = 265$ mV and at $0.01M$ acid + $0.001N$ base $\Delta\eta = 170$ mV with $i_c = 0.1$ A cm^{-2} . The effect diminishes with decrease in the concentration of one of the components.

As noted previously¹ the stimulating action of hydrogen sulphide is appreciably strengthened by the presence of neutral organic compounds. From the magnitude of ΔC the differential capacitance curves indicate additional adsorption of one of them.

A similar effect is observed on addition of hydrogen sulphide to a solution of a sulphonic acid, as can be seen from the polarisation curves in Fig. 3, e.g. from the size of the spontaneous iron-dissolution current, determined from the projection on the horizontal axis of the point of intersection of the linear portions of cathodic and anodic polarisation curves.

In connection with the above we must examine the action on iron of sulphur-containing compounds, many of which are good inhibitors of the corrosion of iron². Among them are thiourea derivatives, sulfoxides, sulphonamides, thiocyanates, etc.⁷ Their action is probably due to a considerable extent to hydrogen sulphide, which appears on reduction and decomposition of these compounds in the course of the acid corrosion of iron^{2,8,9}. This H_2S can be detected by appropriate reagents⁸. The action of sulphur-containing compounds varies greatly depending on the nature of the compound, its concentration and that of the acid, temperature, stirring, etc.¹⁰ In several cases the curve relating rate of corrosion with concentration of sulphur-containing compound passes through either a minimum or a maximum. Fig. 4 gives curves for the dependence of the rate of corrosion (in $g\ cm^{-2}\ h^{-1}$) of Armco iron on the concentration of thiourea and of potassium thiocyanate in $1N\ H_2SO_4$, plotted in logarithmic coordinates. It is seen that the inhibiting effect of thiourea increases up to a concentration of $0.001M$, then decreases, and completely disappears at $0.1M$. Potassium thiocyanate stimulates corrosion up to $0.001M$, and exerts an inhibiting effect only at concentrations above $0.01M$.

In order to explain the above effect, we show in Fig. 5 polarisation curves obtained in $1N\ H_2SO_4$ alone and with addition of $0.001M$ and $0.1M$ KCNS, i.e. concentrations corresponding to maximum stimulation and maximum

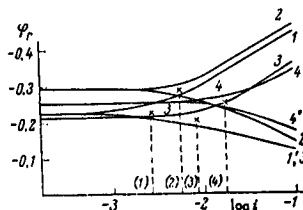


Fig. 3. Polarisation curves for zone-melted iron in $1N\ H_2SO_4$ containing: 1) no addition; 2) $0.001N\ Na_2S$; 3) $0.01M\ C_6H_5(OH)(COOH)SO_3H$; 4) $0.001N\ Na_2S + 0.01M\ C_6H_5(OH)(COOH)SO_3H$.

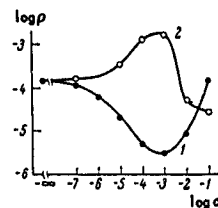


Fig. 4. Dependence in logarithmic coordinates of rate of corrosion of Armco iron in $1N\ H_2SO_4$ on concentration of: 1) $(NH_2)_2CS$; 2) KCNS.

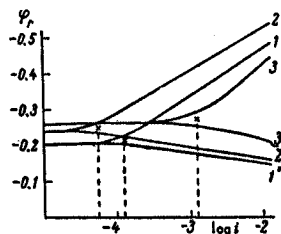


Fig. 5. Polarisation curves for Armco iron in $1N\ H_2SO_4$ containing different concentrations of KCNS: 1) 0; 2) $0.1M$; 3) $0.001M$.

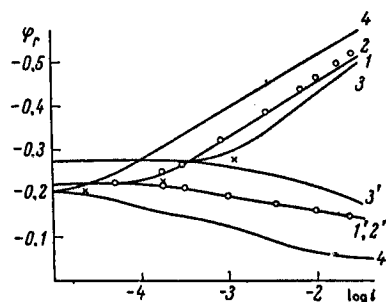


Fig. 6. Polarisation curves for Armco iron in $1N\ H_2SO_4$ containing: 1) no addition; 2) $0.001N\ [(C_4H_9)_4N]_2SO_4$; 3) $0.001M\ KCNS$; 4) $0.001M\ KCNS + 0.001N\ [(C_4H_9)_4N]_2SO_4$.

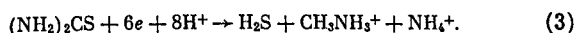
retardation of corrosion. It is seen that $0.001M$ KCNS lowers the overpotential of cathodic and anodic reactions, whereas with $0.1M$ KCNS the overpotential of these reactions is appreciably higher than in the acid solution alone.

A similar situation is found in $1N\ H_2SO_4$ containing $0.001M$ and $0.1M$ thiourea.

