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EDITORIAL

"The Crystalline State"

MESSRS. G. BELL & SONS, LTD. have published the first volume of "The Crystalline State," edited by Sir William H. Bragg and Prof. W. L. Bragg; particulars of it will be found in our list of publications received on page 1002. It is intended that this important work shall be issued in three volumes of which the first, which we are now considering, is a general introduction written by Prof. W. L. Bragg; the second and third volumes will be written by Sir William and Prof. W. L. Bragg assisted by a number of experts and will give an account in detail of the theory and technique of X-ray analysis and the light thrown on crystal physics and crystal chemistry by it.

The first volume is written in the lucid style associated with the name of Bragg and gives a general account of the arrangements in space of the ions or atoms that make up solid bodies. This arrangement in space has been established for an immense number of elements and compounds partly by purely chemical methods extending over a period of about sixty years and partly by physical methods, such as X-ray analysis, extending over a period of about twenty years. The volume does not deal with that branch of stereochemistry that is usually associated with optically active substances and the asymmetric carbon atom, but it covers a great deal of ground, and we think that a careful study of this volume throws more light on the nature of chemical substances than is easily obtained elsewhere. Solid bodies are all formed by the aggregation of minute particles and whether these are called ions or atoms seems to some of us a matter of comparative indifference; prior to their aggregation these particles were free to move and were usually separated by greater distances than they are in the solid state. If we consider the solidification of a pure metal from its molten state we get an example of a simple type of aggregation, a mere close-packing which may take place in more than one manner. If the molten metal contains a percentage of a second metal a modification, or several modifications, will take place as the atoms attract each other and fix their attractions and we may get as the result those solid solutions or alloys that in some respects seem to be intermediates between elements and compounds; they are not abnormal bodies but the normal ones; it is the pure substances that are abnormal in the laboratory and in nature. So too we find the pure crystals, the mixed crystals, and the aggregates of metallic salts with water

of crystallization and these require special consideration. When a solid body is formed by crystallization, precipitation, or otherwise, the atoms concerned do not usually form molecules but, according to the relative number of them and their own characteristics, they range themselves in a regular sequence that is repeated indefinitely in all directions until the limits of the crystal, fibre, or other aggregate are reached. For a long time it was the duty of the chemist to trace the arrangement of atoms in a molecule; the worker in X-rays, with the accurate guidance so often given him by the chemist, has determined the spatial arrangement in hundreds of crystals, alloys, colloids, and other bodies and Prof. Bragg's volume explains exactly how the determination is effected.

X-Rays, as is well known, are produced when a stream of electrons strikes a solid body; they were discovered by Röntgen in 1895, and Laue, in 1912 was the first to obtain a photographic record of the X-ray diffraction pattern of a crystal. Very shortly afterwards Prof. W. L. Bragg, then studying at Cambridge, was advised by Prof. W. J. Pope to investigate photographs of crystals of KCl and NaCl. He did this and was able to deduce the mathematical formulæ necessary for the interpretation of the results; these were the first crystals to be properly analysed by X-ray methods. Since then many crystals have been investigated and Sir William Bragg and his son have been conspicuous workers in this field. X-Ray analysis has been extended to powders, hairs, wires, fibres, cellulose, alloys, steel rails, and a host of other substances and the main principles of these investigations have been explained and illustrated in this volume. In the case of many simple molecules the attractions between the component atoms can usually be conveniently represented by the straight lines familiar to us in structural formulae. In many liquids and in most solids such valency bonds are inappropriate and we must picture to ourselves a number of atoms arranged in a pattern or lattice and held together in equilibrium as the result of the various electrical attractions; it would seem that it is unnecessary and perhaps misleading to denote a solid body like naphthalene by an arrangement of hexagons composed of single and double bonds. These mutual attractions, like the social and other attractions that bind together the members of a committee or council towards one common end, are too complicated to be denoted by a few hyphens. When we see the diagrams of spatial arrangements and of close-packing in this volume we understand much more fully

the nature of those small changes in equilibrium that are so important in explaining allotropy, tautomerism, and the alternate formulae for sugars with which we are all familiar. No one can read through this volume or even spend three or four hours perusing it without obtaining a clearer picture of chemical constitution and chemical change and without hoping that the second and third volumes will be as fascinating and useful as the first.

Natural Colouring Matters

Last September Prof. R. Kuhn of Heidelberg read at the British Association a paper on Natural Colouring Matters related to Vitamins that we think has not hitherto been published and at last appears in this issue. It contains an account of the numerous colouring matters of plants chemically related to vitamins and includes some quite recent work so that it is a convenient and important summary of researches of considerable interest. The colours of plants belong to several classes; the chlorophylls have been studied for many years; so have the tannins; the red colouring matters of rhubarb stalks and beet roots are still being investigated, and the great group of anthocyanins that provide the colours of the delphinium and many other gay flowers have been isolated and synthesized by numerous workers amongst whom Prof. Robinson of Oxford is conspicuous. The paper by Prof. Kuhn deals with a group of red, orange, and yellow pigments familiar to us all and of physiological importance because of their relationship to vitamins and enzymes. Carotene, the red colouring matter of carrots, and lycopene, the red colouring matter of tomatoes, are both hydrocarbons containing forty carbon atoms. Closely allied compounds also containing forty carbon atoms, and many hydrogen atoms and a few oxygen atoms form the yellow pigments found in the yolk of the egg, the yellow maize, the buttercup, the yellow pansy, and the dandelion. The carbon skeleton of these pigments is derived from the union of two molecules of phytol containing twenty carbon atoms and phytol is known to be a constituent of chlorophyll so that it now appears that a great proportion of the green and yellow colours of our common herbs are variations derived from one common type. Other pigments similarly derived are mentioned by Prof. Kuhn and the total number is probably large. The various derivatives are not exclusively pigments for the well-known violet scent, ionone, is an oxidation product of carotene. Moreover the pigments of the capsicum and the lobster are probably allied to phytol and those who are curious in these matters will find in Prof. Kuhn's article references where further information can be obtained. It is not surprising that there should be so many pigments in nature derived from so few fundamental types. Man found out that from benzene he could prepare naphthalene and anthracene and by adding on benzene rings, and methyl groups, and other groups he could make practically all the hues of the rainbow; this art has become easy to him and he does not seek methods for making green dyes out of turpentine or vaseline. So Nature, if we may so personify the automatic chemical control of living organisms,

has found it easy to prepare phytol, $C_{40}H_{78}OH$, and carotene, $C_{40}H_{56}$, and scores of their derivatives. When the conditions of temperature and so forth are propitious the fundamental molecule forms more readily than any other and we should perhaps marvel, not that there is one so common type but that there are so many scores of varieties of it. If the pigment of the buttercup were the only pigment the plant could make our pastures and meadows would indeed be glorious but most monotonous.

