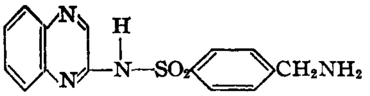
mido derivative of sulfaquinoxaline,[2] [2-(4-homosulfanilamido)-quinoxaline], was carried out.



This compound was synthesized by condensing N⁴-phthaloyl-4-homosulfanilyl chloride[3] with 2-aminoquinoxaline[2] and hydrolyzing the resulting product.

The pharmacological activity of the product was kindly tested by D. Smith and O. Graessle of the Merck Institute. It was found to possess no bacteriostatic activity against *E. coli*, *S. aureus*, *Cl. Welchii* and *D. pneumoniae* Types I and II *in vitro* at concentrations in which marfanil was effective and did not prevent deaths due to *D. pneumoniae* Type I in the mouse when administered subcutaneously or intravenously in doses at which marfanil was slightly active.

Acknowledgment.—The authors are indebted to Dr. R. T. Major for his kind encouragement and advice.

Experimental

2-(N⁴-Phthaloyl-4-homosulfanilamido)-quinoxaline.—A solution of 43.0 g. of N⁴-phthaloyl-4-homosulfanilyl chloride and 16.8 g. of 2-aminoquinoxaline in 100 ml. of dry pyridine was heated on the steam-bath for two hours and then poured into water. The separated gummy material was taken up in 2.5 *N* sodium hydroxide, treated with Norite and filtered. The product was precipitated by acidification with glacial acetic acid, filtered and dried. The crude product weighed 24.7 g., m. p. 235–239° (48% yield).

A sample for analysis was recrystallized from glacial acetic acid, m. p. 246–247°. Calcd. for $C_{23}H_{16}N_4O_4$:[4] N, 12.61. Found: N, 12.90.

2-(4-Homosulfanilamido)-quinoxaline.—The hydrolysis of 26.7 g. of crude 2-(N⁴-phthaloyl-4-homosulfanilamido)-quinoxaline to 2-(4-homosulfanilamido)-quinoxaline was carried out by heating with 8 ml. of hydrazine hydrate (85% in water) in 400 ml. of absolute ethanol for four hours. The solution was then cooled and the resulting precipitate filtered. This precipitate was taken up in 400 ml. of H_2O and 100 ml. of 2.5 *N* hydrochloric acid and heated on the steam-bath for one and a half hours. At the end of this time the solution was filtered. The filtrate was made alkaline with 30% sodium hydroxide, treated with Norite, filtered and acidified with glacial acetic acid. After concentrating the solution to dryness *in vacuo*, the residue (8 g.) was dissolved in 6 *N* ammonium hydroxide, treated with Norite and filtered. The filtrate was boiled until turbid. On cooling, light brown crystals separated; weight 4.8 g., m. p. 228° (25% yield).

A sample for analysis was recrystallized from glacial acetic acid, m. p. 230°. Calcd. for $C_{15}H_{14}N_4O_2S$: C, 57.31; H, 4.49; N, 17.83. Found: C, 57.55; H, 4.32; N, 17.85.

RESEARCH LABORATORIES
MERCK AND CO., INC.
RAHWAY, N. J.

RECEIVED OCTOBER 5, 1945

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[2] Weijlard, Tishler and Erickson, THIS JOURNAL, **66**, 1957 (1944).

[3] Bergeim and Braker, *ibid.*, **66**, 1459 (1944).

[4] Microanalyses were kindly performed by R. H. Boos, J. H. McGregor and E. J. Thornton.

COMMUNICATIONS TO THE EDITOR

PENICILLIN YIELDS FROM NEW MOLD STRAINS

Sir:

Following ultraviolet irradiation of spores from a monoconidial isolate of the well-known strain X-1612 of *Penicillium chrysogenum*, a promising new strain, Wis. Q176, was obtained in June, 1945. This has consistently surpassed its parent in penicillin production, usually by a considerable margin.