If a nitrogenous organic base is added to an acid solution containing KCNS at concentrations which stimulate corrosion, a strong inhibiting action appears in the mixture. This effect follows from the polarisation curves in Fig. 6. The explanation is that KCNS and its decomposition products (mainly H_2S) promote adsorption of the organic base. This conclusion is supported by the differential capacitance curves

obtained on iron 1N H₂SO₄: the values of ΔC obtained on addition of 0.001M tribenzylamine, 0.0001N KCNS, and both together in the solution are 2, 15, and 29 $\mu F cm^{-2}$ respectively. A similar increase in adsorption and intensification of the inhibiting effects are observed in the presence of thiourea.

Agreement has not yet been reached on the composition of the reduction products of e.g. thiourea. The assumption has been made⁹ that it breaks down in acid solutions to form NH₃, CO₂, and H₂S. Another paper¹¹ suggests the formation of CH₂(NH₂)₂. However, diaminomethane is unlikely to be formed, because of the ease with which it is hydrolysed to HCHO and NH₃. We have examined the effect on the corrosion of iron of specially prepared mixtures containing equivalent proportions of H₂S + (NH₄)₂SO₄ and H₂S + HCHO + (NH₄)₂SO₄ dissolved in 1N H₂SO₄. In both cases acceleration of corrosion was observed, which increased with increase in the concentration of the mixture: i.e. the relationship obtained differed from that shown in Fig. 4. It was therefore concluded that a more probable mechanism for the decomposition of thiourea is that suggested in Ref. 10

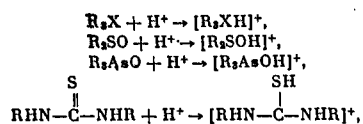


The methylamine obtained according to this mechanism adds on hydrogen ions, and is converted into organic cations, which can be adsorbed on iron in the presence of H₂S. A test on a mixture of end-products of reaction (3) showed that at high concentrations this mixture stimulates the corrosion of iron, but low concentrations have no appreciable effect. Hence it was concluded that thiourea molecules themselves are inhibitors in the presence of their decomposition products.

A very small fraction of the thiourea present in solution is reduced during the acid corrosion of iron. According to Eqn. (3), complete reduction of 50 ml of 0.1M thiourea in 1N H₂SO₄ requires the consumption of a quantity of electricity corresponding to the evolution of 350 ml of hydrogen. In experiments involving corrosion in the above solution for 16 h, 0.6–1 ml of hydrogen was consumed in the reduction of thiourea (the difference between gravimetric and volumetric methods of determining corrosion, expressed as a volume of hydrogen): i.e. only a few tenths of 1% of the quantity of thiourea present in solution is reduced. After the same time in 0.001M solution, less than 10% of the thiourea in the solution is reduced with a specimen of surface area about 10 cm².

Formation of a monolayer of chemisorbed HS⁻ ions requires about 3×10^{-9} mole cm⁻².¹² Therefore a very minute quantity of H₂S, obtained by reduction of the sulphur-containing compound directly on the iron surface, can provide the necessary layer of adsorbed HS⁻ ions.

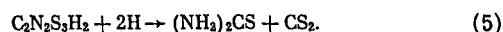
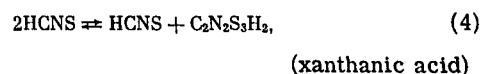
The further action of thiourea and its derivatives, as well as of several other sulphur-containing compounds, is associated with their onium character: like the organic bases, they can add on hydrogen ions with conversion into organic cations, e.g.



where R is an aliphatic or aromatic radical, and X = P, N, As.

Evidence that hydrogen sulphide formed by reduction of an organic sulphur-containing compound promotes the adsorption and retarding effect of these compounds is provided by experiments on the combined effect of thiourea derivatives and specially added hydrogen sulphide on the corrosion of iron. Small concentrations of hydrogen sulphide results in an increase, not a decrease, in the inhibiting effect of the thiourea derivative in sulphuric-acid solution. For example, the rate of corrosion of Armco iron in 8N H₂SO₄ containing 0.0004M allylphenylthiourea is 1.4×10^{-6} g cm⁻² h⁻¹, which on addition of 10⁻⁴N H₂S becomes 2.4×10^{-6} g cm⁻² h⁻¹, whereas with 10⁻⁶N H₂S the rate of corrosion is 0.82×10^{-6} g cm⁻² h⁻¹.

Potassium thiocyanate in acid solutions is probably reduced according to the scheme



The resulting thiourea is then reduced as above, according to Eqn. (3). However, the experimental results available do not yet permit an explanation of the observed dependence of rate of corrosion on the concentration of potassium thiocyanate.