As to the flavines, the other topic of Prof. Kuhn's paper, there is much less information. These substances are quite new, having been isolated at Heidelberg only this year. Some of them are yellow pigments; they are all soluble in water, which the carotenes are not. They are very widely distributed in plants and animals but in quite small quantities, like titanium in rocks. The few that have been isolated contain many carbon atoms, many hydrogen, and a few nitrogen and oxygen atoms. They have been isolated from yeast, milk, the white of egg, and meat, and are probably contained in all substances in which vitamin- B_2 is found, e.g., meat, milk, spinach, cabbage, and bananas. The flavine or yellow pigments in egg-white and whey are probably identical and in the crystalline state constitute the most active preparation of vitamin- B_2 hitherto obtained. The yellow enzyme contained in yeast on irradiation produces a yellow pigment that seems to be identical with the pigment obtained by irradiation of the flavine obtained from the white of egg. It seems that the yellow flavine, identical with vitamin- B_2 , readily forms the yellow enzyme of yeast and we suppose that further investigations will very likely add to our knowledge both of the vitamin and the enzyme. We have seldom published a paper of so much chemical, biochemical, and physiological interest as this. Not merely does it collect in one place information hitherto squandered in many journals; it brings us nearer to exact knowledge of the vitamins, now familiar acquaintances, and the enzymes, more elusive and less easy to understand, and probably more charming. The vitamins have become so universally known that it is no longer a distinction to be on good terms with them. Calciferol can be readily obtained and we have on our table some crystalline vitamin-C, ascorbic acid, prepared by the British Drug Houses and to be obtained, we suppose, at any druggist's shop we care to visit. Personally we have not yet required any ascorbic drugs, though in bygone days we might have been familiarly described in terms we should modernize as a scorbutic knave; whether it is the orange juice that we occasionally take that has kept off scurvy we do not know; in any case there is a demand for vitamin-C, and there is now a supply of it. A few years ago this would have appeared to be a very improbable thing, but it now provokes no surprise; we pay a little tribute to the enterprise of the manufacturers, and return to consider the enzymes now about to cross the threshold from their dim obscurity into the brilliant light of scientific knowledge. Enzymes are now in the position that vitamins were a few years ago. We trust that the labours of Prof. Kuhn and his associates, and of other chemists in other countries, will soon give us a closer acquaintance with them.

ON NATURAL COLOURING MATTERS RELATED TO VITAMINS: CAROTENES AND FLAVINES

By PROF. R. KUHN

Lecture delivered on Sept. 7, 1933, before Section B of the British Association for the Advancement of Science at Leicester

At the request of Prof. R. Robinson, to whom I am greatly indebted for his kind invitation, I propose to speak about certain natural colouring matters related to vitamins, namely, the carotenes and the flavines.

I. CAROTENES AND CAROTENOIDS

The common peculiarity of constitution, which determines the colour of carotenoids, is the regular sequence of singly and doubly bound carbon atoms in open chain. Hydrocarbons of this kind (polyenes) were at first prepared by me and A. Winterstein¹ in the laboratory 6 years ago. The investigation of the carotene pigments, whose chemical nature was at that time completely unknown, has since made considerable progress, to which important contributions have been made by Prof. L. Zechmeister and by Prof. P. Karrer and their pupils. These researches became of special importance when Prof. H. v. Euler established that carotene promotes growth in rats receiving a diet deficient in vitamin-A. T. Moore has shown that carotene is converted into vitamin-A in the animal's body.

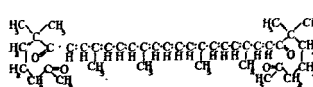
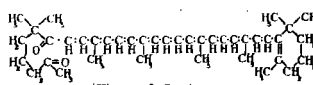
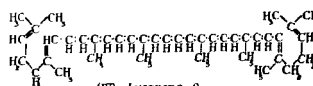
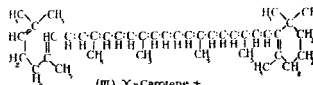
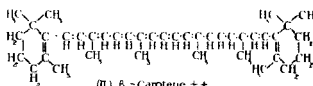
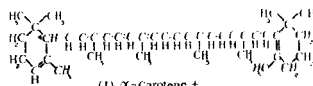
The investigations of R. Willstätter had shown that carotene,² the colouring matter of carrots, and lycopene³ that of the tomato, are hydrocarbons with 40 carbon atoms. The formulae correspond to C₄₀H₅₆. In addition the hydroxyl-containing xanthophylls such as the lutein⁴ of egg-yolk C₄₀H₅₆O₂, which is widely distributed in plants,⁵ and the fucoxanthine⁶ of brown alga C₄₀H₅₆O₃ also contain 40 carbon atoms. In recent years the following xanthophylls have been added to this series: zeaxanthine C₄₀H₅₆O₂ from yellow maize,⁷ flavoxanthine C₄₀H₅₆O₃ from *ranunculus acer*,⁸ violaxanthine C₄₀H₅₆O₄ from yellow pansies,⁹ taraxanthine C₄₀H₅₆O₄ from dandelions¹⁰ and rhodoxanthine, a diketone C₄₀H₅₆O₂ from the ripe seeds of the yew.¹¹

This number, 40, the number of carbon atoms in all these colouring matters, is important in plant biology, since it became known that the carbon skeleton is simply related to that of phytol C₂₀H₃₈OH, one of the constituents of chlorophyll, discovered by R. Willstätter¹² and synthesized, after determination of its constitution,¹³ by F. Gottwalt Fischer.¹⁴ The assumption made by P. Karrer,¹⁵ that the carbon skeleton of the carotene pigments is formed by symmetrical combination of 2 phytol skeletons is proved conclusively in the case of lycopene by Ch. Gründmann¹⁶ in my laboratory and is probable in the case of other carotene pigments.