In shake flask tests, 77% of the single spore lines from Q176 likewise exceeded X-1612 in yield. The best of these lines was Q176A8; 76% of the single spore lines from this culture also outperformed X-1612, two of them giving yields somewhat greater than any flask yields reported in this communication. Strains Q176 and Q176A8 have also been tested in shake flasks by the Department of Agricultural Bacteriology and a similar increase in yield over X-1612 was obtained.

Table I summarizes results obtained on strains Q176 and Q176A8 in both shake flasks and tanks. The shake flasks were 500-ml. Erlenmeyer flasks with 100 ml. of a medium containing per liter 40 g. of lactose, 20 g. of corn steep liquor solids, 3 g. of $NaNO_3$, 0.5 g. of KH_2PO_4, and 0.25 g. of $MgSO_4 \cdot 7H_2O$. They were incubated in a shaker at 23°. The tank fermentations were made at 23° with 55 gallons of medium in 80-gallon tanks,

TABLE I

PENICILLIN YIELDS ON VARIOUS CULTURES

Expt.	X-1612 units/ml.[a]	Q176 units/ml.	Q176A8 units/ml.
	Shake Flask Fermentations		
1	67	212	...
2	78	115	215
3	94	125	178
4	107	...	129
5	120	155	205
	Tank Fermentations		
1[b]	367[c]	...	337
2	427	728	...
3	501	920	...

[a] *S. aureus* cup assay. [b] A different lot of corn steep liquor was used for each of the tank experiments. [c] Each tank yield figure is the mean yield of duplicate tanks which differed in yield by from 4 to 18%.

agitated by 18-inch propellers running at 270 r. p. m., and aerated at the rate of 200 liters per minute. The medium used contained 4% corn steep liquor solids, 4% lactose, and 1% calcium carbonate.

It will be seen that although shake flask yields varied considerably in every experiment, both Q176 and Q176A8 surpassed X-1612. In the tank tests Q176 gave yields higher than those thus far obtained with any other culture. Q176A8, however, failed to surpass X-1612.

The fundamental studies on variability in *Penicillium notatum* and *P. chrysogenum* of which these strains were a by-product will be reported in detail elsewhere. Upon request, transfers of any of the cultures mentioned in this note will be sent to laboratories engaged in penicillin research or production.

DEPARTMENTS OF BOTANY AND
BIOCHEMISTRY
UNIVERSITY OF WISCONSIN
MADISON, WISCONSIN
M. P. BACKUS[1]
J. F. STAUFFER
M. J. JOHNSON

RECEIVED DECEMBER 7, 1945

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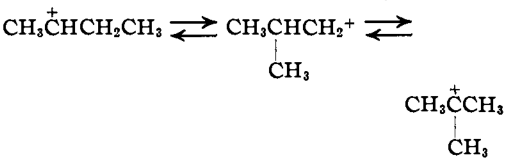
[1] With the assistance of O. H. Calvert, Eugene Dulaney, J. J. Stefaniak, F. B. Gailey and F. G. Jarvis.

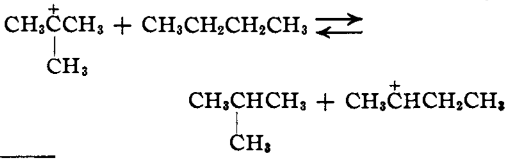
THE MECHANISM OF PARAFFIN ISOMERIZATION

Sir:

It has been shown[1] that under controlled conditions paraffin hydrocarbons do not undergo isomerization in the presence of aluminum halide catalysts unless traces of olefins or their equivalent are present. These results suggest that the isomerization may proceed by a chain mechanism similar to that proposed[2] for the alkylation of isoparaffins with olefins. Thus, it is postulated that isomerization of *n*-butane proceeds by a sequence of reactions which may be expressed as follows in terms of carbonium ions[3] as has been done[4] in the case of alkylation mechanism.