SUMMARY

1. An investigation has been made of the effect of hydrogen sulphide and other compounds containing sulphur on the adsorption of inhibitors (organic bases) from sulphuric-acid solution on iron, determined from the decrease in the differential capacitance of the double layer measured by means of a.c.
2. Examination of the polarisation curves has established the mechanism by which corrosion stimulators—hydrogen sulphide, sulphonic acids, and other sulphur-containing compounds — increase the adsorption of organic bases in acid solutions and result in their exerting a strong retarding effect on the corrosion of iron.
3. The action of a thiocyanate salt, thiourea, and its derivatives on the acid corrosion of iron has been investigated.

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Received 29th May 1964

U.D.C. 541.183.12

ION EXCHANGE OF WEAK ORGANIC ELECTROLYTES

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The characteristic features of the exchange of organic ions on ion exchangers have been very vigorously investigated in recent years^{1,2}. However, the effect of the van der Waals interaction between the organic part of the molecule and the matrix of the ion exchanger on the exchange and in particular on its selectivity has not yet been elucidated. In a number of studies³⁻⁵ it is emphasized that the overall absorption process involves a superposition of molecular sorption on ion exchange. The present paper presents the results of a study of molecular sorption and anion exchange of straight-chain aliphatic acids, ranging from formic to nonanoic, on the strongly basic anion exchanger Dowex-1x2 in the fluoride, chloride, and iodide forms.

EXPERIMENTAL

Dowex-1 resin (grain size 100/200 mesh), with a nominal content of 2% of divinylbenzene, was washed free of iron and organic impurities (checked interferometrically), and conditioned by converting the hydroxide form into the appropriate salt form and back again four times, using 2 N NaOH and the appropriate salt. The degree of swelling of the fluoride, chloride, and iodine forms, determined by centrifugation⁶, was 4.05, 3.25, and 0.55 g, and the exchange capacity was 3.71, 3.50, and 2.65 milliequivalents per gramme of completely dry resin respectively. The salt forms of the resin were dried at 105°. They are fairly stable at this temperature.

The experiments on the sorption and exchange were carried out at 20° ± 2° in flasks with carefully ground stoppers in which 0.5 g of air-dried ion exchanger with known moisture content and 20 ml of the organic acid solution were kept long enough (2-3 days) to ensure reliable attainment of equilibrium. The same state of equilibrium is attained when the given concentration and temperature are approached from opposite directions. The extent of total absorption was found from the change in the initial concentration of the acid, and the extent of anion exchange by measuring the concentration of the halide in the equilibrium solution. In calculating these quantities, allowance was made for the

change in the volume of the solution as a result of the swelling of the resin. A small correction for the hydrolysis of the salt form of the resins was applied on the basis of the results of trial experiments. The concentration of the acids, up to butyric inclusive, was determined by alkalimetric titration in the presence of phenolphthalein, and the concentration of chloride and iodide in the equilibrium solution by argentimetric titration by Mohr's method; the concentration of fluoride was found colorimetrically⁷. Organic acids from valeric upwards were determined interferometrically in a cuvette 8 mm long. It was established in preliminary experiments that in the concentration range investigated the readings for organic and mineral acids are additive. The concentration of the mineral acid was found in a separate aliquot by determining the anion (by the Mohr titration or colorimetrically) and after subtracting the corresponding reading of the interferometer from the overall reading, the concentration of the organic acid was found. Using butyric acid as an example, satisfactory agreement of the results of the alkalimetric and interferometric methods was demonstrated. The organic acids were purified by distillation at reduced pressure; acids of "chemically pure" grade were used without preliminary purification.

DISCUSSION

The molecular-sorption and ion-exchange isotherms are shown in Figs. 1-3. For all the salt forms of the resin, molecular sorption increases with the length of the hydrocarbon chain and plays the dominant role in the overall process. The ion-exchange isotherms exhibit an unusual feature. For equal equilibrium concentrations, the extent of exchange decreases on going from formic to propionic or butyric acid, in agreement with the variation of the ionisation constants of the acids; however, starting with valeric acid the exchange increases in proportion to the length of the hydrocarbon chain of the acid. The effect of the chain length and the salt form of the anion exchanger on the exchange is illustrated in Fig. 4. The values for octanoic and nonanoic acids were extrapolated by means of Freundlich's adsorption equation, which describes ion-exchange isotherms

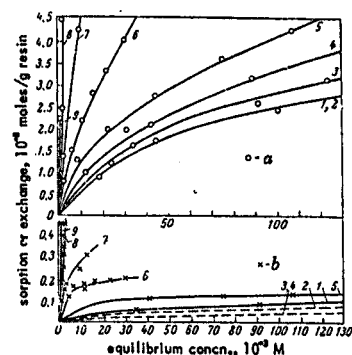


Fig. 1. Molecular-sorption and ion-exchange isotherms on the fluoride form of Dowex-1x2 anion-exchange resin: a) sorption; b) ion exchange; acids: 1) formic; 2) acetic; 3) propionic; 4) butyric; 5) valeric; 6) hexanoic; 7) heptanoic; 8) octanoic; 9) nonanoic.