However it is not proved that carotene pigments actually arise from phytol (chlorophyll). If plucked green fruit, e.g., physalis, tomatoes, are allowed to ripen artificially the amount of carotene pigment formed is

very much greater than the amount which could be produced from the quantity of phytol already present in the form of chlorophyll.¹⁷

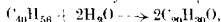
From ordinary carotene 2 new hydrocarbons, α-carotene¹⁸ (about 15%) and γ-carotene¹⁹ (0.1%) have been isolated in collaboration with E. Lederer and with H. Brockmann. β-carotene which predominates occurs frequently alone in nature. Very extended experiments



+ means biologically active, θ means inactive on rats deficient in vitamin-A

I have carried out with Dr. Brockmann at Heidelberg and with Prof. A. Scheunert and Dr. M. Schieblich of Leipzig on rats deficient in vitamin-A have shown that α-, β-, and γ-carotene have qualitatively identical actions on growth, xerophthalmia, kolpokeratosis, and sexual

ole²⁰ Quantitatively, however, β -carotene is about 100 times as active as α - and γ -carotene. In curative experiments 2.5×10^{-6} g. of β -carotene are sufficient for normal growth, while of α - and γ -carotene about $< 10^{-6}$ g. per day are necessary for the same effect.²¹ According to the above formulae of the carotenes, which are at present the most probable but not yet proved,²² and according to the formula of vitamin-A, finally established by P. Karrer,²³ our results indicate that in the animal body 2 mol. of vitamin-A are formed from 1 mol. of the symmetrical β -carotene:

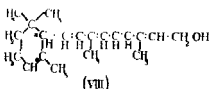
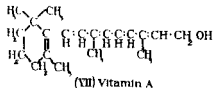


and only 1 molecule of vitamin-A from the unsymmetrical α - and γ -carotene.

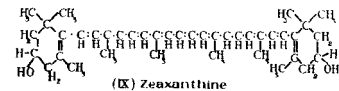
So far present 6 different provitamins-A of the carotene type are known: the 3 natural occurring carotenes, which the names α -, β -, and γ - have been given, and artificial products derived from β -carotene, namely, *oxy*-carotene²⁴ β -carotene-oxide²⁵, and semi- β -carotene.²⁶

The common peculiarity of constitution, which determines the biological activity, consists in the rings of onone type attached to a chain of at least 4 conjugated double bonds, as they occur in vitamin-A (VII).

With α -carotene it is probable that as well as the own vitamin-A an isomeric form (VIII), related to onone, is formed.²⁷ This, however, has not yet been proved. According to the definitely lower biological activity of α -carotene (this form of vitamin-A is expected to have a lower or even no activity, or to be produced much slower in the animal's body).



Contrary to some statements in literature the xanthophylls mentioned above, e.g., zeaxanthine, (IX) cannot promote growth in animals deficient in vitamin-A, but anthophyll recently discovered²⁸ and called kryptothine which contains only one OH-group, $C_{40}H_{56}O$, has been found to be active.[†]

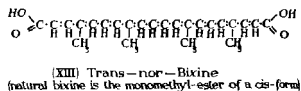
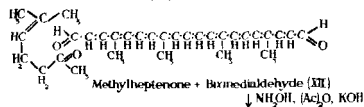
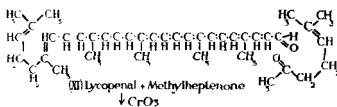
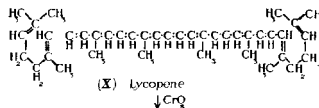


As well as the carotene pigments with 40 carbon atoms a number of carotenoids with fewer carbon atoms have been found in nature, among these being the

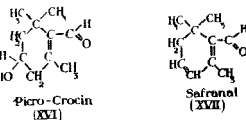
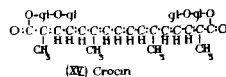
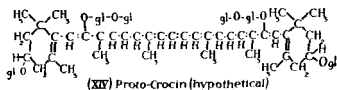
The biological effects observed with dihydro-carotenes and tetra-hydroles are apparently caused by the carotenes themselves, which are regenerated in the animal's body; compare the bibliographical list at end of article.

Added on Nov. 25.

pigments of bixa seeds (bixin), of saffron (crocetin), and of the roots of eschobedia (azafarin). According to the determination of constitution of these carotenoid carboxylic acids, they appear to be decomposition products of carotene pigments with 40 carbon atoms. Together with Ch. Grundmann²⁹ lycopene with 11 carbon atoms has been converted into bixin with 24 carbon atoms by removing 8 carbon atoms from each end of the chain in the form of methylheptenone. This was effected by means of chromic acid:



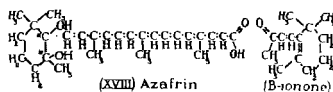
Together with crocetin the colourless bitter-tasting picrocrocin³⁰ occurs in saffron. Picrocrocin is the glucoside of a terpene aldehyde safranal with 10 carbon atoms, the constitution of which corresponds according to an investigation with A. Winterstein³¹ to the carbon rings of the carotene pigments, especially the xanthophylls (cf. zeaxanthine IX).



The pigment of saffron appears to be the central portion of the hypothetical picrocrocin, while the

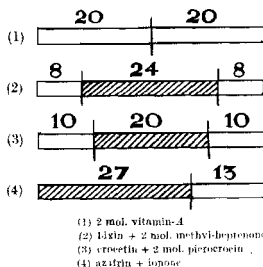
picrocrocine comes from the terminal ring systems. experimentally 1.4 mol. of picrocrocine have been found together with 1 mol. of crocetin in fresh saffron. Saffranal, which is formed by splitting off glucose from picrocrocine, has a strong characteristic odour.