Eq. 1 $$CH_3CH_2CH_2CH_3 + R^+ \xrightarrow[HCl]{AlCl_3} CH_3\overset{+}{C}HCH_2CH_3 + RH$$

Eq. 2 
$$CH_3\overset{+}{C}HCH_2CH_3 \rightleftarrows CH_3\underset{CH_3}{CH}CH_2^+ \rightleftarrows CH_3\underset{CH_3}{\overset{+}{C}}CH_3$$

Eq. 3 
$$CH_3\underset{CH_3}{\overset{+}{C}}CH_3 + CH_3CH_2CH_2CH_3 \rightleftarrows CH_3\underset{CH_3}{CH}CH_3 + CH_3\overset{+}{C}HCH_2CH_3$$

The reaction of Eq. 1 serves only to initiate the chain and the reactant, R^+, need therefore be present in small amount only. The chain initiating ion, R^+, may be produced in several ways. It may be formed by the addition of hydrogen chloride or hydrogen aluminum tetrachloride ($HAlCl_4$, probably the true catalyst) to an olefin which is present in the paraffin as an impurity, or which is added as such, or which results from cracking of the paraffin. It may also be introduced in the form of an alkyl halide.

Dehydrogenation of the paraffin by reaction with the hydrogen chloride or hydrogen aluminum tetrachloride offers yet another means of obtaining the necessary chain-initiating ion:

Eq. 4 $$n\text{-}C_4H_{10} + HCl \xrightarrow[AlCl_3]{} s\text{-}C_4H_9^+ + Cl^- + H_2$$

Experimental evidence in support of this reaction may be found in the observation that minor quantities of hydrogen are actually formed during the initial stages of butane isomerization with a supported aluminum chloride catalyst and hydrogen chloride.[5] The rearrangement of the *s*-butylcarbonium ion (Eq. 2) finds analogy in the rearrangement of olefins in the presence of acidic substances.[6] The reaction of Eq. 3 (as well as that of Eq. 1) is similar to the hydrogen–halogen exchange reaction which occurs when isoparaffins are contacted with *s*- or *t*-alkyl chlorides in the presence of aluminum chloride.[2]

In accordance with the lesser tendency of normal paraffins to undergo the exchange reaction, higher temperature or otherwise more severe reaction conditions are necessary for isomerization of normal paraffins than are required for the alkylation of isoparaffins.

It is evident that the mechanism herein proposed is also applicable to the isomerization of cycloparaffins.

RESEARCH LABORATORIES
UNIVERSAL OIL PRODUCTS COMPANY
RIVERSIDE, ILLINOIS
H. S. BLOCH
HERMAN PINES
LOUIS SCHMERLING

RECEIVED[7] AUGUST 31, 1945

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[1] H. Pines and R. C. Wackher, THIS JOURNAL, **68**, in press (1946).

[2] L. Schmerling, *ibid.*, **66**, 1422 (1944).

[3] In accordance with current theory, carbonium ions are used in this paper as the active equivalent of alkyl halides or of olefins plus hydrogen halide.

[4] P. D. Bartlett, F. E. Condon and A. Schneider, THIS JOURNAL, **66**, 1531 (1944).

[5] H. S. Bloch, unpublished results.

[6] F. C. Whitmore, THIS JOURNAL, **54**, 3274 (1932). See also Egloff, Hulla and Komarewsky "Isomerization of Pure Hydrocarbons," Reinhold Pub. Corp., New York, N. Y., 1942, Chap. II.

[7] Original manuscript received June 7, 1945.

LIGHT-FIELD ULTRAMICROPHOTOGRAPHY OF LYOGELS

Sir:

In a recent publication (*Ind. Eng. Chem.*, **37**, 786 (1945)) we reported on a new microscopic technique with ultra-illumination by incident light resulting in a dark-field effect, which has proved to be of particular value in the study of lyogels.

