Two New Chemical Plant Growth Substances

BENZOYL oxide and benzoyl peroxide, as I have found, can now be added to the list of chemicals which act on plant growth like the natural hormone, auxin. Benzoyl oxide, when applied in lanoline at concentration 1 in 200 to ten dark-grown decapitated oat coleoptiles along one side, caused negative curves the mean of which was 50° after 4¼ hours at 19° C. The peroxide applied similarly caused negative curves the mean of which was 31°. Thus both substances accelerated growth strongly. At 1 in 2,000 in lanoline, the benzoyl oxide caused slight negative curves of about 5°, and comparison with the curves caused by very dilute hetero-auxin in lanoline showed that the activity of benzoyl oxide is very roughly equal to 1/400 of that of hetero-auxin. The oxide keeps well in lanoline, but the peroxide loses its activity in a few hours.

The results seem of interest since first, benzoic acid is quite inactive, and secondly, the benzoyl oxide and peroxide are scarcely soluble, if at all, in water. In spite of this, the oxide is not only active, but also is even transported downwards in coleoptiles, though much less rapidly than hetero-auxin. For when it was applied in lanoline near the tops of coleoptiles on one side, the curves extended for about 5 mm. below the lanoline after 5½ hours at 19° C. Carotene also, as Lazar[1] has shown, though insoluble in water, can produce effects which are distant from the part to which it is applied in plants.

I am indebted to Dr. E. Hope for help and advice concerning the substances tested.

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Mém. Soc. Roy. Sci. Liége, (4), **1**, fasc. 2–3 (1936).

Alkaloids from *Arundo Donax* L.

DONAXINE[1], $C_{11}H_{14}N_2$, is according to von Euler, Erdtman and Hellström[2], identical with gramine from certain strains of barley, and according to a paper by Th. Wieland and Chi Yi Hsing[3], to which my attention has just been directed, gramine has the constitution of β-dimethylaminomethyl-indole, $(CH_3)_2NCH_2.C_8H_6N$.

I have for some time been engaged in the study of the alkaloids of *Arundo Donax* L. from the shores of the Mediterranean, and find that, by joint action of alcoholic potassium hydroxide and methyl iodide in the cold, donaxine furnishes tetramethylammonium iodide and a (methoxy methyl)-indole; with ethyl iodide an (ethoxy methyl)-indole results and presumably also dimethyldiethyl ammonium iodide.

Besides donaxine, I have obtained a crystalline alkaloid, $C_{13}H_{15}O_2N_2$, and an amorphous phenolic base; both are indole derivatives. Their relationship to donaxine is being investigated.

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[1] Orechoff and Norkina, *Ber.*, **68**, 436 (1935).
[2] *Ber.*, **69**, 743 (1936).
[3] *Annalen*, **526**, 188 (1936).

Viscosity of Binary Mixtures

IN a recent communication[1], Mr. A. J. A. van der Wyk has presented a new formula for the calculation of viscosity of binary mixtures. I would point out that this problem has already been fully solved in two ways. On the base of thermodynamical considerations, the formula[2]

$$\log \eta = m_1 \log \eta_1 + m_2 \log \eta_2 - \int \frac{q_m}{4{\cdot}57T^2} \quad . \quad . \quad . \quad (1)$$

has been found, where η denotes the viscosity of the mixtures, m_1, η_1, m_2 and η_2 the mole fractions and viscosities of the two components, T the absolute temperature and q_m the molecular heat of solution. The latter may be also considered as the total change in energy caused by the interaction of both components. This change in the energy being rather difficult to determine experimentally, another method[3] based on the association of the molecules has been chosen. It has been found that the simple formula of Arrhenius

$$\log \eta = n_1 \log \eta_1 + n_2 \log \eta_2 \quad . \quad . \quad . \quad . \quad (2)$$

gives quite satisfactory results (as must be the case for 'ideal mixtures' where no change in energy takes place), when for the calculation of mole fractions the *physical* molecular weights instead of the *chemical* molecular weights are taken into consideration. If S denotes the number of molecules of the component 2, which in the mixture are associated, the equations

$$n_1 = \frac{m_1}{m_1 + m_2.S} \text{ and } n_2 = \frac{m_2.S}{m_1 + m_2.S} \quad . \quad . \quad . \quad (3)$$

must hold. (In the quoted paper S has been defined as "degree of solvation"; it is better defined as "degree of association".)

It has been shown in the above-mentioned paper that the value S may be calculated from the experimental data in a very simple manner, for it is easy to show that

$$n_1 = \frac{\log \eta - \log \eta_2}{\log \eta_1 - \log \eta_2}.$$

In previous papers the fitness of the above-mentioned formulæ has been shown for quite a number of examples. It will be perhaps sufficient to show it now on the mixture chosen by Mr. van der Wyk, that is, the system benzylbenzoate-toluene. The results calculated on the basis of the equation (2), where for S the value of 1·197 has been found, are shown in the accompanying table:

Viscosity of mixtures of benzylbenzoate and toluene. (S=1,197)

m_1	n_1	η obs. (K. and M.)	η calc. (equ. (2))	Difference per cent
0	0	0·552	0·552	0
0·2367	0·2785	1·183	1·154	− 2·4
0·4261	0·4762	2·015	1·993	− 1·1
0·6502	0·6948	3·614	3·624	+ 0·3
0·7890	0·8208	5·080	5·104	+ 0·5
0·9002	0·9170	6·660	6·707	+ 0·7
1	1	8·450	8·450	0

The results agree with at least the same accuracy as the data found on the base of the complicated formula of Mr. van der Wyk. Besides, every constant used has a definite physical meaning. Further, with the aid of the equation (1) it is possible to determine also the relationship between viscosity and temperature which is missing in van der Wyk's formula. This relationship shows that the formula of Arrhenius holds better at higher temperatures according to the