For azafurin with 27 carbon atoms A. Deutch and ¹³² have proved a formula corresponding to the following scheme:



The fragment with 13 carbon atoms, which has not yet been isolated, might be the ionone $C_{13}H_{20}O$, the centred substance of violets, which is formed by atmospheric oxidation of carotenes.

These researches clearly give us a simple and expressive picture of the formation in nature of carotenoid-acarboxylic acids and related compounds. One realizes now on the one hand vitamin-A in the animal body can be formed by hydrolytic cleavage of the carotenes and how on the other hand by oxidative cleavage in plants not only new substances notable for their colour but also substances notable for their characteristic taste and smell are formed:



Coloured substances marked by [//////]

Other carotenoids containing fewer than 40 carbon atoms are the capsanthine from paprika, isolated by Zechmeister and L. v. Cholnoky³⁵ and the astaxanthin from the colouring matters of the lobster and other crustaceans, which has been isolated with E. Lederer.³⁴ The composition of these is not yet completely known, but it is probable that these too are formed by oxidative decomposition processes, similar to those described.

II. FLAVINES

A second group of natural colouring matters, related to vitamins, is that of the flavines.³⁵ The first pigments of this group have been isolated this year at Heidelberg in collaboration with Prof. P. György and Priv.-Doz. Dr. Th. Wagner-Jauregg. The flavines are widely distributed in nature, but occur only in very small concentrations. They contain nitrogen and are soluble in water. Therefore they have also been called lyo-

chromes³⁶ in contrast to the fat-soluble lipochromes (carotenoids).

Distribution in nature.—According to the investigations with P. György and Th. Wagner-Jauregg the distribution of flavines in animals and plants is closely related to that of vitamin-B₂. This vitamin was discovered in 1926 by J. Goldberger³⁷ as a thermostable part of vitamin-B. It has been related to pellagra in man, but in our experimental rats we have only very infrequently observed alterations in skin and fur. B₂-deficiency is manifested chiefly by inhibition of growth in young animals. The unit of vitamin-B₂ is defined as that amount which produces in 30 days a gain in weight of 40 grams. According to our experiments, which are largely in agreement with previous statements,³⁸ 1 unit of vitamin-B₂ is contained in the following amounts of various animal- and plant-products:

	Daily dose gr.
Liver (beef)	0.2-0.4
Kidney (beef)	0.2-0.4
Heart (beef)	0.5
Yeast	0.5
Stomach (mouse's memb.)	1.0
Muscle (chicken leg)	1.5
Muscle (chicken breast)	3.0
Muscle (beef)	2.0-3.0
Egg-white	2.5-5.0
Cows' milk	3.0-5.0
Human milk	10-20
Spinach	3-5
Cabbage (green leaves)	5
Cabbage (stoluted)	10
Bananas	5

A similar series holds for the distribution of the flavines

ISOLATION

For the isolation we first used as raw material yeast, heart, and liver, later egg-white and whey from cows' milk. It was known that vitamin-B₂ is easily adsorbed by fuller's earth in acid solution,³⁸ but no means of elution were known. We found that this could easily be done by the use of pyridine.³⁹ By precipitation of colourless materials with methyl-alcohol and acetone one obtains beautiful yellow solutions, which fluoresce green and have high vitamin activity. Further purification was effected with picric acid and preparation of the silver salts. In this way we obtained preparations which crystallized from 2N-acetic acid in beautiful orange brown needles. From 50 kg. of dried egg-albumin* we obtained after 3 recrystallizations 50 mg. ovoid flavine⁴⁰ and from 3000 litres of cows' milk 60 mg. lacto flavine.⁴¹

Properties.—The composition of the pigments isolated from egg-white and whey corresponds approximately to the formula $C_{17}H_{20}N_2O_6$. They agree also in melting point, 270° and 271° respectively, and in crystalline form. The absorption-spectra of ovoid flavine and lacto flavine are practically identical (Fig. 1). With acetic anhydride in pyridine solution one obtains well crystallized chloroform-soluble tetra-acetyl-compounds m.p. 242°, which give no depression of melting point when

* About 17,000 eggs.
 † The probable error is ±1C and ±2H.

mixed. It follows that the colouring matters of whey and egg-white are probably identical.

Flavines are easily decolorized by heating with alkalis. In this reaction lactoflavine yields a urea (0.3 mole) which was identified as a dixanthyl-compound m.p. and mixed m.p. 270° . Since no reaction occurs with nitrous acid, it follows that ureido-groups NH-CO-NH_2 and guanidino-groups NH-C-NH-NH_2 are absent and that the urea is formed from a group -NH-CO-NH- probably belonging to a ring system. The two other nitrogen atoms seem to be tertiary and correlated with the conjugated double bonds, which determine the colour. Some of the oxygen atoms belong to hydroxyl-groups and take up acetyl. This part of the molecule is split off by irradiation. On elimination

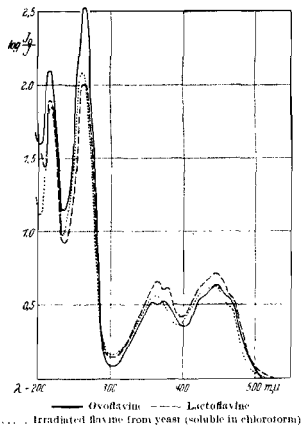


FIG. 1

Absorption spectra of flavines

of the hydrophilic hydroxy-groups by irradiation or acetylation chloroform-soluble flavine derivatives are formed.

VITAMIN ACTIVITY

Crystallized lactoflavine, when tested by administration to rats receiving the basal diet of A. Bourquin and H. C. Sherman⁴² was at first completely inactive even in doses of 50×10^{-6} g. per day. In spite of this one had to assume some relationship between the pigment and the vitamin, since we observed that vitamin- B_2 is exceedingly sensitive to light.³⁵ It is destroyed by blue and violet light even after filtering off the ultra-violet (Fig. 2).