Since then we have made a great number of color microphotographs of such preparations, using Kodachrome A film. Due to the absence of any grain in the developed film, the color photographs lend themselves very well to considerable enlargement. However, enlarged color prints can so far not be made by the individual, and reproduction of color pictures for periodicals or books is expensive.

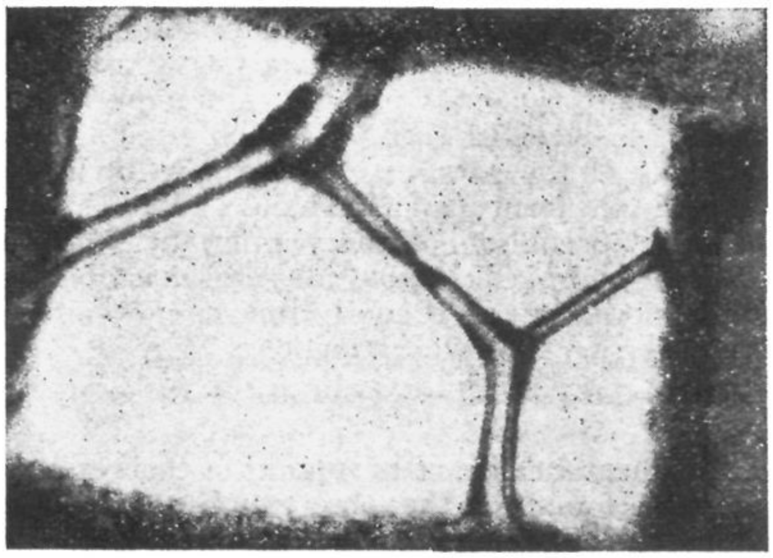


Fig. 1.—GR-S Rubber milled ten minutes, dissolved in benzene. Enlarged print from Kodachrome A film. Magnification is approx. 5000.

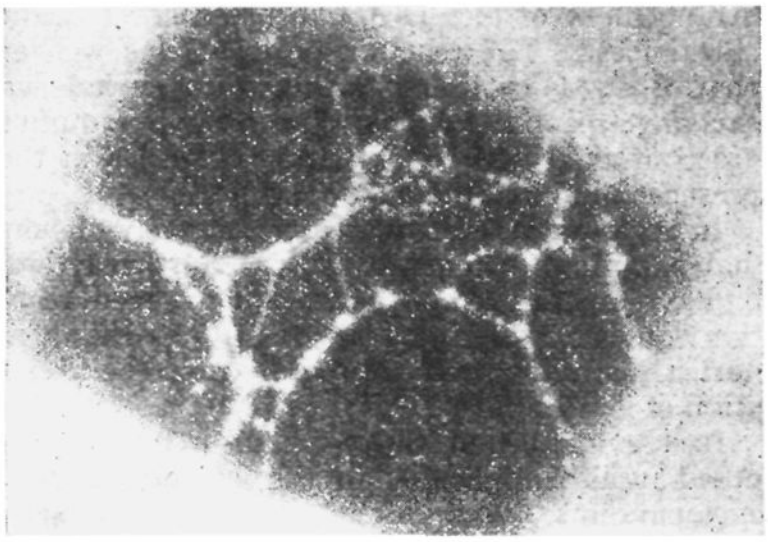


Fig. 2.—Pale crepe milled thirty minutes, dissolved in benzene. Ultra-illumination by incident light. Magnification is approx. 5000.