Hence it appeared probable that vitamin- B_2 is a yellow colouring matter, which absorbs blue and violet light. We then found⁴³ that the basal diet of A. Bourquin and H. C. Sherman is deficient in vitamin- B_2 . If the diet is completed by the addition of this vitamin, which

was discovered by Miss V. Reader⁴⁴ at Oxford, then lactoflavine has a strong effect on growth even in doses of 5×10^{-6} g. per day (Fig. 3).

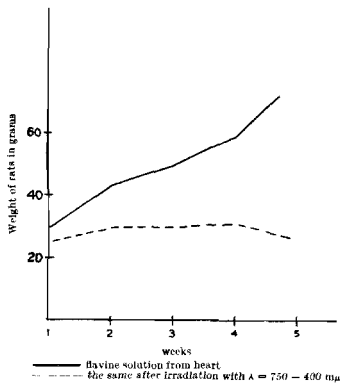


FIG. 2

Destruction of vitamin- B_2 by visible light

Crystallized lactoflavine is therefore the most active preparation of vitamin- B_2 hitherto obtained.^{41,43} Whether the biological activity is due to the pigment itself

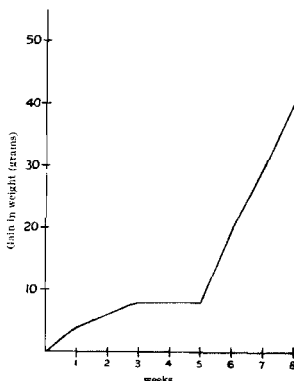


FIG. 3

Growth effect with 7.5×10^{-6} g. lactoflavine per day

should be further investigated. For the present we can say that the vitamin activity remains not only after repeated crystallizations but also after purification by

regeneration of the chloroform-soluble acetyl-compound and regeneration of the lactoflavine from this.

Comparison of lyochromes and lipochromes.—Besides carotenes the flavines also now appear as exogenous pigments, which are necessary for the life of mammals and must be present in the animals' food. In many respects the properties of the two classes of pigments appear to be complementary.⁴¹

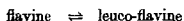
	Lyochromes	Lipochromes
colour	yellow, orange	yellow, orange, red
fluorescence	green (very strong)	yellow-green (very weak)
composition	containing nitrogen	nitrogen-free
solubility	soluble in water	insoluble in water
acids	resistant	labile
alkalis	labile	resistant
oxidation	resistant	labile
related to	vitamin-B ₂	vitamin-A
effective dose p.d.	5 × 10 ⁻⁸ g. lactoflavine	5 × 10 ⁻⁸ g. α- or γ-carotene 2.5 × 10 ⁻⁸ g. β-carotene.

Relation to enzymes.—According to recent investigations of O. Warburg and W. Christian⁴⁵ a yellow oxidation-enzyme occurs in yeast. This enzyme, together with a second colourless enzyme and a co-enzyme, is capable of oxidizing hexose-monophosphoric acid. By irradiation in alkaline solution O. Warburg and W. Christian⁴⁶ have obtained crystals of a chloroform-soluble pigment. This has the composition C₃₂H₁₂N₄O₂. It is remarkable that we have obtained apparently the same pigment by irradiation of ovoidlavine. The chloroform-soluble pigment has no more vitamin activity.

Our observations suggest for the first time a reversible relationship between a vitamin and an enzyme. One may imagine that vitamin-B₂ is the exogenous precursor of the yellow oxidation-enzyme. The formation of the enzyme is supposed to occur by combination of the flavine with a colloidal-carrier. In this connexion it is very remarkable that we have observed an excellent increase in growth of animals deficient in vitamin-B₂, which have been given well dialyzed preparations of the yellow enzyme.⁴⁷ Therefore there exist not only free vitamin-B₂, which dialyzed easily, but also vitamin-B₂ attached to carriers of high molecular weight, which cannot be dialyzed—just as in the case of the flavines. The relationship, which has been established, can be seen from the following table:

	Dialysate water	Soluble in CHCl ₃	Activity as vitamin	Activity as enzyme
1. Flavo-proteins				
Flavo-poly-saccharides	—	+	—	+
2. Flavines	+	+	—	+
3. Irradiated flavines	+	+	+	—

Flavines as biological hydrogen acceptors.—Flavines are reduced to colourless leuco-flavines by sodium hydro-sulphite in neutral or weakly alkaline solution or by hydrogen in presence of platinum. The pigments are re-formed by shaking with air. There exists a reversible equilibrium:



This characteristic behaviour was first observed by O. Warburg and W. Christian in the case of the yellow enzyme from yeast. This takes up hydrogen from hexose-monophosphoric acid with formation of the leuco-enzyme, which then gives up the hydrogen to molecular oxygen with formation of hydrogen peroxide and the original pigment. The enzyme solution becomes inactive on heating, since the yellow prosthetic group is split off and may be removed by dialysis.

Th. Wagner-Jauregg and H. Ruska⁴⁸ have recently established that our thermostable crystalline flavine pigments also act as biological hydrogen acceptors. They succeeded in preparing enzyme solutions from liver and yeast, which in presence of suitable substrates and in absence of oxygen can decolorize ovoidlavine and lactoflavine. The original colour immediately reappears when air is admitted. So it is apparent that these natural colouring matters act as oxygen-carriers.

A great variety of substrates have proved suitable, e.g., lactic acid, pyruvic acid, succinic acid, different aldehydes, hexose-mono-phosphoric acid etc. The measurements were made in Thunberg tubes. The time necessary for decolorization was with enzyme + lactoflavine more than 4 hours, but in presence of the substrates mentioned above 15–30 minutes were sufficient.

With respect to the biological mode of action it follows that the flavines are not only of importance as prosthetic groups and precursors of the yellow enzyme, but that they can act themselves as hydrogen acceptors, in other words, as intermediate substances in cell respiration. These conclusions, according to my previous remarks, can be applied unchanged to vitamin-B₂, the mode of action of which is now more easily understood.

The enzymatic hydrogenation of lactic acid, pyruvic acid, succinic acid, etc. is strikingly similar to the enzymatic hydrogenation of methylene blue, a reaction which for many years has been the subject of biochemical investigations. One may be justified in calling the flavines the "methylene blue of living cells."

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BRITISH CHEMICAL STONWARE

By G. N. HODSON

Paper read at a joint meeting of the Bristol Section and the Chemical Engineering Group of the Society on December 7

The manufacture of British chemical stoneware is an old industry: the potter Wedgwood in the middle of the 18th century developed a body for mortars and pestles, which has not been bettered to this day. Apart, however, from this example of a great potter's skill, the development of stoneware making in this country has proceeded rather slowly.

Until the commencement of the Great War, much of the stoneware used in this country was imported from abroad, from countries where co-operation between makers of stoneware and the chemical industry had resulted in a more highly developed product. Naturally, the stoppage of supplies and the demand for stoneware in the explosives industry consequent upon war considerably stimulated its production. The evils of unpreparedness were also made manifest in the poor qualities of some of the ware produced during the war period.

Recent research and experiment have resulted in British stoneware of a quality greatly superior to that available only a few years ago.

COMPOSITION OF STONWARE

Stoneware is a clay substance; a complex aluminium silicate. It usually contains an excess of silica and is therefore definitely acid in character. There is often considerable confusion on the difference implied by the terms earthenware and stoneware. The difference is one of vitrification or melting. An easy rough division can

be made by the porosity of the bodies, also, a good stoneware will break with a conchoidal or glasslike fracture. The term earthenware embraces all clay bodies of considerable porosity, which have to be covered by glaze to make them water-tight. This term covers everything from peasant pottery to fine white earthenware plates, cups, and saucers, having a porosity unglazed of from 15% to 25%.

Stoneware is formed when a clay body partially melt during firing, consequently the pores which are present in earthenware are filled up with molten silicates. The fluxing process is accomplished by an increase in the firing temperature of the ware, and the addition of calcium, sodium, or potassium compounds to form silicates of lower melting point. Thus a body which may be earthenware at one temperature becomes stoneware at a higher temperature. The degree to which this melting has occurred determines the quality and porosity of the ware. Naturally the closer the ware approaches to a molten mass the more care is necessary to keep the shape from warping and twisting in the kiln during burning and cooling.

There is no definite line of demarcation between earthenware and stoneware, but a good chemical stoneware will probably have a porosity lower than 2% with the best ware considerably lower than this. In fact, the best stoneware very closely approaches porcelain, with a porosity in the region of 0.1% to 0.3%.

It is also more nearly akin to porcelain than to earthenware in its chemical and physical properties.

Porcelain is made from a clay which is whiter than that used in stoneware. The fluxing process is a little more complete, but articles can only be made of limited size. Porcelain can usually be distinguished by the fact that it is translucent in section when thinner than $\frac{1}{4}$ in., as, for example, a tea cup.

From the point of view of porosity, between the low-porosity stonewares and the porous earthenwares, come a variety of clay products which are used in the chemical industry. Fireclay products and refractory materials for high temperature work, with porosities of 10% to 25%, also sanitary stoneware or earthenware pipes, with porosities of 5% to 15%, are among these.

Porosity is very important in many chemical processes. The theory that any vessel made of clay, covered with a good glaze, is suitable for acid conditions, has in the past, caused, and still causes, the loss of time and money to those who apply it. Commercially produced glazes invariably contain some blemishes or "pin-holes," and through these, the liquor passes into a porous body, and eventually makes its presence unpleasantly felt on the outside. On a good stoneware the glaze merely acts as a smooth finish, the body of the vessel is vitreous and dense, and there are no pores through which the liquor can pass. Thus a stoneware is not dependent upon its glaze for acid-resistance, whilst an earthenware is so dependent.

MANUFACTURE OF STONWARE

A short description of the processes involved in the manufacture of stoneware will aid the user to achieve a better understanding of the properties of the finished product.

Its raw materials are a mixture of clays to give the requisite final properties and a certain amount of "grog." This "grog" is a carefully graded fired clay. It acts as a reinforcement during manufacture and firing, lessening the shrinkage and twisting. These components are ground together and carefully graded, after which water is added to make a plastic mass. It is largely upon the care and scientific control of the raw materials and of their admixture that the production of high-grade ware is dependent.

Meanwhile, if a new shape is to be produced, a plaster-of-Paris model, identical in shape but about 12% larger all round than the finished article, is made in accordance with working drawings. A reverse mould, also in the same material, formed in sections to allow easy removal, is then made from the model. This mould is taken along to the pressing shop, where it is lined to the required thickness by pressing in the prepared clay, which at this stage is a stiff paste. The mould lined with clay is allowed to stand for some time. Part of the water in the clay is absorbed by the plaster and the clay becomes stiff enough to hold its own weight without sagging. The mould is now stripped off and the clay vessel allowed carefully to dry, to remove the water, which amounted to about 20% of its original weight.

During this drying, a linear shrinkage of about 6% takes place in the clay shape, and as the tensile strength

of the clay at this period is sometimes as low as 25 and never more than 100 lb. per sq. in., care is necessary to prevent uneven drying and consequent fracture of the body, especially in the production of vessels of large size containing a considerable weight of clay.

The drying period takes from a day or so up to a fortnight, according to the size and shape of the article.

Such articles as pipes are not made in moulds, but are extruded through a die of the required shape by an auger machine. Apart from this point their treatment in drying is the same as for moulded goods.

Two methods of glazing are used: (a) glaze materials applied before burning and (b) salt-glazing. For the first method a thin coating of glaze material is painted over the dry body where necessary. The glaze is a mixture of materials containing calcium, sodium, or potassium oxides, and silica which, at the high temperature reached during firing, fuse to a glass-like material,



STONWARE FILTER (CHICALAK TYPE)

knitting to the body of the stonewares. The other method of glaze application extensively used is to throw common salt on the fires when the stoneware is at 1100° C. or 1200° C. The salt vaporizes and forms fusible silicates with the body of the ware in the kiln.