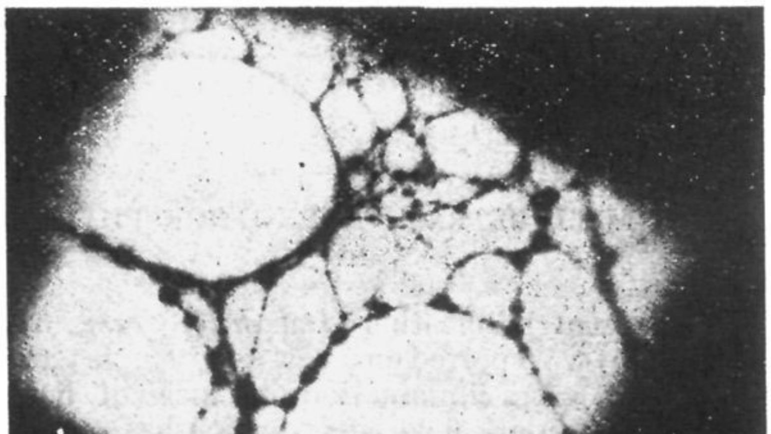


Fig. 3.—Pale crepe milled thirty minutes, dissolved in benzene. Print from positive film. Magnification is approx. 5000.

Since color photographs are definitely superior to regular black and white film for recording fine microstructures, we made enlargements on regular printing paper using the Kodachrome picture as negative. We have termed the so produced positive "light-field ultramicrophotograph," because the result is really a reversed ultramicroscopic effect. Wherever a specific color of the preparation is not the predominant factor in its study, this technique enables one to obtain very satisfactory prints from the color slide. Besides this, the light background generally offers a better contrast.

If no Kodachrome is available or desired and one still wants to benefit by this technique, one can expose the dark-field negative to a film and produce a positive which, if then used for making prints, will again give a light-field background.

The microphotographs are offered as illustrations.

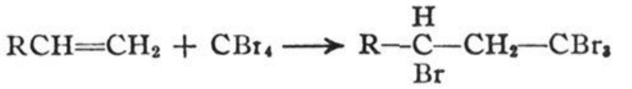
DEPARTMENT OF CHEMICAL ENGINEERING
MASSACHUSETTS INST. OF TECH.
CAMBRIDGE 39, MASS.
ERNST A. HAUSER
DESIREE S. LE BEAU

RECEIVED DECEMBER 12, 1945

ADDITION OF CARBON TETRABROMIDE AND BROMOFORM TO OLEFINS

Sir:

When a mixture of an olefin and carbon tetrabromide is heated at 70–90° in the presence of 1–5 mole per cent. of a diacyl peroxide, the carbon tetrabromide adds to the olefin.



$$RCH{=}CH_2 + CBr_4 \longrightarrow R{-}\overset{H}{\underset{Br}{C}}{-}CH_2{-}CBr_3$$

The mechanism of this type of addition has been discussed in previous papers.[1] However, carbon tetrabromide differs from the halides there mentioned in that its addition is initiated not only by diacyl peroxides but by visible light.

$$CBr_4 \xrightarrow{\text{Light}} Br\cdot + \cdot CBr_3$$

For example, a mixture of octene-1 (56 g.) and carbon tetrabromide (600 g.) was heated to 75° for seven hours in an apparatus illuminated internally by a mercury-filled coil coated with a fluorescent material so that it gave a white light.[2] Distillation of the reaction mixture yielded a product (196 g. = 88% on the basis of the octene-1 used) which boiled at 127° (0.02 mm.). The substance was 1,1,1,3-tetrabromo-*n*-nonane (n^{20}_D 1.5488).

Anal. Calcd. for $C_9H_{16}Br_4$: Br, 72.1; mol. wt., 444. Found: Br, 72.8; mol. wt., 441.

Excellent yields of the same substance were also obtained when a similar mixture of octene-1 and carbon tetrabromide was heated to 80° in the pres-

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[1] Kharasch, Jensen and Urry, *Science*, **102**, 128 (1945); Kharasch, Urry and Jensen, THIS JOURNAL, **67**, 1626 (1945); Kharasch, Jensen and Urry, *ibid.*, **67**, 1864 (1945).

[2] Carbon tetrachloride, phosphorus trichloride and a number of other substances add to olefins when mixtures of olefins with these halides are exposed to ultraviolet light.

ence of acetyl peroxide (1–5 mole per cent.). Carbon tetrabromide and ethylene (in the light) gave 1,1,1,3-tetrabromopropane ($n^{20}\text{D}$ 1.6090), b. p. 65–68° (0.3 mm.).