After the application of the glaze by the first method above the white-dry ware is placed in a kiln, an arched firebrick structure, usually not greater than 25 ft. long and 15 ft. wide, heated by fires round the outside.

The ware is gradually heated up, and at about 500° C. the raw body begins permanently to change, and the water in combination with the clay is driven off. Any carbonaceous matter present is removed about 700° C., and at 1100° C. the fluxes present begin to melt and attack the less fusible silicates. During this process a further shrinkage of about 6% takes place, and when the temperature of 1100° C. is reached the glaze fluxes and covers the ware. The finishing temperature is dependent upon the degree of vitrification or melting required to

produce a satisfactory body, and usually lies between 1200° C. and 1350° C. After reaching the maximum temperature the kiln is allowed to cool slowly to ordinary temperature. The firing process, from loading the kiln to the removal of the ware, occupies a fortnight, and for every ton of stoneware produced approximately two tons of coal are burned.

The stoneware is now finished and ready for despatch, unless it has to be machined for special work, or has to be fitted with taps or plugs. Stoneware can be ground and machined like a metal to accurate dimensions after firing. Taps and plugs are made a little oversize, being ground down with carborundum powder and water to fit tightly into tanks and vessels. Conical-flanged pipes are ground to size at the ends, whilst shafts and sleeves for stoneware pumps and fans are turned down to size and polished.

PHYSICAL PROPERTIES OF STONEWARE

Stoneware is not a definite and fixed chemical compound, but a highly complex mixture governed not merely by the original composition of its ingredients, but also by the time, temperature, and conditions of the firing to which it is subjected. Consequently the physical properties of the ware vary considerably.

The properties of the average wares produced commercially are set out below:

Specific gravity	2.4—2.8
Porosity (i.e., volume of pore space per unit volume of material)	2%—0.5%
Tensile strength (lb. per sq. in.)	1200—1800
Compression strength (lb. per sq. in.)	60,000—80,000
Coefficient of expansion (per °C.)	4—6 × 10 ⁻⁶
Thermal conductivity (gm. cal. per sec., per cm. cube, per °C.)	0.003—0.0045

These figures show the properties met with in a wide range of the normal wares, suitable for production in large pieces. For stoneware to be made in small sizes and for particular conditions, different, and in some cases rather more spectacular, figures can be obtained, but I have endeavoured in this list to keep to those bodies suitable for manufacture in the large sizes for clay wares, which are associated with the name of chemical stoneware in the mind of the average user.

Owing to the rigid control of materials and mixings in the modern British chemical stoneware factories, the physical properties of the various grades can be held constant to a high degree of accuracy. Two figures will give some idea of the progress in British chemical stoneware in the past ten years. In the material composing a 200-gal. tank made ten years ago, I have found a porosity of 8% and a tensile strength of 1000 lb. per sq. in. Modern figures for such a vessel would be 0.5% and 1800 lb. per sq. in.

Cleanliness in use, caused by the smooth surface of the glaze and the lack of corrosion are the most important attributes of stoneware, and there is no contamination of the product by the container. This facility for cleaning is particularly useful in the dyeing industry, enabling one container to be used successfully for several colours, without fear of contamination.

I would like to emphasize the physical strength of stoneware in suitable shapes. Any reasonable care will ensure complete freedom from breakage.

Hydrofluoric acid in strong solution attacks chemical stoneware, but all other industrial acids have practically no effect upon the ware.

RESISTANCE TO HEAT CHANGES

Stoneware, which in course of manufacture has been subjected to a temperature between 1100° and 1300° C., will, of course, withstand any of the lower temperatures usually found in the chemical industry. In common with all ceramic materials, stoneware has a low coefficient of heat conductivity, consequently it is the rate of change of temperature and the difference in temperature throughout the vessel which are important. Apart from the composition of the body, the size and shape of the stoneware article are factors influencing the resistance to heat changes. A small vessel heats up more readily and evenly than one of large dimensions, and consequently offers greater resistance to heat changes.



STONEWARE CONDENSING COIL

Circular vessels are always stronger than rectangular ones, and for high temperatures all sharp angles should be avoided. Varying thicknesses of and abrupt changes in the wall size of stoneware vessels are also unsuitable for high-temperature work.

Method of heating stoneware vessels.—(1) Direct flame heating is unsuitable for all but the smallest vessels unless great care is taken to apply the flame very gradually and so heat up the ware evenly. The writer has known stoneware tubes to be successfully used at a temperature of 600° C. by this method.

(2) Heating by hot gases is used for coppers and stills. Provided reasonable care is used to heat slowly and evenly, this method is suitable for all sizes of vessels.

(3) Heating in a sand or water bath is another method ensuring even heating of coppers and evaporating dishes. This method is in use for stoneware vessels heated to more than 200° C.

(4) Heating of the liquor in the vessel by steam coil or by live steam is extensively used. Live steam, however, should not impinge directly on to the stoneware, thus avoiding local heating, and some kind of steam denser to prevent chattering and vibration is useful. Rectangular stoneware tanks about 6 ft. long, 3 ft. wide, and 3 ft. deep, extensively used in the bleaching and dyeing industries, are heated by this method to a temperature of 60° C. from cold in about half-an-hour. When the heating of a large stoneware tank is done from inside, a certain amount of lagging and insulation on the outside both conserves the heat and by protecting the vessel from cold draughts, lowers the temperature gradient between inside and outside.

To summarize the conditions under which various articles of stoneware will give satisfactory results:

(a) Small vessels below about 30 gal. will stand boiling water suddenly poured into them.

(b) Pipes and other small stoneware articles, condensing coils, if made in a good grade of heat-resisting stoneware, can be used under normal conditions of working for temperatures up to 150° C. without any fear of cracking.

(c) Larger vessels, if heated more slowly, and if protected from sudden chilling on the outside, are quite suitable for boiling liquors. With vessels of 200 to 300 gal. capacity, several hours should be occupied over the heating.