Anal. Calcd. for $C_3H_4Br_4$: Br, 90.0. Found: Br, 89.8.

It is significant that in every case studied only the mono addition product of carbon tetrabromide to the olefin was formed; there was practically none of the product which would be formed by the addition of two or more molecules of the olefin to one molecule of carbon tetrabromide (*cf.* ref. 1). The mono addition product was formed even when the olefin contained an aromatic radical. Thus, when a mixture of styrene and carbon tetrabromide (dissolved in carbon tetrachloride) was illuminated, a nearly quantitative yield of 1,1,1,3-tetrabromo-3-phenylpropane was obtained (b. p. 123°(0.1 mm.); m. p. 57–59°).[3]

Anal. Calcd. for $C_9H_8Br_4$: Br, 73.4; mol. wt., 436. Found: Br, 73.3; mol. wt., 451.

Bromoform reacts extremely slowly with olefins when illuminated in the manner indicated. The yield of addition product was only 1% at the end of twelve hours. However, a nearly quantitative yield of the mono addition product was obtained when a mixture of octene-1 and bromoform was heated at 80° in the presence of a small amount of acetyl peroxide (1–5 mole per cent.). The product was a tribromo-*n*-nonane (b. p. 99–102° (0.3 mm.), $n^{20}\text{D}$ 1.5178), the structure of which has not been definitely established.

Anal. Calcd. for $C_9H_{17}Br_3$: Br, 65.8; mol. wt., 365. Found: Br, 65.1; mol. wt., 361.

The unusual behavior of the tetrahalogenated methanes containing at least one bromine atom, in yielding exclusively one-to-one addition products with olefins, is readily explained by the mechanism suggested in our previous papers.[1]

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[3] Hydrolysis of this compound with hydrochloric acid and a small amount of cuprous chloride gave cinnamic acid. The acid thus obtained did not depress the melting point of an authentic sample of cinnamic acid.

GEORGE HERBERT JONES LABORATORY M. S. KHARASCH
UNIVERSITY OF CHICAGO ELWOOD V. JENSEN
CHICAGO, ILLINOIS W. H. URRY

RECEIVED NOVEMBER 23, 1945

ELECTRONIC PROCESSES IN LIQUID DIELECTRIC MEDIA. THE PROPERTIES OF METAL-AMMONIA SOLUTIONS

Sir:

New experimental results appear significant in the elucidation of the properties of dilute liquid ammonia solutions of alkali and alkaline earth metals. Extremely dilute sodium solutions (some 10^{-5} molar) observed in the temperature range -35 to $-75°$ displayed a marked increase in electrical conductivity upon irradiation with visible light. It is particularly important that the quantum efficiency of this photoconductivity is an inverse function of the concentration of the solution. This fact renders the effect experimentally observable with reasonable light intensities only at the low concentrations employed.

Dilatometric measurements (at constant temperature), in which sodium was extracted from dilute solutions by metallic mercury, indicated a volume change amounting to some 700 cc. per mole of solute (temperature $-35°$, concentration of solutions some 3×10^{-3} molar). That is, the dissolving of metallic sodium under these conditions results in an expansion nearly thirty times as great as the volume of the solid metal sample.

The close parallelism of the above photoconductivity experiments to those of Hilsch and Pohl[1] dealing with solid solutions of alkali metals in alkali halide crystals suggests a mechanistic explanation similar to that commonly accepted[1] for the latter case. Whereas in ionic crystals the electrons are trapped at vacant negative ion sites, giving "F centers," in the solutions in question they are trapped in cavities which they have "dug" in the solvent. That these cavities are relatively enormous (of the order of 7×10^{-8} cm. in radius) is indicated by the very great expansion attendant upon dissolving the metal to form highly dilute solutions. The bodily mobility of such huge ions would be negligible, but thermal or photoexcitation may raise the trapped electrons to the conduction band. The mobility of a conduction electron would appear to be limited by "redigging" its cavity and by capture in a cavity containing a trapped electron, forming a pair analogous to the "F' centers" of Hilsch and Pohl. The importance of this latter process is indicated by the above inverse dependence of the photoeffect upon concentration.

Considerations of quantum mechanics lend theoretical support to the above model. These considerations, which visualize the electron trapped in a spherical cavity, lead to the following results: (1) the ground state of the system is an "S" state of total energy -0.21 volt (-4800 cal./mole) in a cavity of radius 7.6×10^{-8} cm. (1100 cc./mole); (2) all other states are unstable; (3) photoconductivity follows a transition from the ground state to the lowest "P" state; (4) *two* electrons trapped in the same cavity are appreciably stable with respect to either two electrons in separate cavities or one trapped and one conducting electron. The absorption spectrum and magnetic susceptibility of metal ammonia solutions are in at least qualitative agreement with these calculations which will be described in detail later.

DEPARTMENT OF CHEMISTRY
STANFORD UNIVERSITY
STANFORD UNIV., CALIF. RICHARD A. OGG, JR.

RECEIVED DECEMBER 19, 1945

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[1] For literature references, see N. F. Mott and R. W. Gurney, "Electronic Processes in Ionic Crystals," Oxford Press, New York, N. Y., 1940.

TRIALKYLSILYL SULFATES

Sir:

Treatment of a concentrated sulfuric acid solution of a hexa-alkyldisiloxane with ammonium chloride or fluoride gives the trialkylchlorosilane or the corresponding fluoro compound.[1] During a study of the mechanism of this reaction we have obtained two trialkylsilyl sulfates, the first examples of sulfuric acid esters of silanols.

The trialkylsilyl sulfates are obtained by the action of fuming sulfuric acid on hexa-alkyldisiloxanes. Concentrated sulfuric acid

$$R_3SiOSiR_3 \xrightarrow{SO_3} (R_3Si)_2SO_4$$

gives a much lower yield.

Hexamethyldisiloxane, 100 g., 0.62 mole, was added slowly with cooling and vigorous agitation to 85 g. of fuming sulfuric acid containing 20% SO_3. The cold solution was extracted with six 100-cc. portions of dry pentane. After removal of the solvent under reduced pressure, the liquid residue changed on cooling to a mass of white crystals. Treatment of the sulfuric acid layer with water gave a recovery of 26% of the disiloxane used. The filtered sulfate, m. p. 56–58°, weighed 76 g., 69% yield based on unrecovered disiloxane. The sulfate must be handled in a dry atmosphere as it fumes vigorously in ordinary air. Treatment with water gave hexamethyldisiloxane. Titration of the sulfate with standard alkali gave a neutral equivalent of 117; calcd. 121. Carbon was determined by wet combustion with dichromate, sulfuric acid and silver chromate.

Anal. Calcd. for $C_6H_{18}Si_2SO_4$: Si, 23.1; SO_4, 39.6; C, 29.6. Found: Si, 22.7; SO_4, 40.4; C, 29.7.

Triethylsilyl sulfate, b. p. 170° at 12 mm., $n^{20}D$ 1.4442, was prepared similarly. With water it gave the original disiloxane and sulfuric acid.

Anal. Calcd. for $C_{12}H_{30}Si_2SO_4$: Si, 17.2; SO_4, 29.4; neut. equiv., 163. Found: Si, 17.2; SO_4, 29.5; neut. equiv., 166.

We thank R. N. Walter of this Laboratory for the analyses reported in this Communication.

[1] *Cf.* Flood, THIS JOURNAL, **55**, 1735 (1933).

DEPARTMENT OF CHEMISTRY
THE PENNSYLVANIA STATE COLLEGE
STATE COLLEGE, PENNA.

L. H. SOMMER
E. W. PIETRUSZA
G. T. KERR
F. C. WHITMORE

RECEIVED NOVEMBER 16, 1945

DETERMINATION OF THE ACTIVITIES OF SEVERAL COEXISTING IONS BY THE GIBBS-DONNAN EQUILIBRIUM WITHOUT THE USE OF SPECIFIC ELECTRODES

Sir:

The electrometric determination of the activities of ions for which specific electrodes do not exist has recently become possible in solutions of single electrolytes by the use of "membrane electrodes."[1,2] Heretofore, however, the activities of several coexisting species of ions of the same sign in solution could be determined unequivocally only if specific electrodes, which are lacking for many common ions, could be used. Attempts to overcome this difficulty indirectly have been only indifferently successful.

I should like to point out that the Gibbs–Donnan membrane equilibrium principle permits a solution of this problem in a general manner by consideration of the ion distribution *ann* of the membrane potential.

Membranes of extreme ionic selectivity[1,2,3] make the new method widely applicable, permitting the measurement of membrane equilibria under particularly favorable conditions with speed and accuracy.[2,4,5] It is however not exclusively restricted to these simple conditions.

A solution I contains the anions R^- and NO_3^-, and the cations K^+, Na^+ and NH_4^+, the activities of which $(a_{K^+})_I$, $(a_{Na^+})_I$ and $(a_{NH_4^+})_I$ have to be determined. A "permselective" membrane permeable to all cations and impermeable to all anions[1,2,3,5] separates solution I from a KCl solution II of known concentration. Solution II is isoösmotic with I, or is made isoösmotic by the addition of non-diffusible non-electrolyte.[6] The volume of I is made infinitely larger than that of II so that the composition of I is not changed significantly after equilibration with II.

After the system is equilibrated the membrane potential E is measured and solution II analyzed. The final state of the system is

$$\overset{\text{I}}{[K^+]_I[Na^+]_I[NH_4^+]_I[R^-]_I[NO_3^-]_I} \Big\| \overset{\text{II}}{[K^+]_{II}[Na^+]_{II}[NH_4^+]_{II}[Cl^-]_{II}}$$

The activities of the cations in II $(a_{K^+})_{II}$, $(a_{Na^+})_{II}$ and $(a_{NH_4^+})_{II}$ are calculated from the known analytical concentrations according to the Debye–Hückel theory.

The Gibbs–Donnan theorem postulates for the ion distribution

$$\frac{(a_{K^+})_I}{(a_{K^+})_{II}} = \frac{(a_{Na^+})_I}{(a_{Na^+})_{II}} = \frac{(a_{NH_4^+})_I}{(a_{NH_4^+})_{II}} \qquad (1)$$

and for the membrane potential

$$E = \frac{RT}{F}\ln\frac{(a_{K^+})_I}{(a_{K^+})_{II}} = \frac{RT}{F}\ln\frac{(a_{Na^+})_I}{(a_{Na^+})_{II}} = \\ = \frac{RT}{F}\ln\frac{(a_{NH_4^+})_I}{(a_{NH_4^+})_{II}} \qquad (2)$$

The unknown activities of the cations in solution I $(a_{K^+})_I$, $(a_{Na^+})_I$ and $(a_{NH_4^+})_I$ can be evaluated from equation (2).

The new method should be of particular interest in colloid chemistry and physiology.

DEPARTMENT OF PHYSIOLOGY
UNIVERSITY OF MINNESOTA
MINNEAPOLIS 14, MINNESOTA

KARL SOLLNER

RECEIVED DECEMBER 6, 1945

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[1] K. Sollner, THIS JOURNAL, **65**, 2260 (1943).

[2] H. Gregor, Ph.D. Thesis, Minneapolis, 1945.

[3] K. Sollner, *J. Phys. Chem.*, **49**, 47, 171 (1945).

[4] K. Sollner, *ibid.*, **49**, 265 (1945).

[5] K. Sollner and H. Gregor, THIS JOURNAL, **67**, 346 (1945).

[6] This precaution is actually unnecessary; cation exchange equilibrium is reached without significant osmotic water movement.[5]