In general, to obtain the maximum resistance to thermal shock, stoneware vessels must be carefully designed, and should not be thick and clumsy. Conditions of temperature should always be specified when dealing with stoneware.

SOME NOTES ON THE USES OF STONWARE

A. Stoneware pipes.—These are normally used in standard lengths of 1 m. or yard. There are three types of piping in general use, namely:

(i) Spigot and socket piping.—The joints in these pipes are made either with an acid-proof silicate cement

pipe. The joint is then flexible enough to take up heat expansion, which is very small. There should be at least one hanger or support for each length of pipe, preferably



180-GAL. VACUUM VESSEL

near the socket, and on long vertical pipe lines the superimposed weight should be carried by a bracket under the socket every 10 ft. or so.

(ii) *Conical flanged piping.*—Such joints are designed for higher pressures than socket and spigot piping. The conical flanges are ground to a flat surface after firing. They are used with rubber or asbestos washers between the ground faces and are held together by metal collars bearing on the conical ends of the pipe. A soft asbestos or rubber packing strip should be used between the stoneware and the metal collar, and care should be taken to screw up the couplings evenly. Hangers and supports should be distributed as for spigot and socket pipes. Plain stoneware flanges drilled and bolted together are not suitable for stoneware pipes.

(iii) *Armoured stoneware piping.*—This piping is suitable for high temperatures and pressures. Stoneware pipes armoured with cast-iron jackets are used. These are jointed with rubber or asbestos rings and are bolted together through the iron flanges.

B. Taps and cocks.—These are fitted to suit the various types of piping. In addition stoneware block cocks are used, bolted to iron or lead pipe-lines, where a non-corroding cock is required. The plugs of stoneware cocks are ground to each individual barrel after firing, and are tested with a hydraulic pressure of at least 60 lb. per sq. in. Where a considerable head of liquid is above



BOLTED-UP SECTION OF CONICAL FLANGED PIPE-LINE, SHOWING METAL COUPLINGS

or a mastic poured in hot. An asbestos ring should be placed in the bottom of the socket to prevent the molten mastic running into the pipe, and the spigot end should not actually touch the bottom of the socket of the next

the tap, metal clamps of some kind should be used to prevent the tap rising and lifting out. Vaseline or a suitable lubricant should be smeared over the plug before use, and tap bodies should always be kept clean. If in a position exposed to accidental damage, a frame or guard round the tap is advisable. When treated with reasonable care, stoneware taps and cocks have an almost indefinite life.

C. Tanks and vessels.—The limit to the economic size of stoneware tanks and vessels made in one piece, is in the region of 600 to 700 gal. in the circular types, and 7 or 8 ft. long with rectangular tanks. The manufacturing difficulties above these sizes increase the price very considerably.

For conditions where shape of container is immaterial, circular vessels, which are stronger than the rectangular tanks, are preferable. The strongest shape in stoneware vessels is the closed jar, used for the storage of acid in bulk.

For pharmaceutical, foodstuff, bleaching and dyeing, and other industries where cleanliness is essential, vessels of white stoneware covered with a bright white glaze are used. The advantages of a container on which every speck of dirt can be seen and which can be kept clean by rubbing over with a damp cloth, are obvious.

D. Tile linings.—For the lining of existing vats or for sizes larger than can be supplied in one piece, stoneware tiles set in acid-proof cement are used. The mixtures used in these cements are numerous, although sodium silicate or mastic form the base of most of them.

Two or even three rows of tiles are sometimes employed, arranged so as to break the joint in every direction.

E. Coppers, stills, turbines, condensing coils.—The only point in connexion with these is the method of heating, which I have dealt with already.

F. Condensation and absorption towers.—These are built up in sections, usually 3 to 4 ft. in length and up to 5 ft. in diameter. The methods of jointing are similar to those of smaller pipes. The ceramic materials used in packing are small stoneware rings, usually 1 in. diameter and 1 in. long. These rings are piled in at random and give a free space of 70% to 75%, and exposed surface of 60 sq. ft., and have a weight of 40 lb. per cu. ft. Larger plain or spiral rings are stacked upright.

G. Fans, exhausters, pumps.—Stoneware is used extensively for fans and pumps dealing with corrosive liquors and gases.

CONCLUSION

The merits of stoneware are its complete freedom from corrosion under almost all chemical conditions, its cleanliness and its low cost compared with other materials or combination of materials having the same acid resistance.

A committee set up by the British Standards Institution is at present engaged upon the definition of the properties of chemical stoneware and the standardization of sockets and flanges. It is to be hoped that the work of this committee will, by a reduction in the multiplicity of sizes now existing, facilitate the production of standard

designs, and so pave the way to a wider appreciation of the merits of stoneware.

Comparing the position 10 years ago with that existing to-day, we find that the manufacture of British stoneware has increased by 600%, whilst foreign imports are now only 20% of those in 1923; a fact which gives some practical expression of the value of the endeavours of the British manufacturers to improve their product.

I have tried in this paper to give some idea of the conditions under which stoneware can successfully be used. Co-operation, closer than has hitherto operated, between user and manufacturer is essential if causes of needless failure are to be eradicated. Under these conditions British chemical stoneware will fill a need widely felt in the chemical industry.

THE USE OF CELLOPHANE IN THE DETERMINATION OF HUMIDITY

An article of considerable interest on this subject, by E. Schweitzer, appeared in *Die Naturwissenschaften* of November 3, 1933. A fundamental property of cellophane is its permeability to water vapour. It is suggested that in many factories where a knowledge of the degree of humidity is required for the efficient working of a process, and the ordinary hygrometer is rapidly corroded, or rendered useless by dust, the instrument might be enclosed in a cellophane sheath. The latter allows water vapour to get through very quickly, but will keep out all dust and corroding vapours. Experiments are quoted which show that hygrometers enclosed in cellophane give the same readings as those not so protected.

Cellophane is also hygroscopic: if the relative humidity is changed from 60% to 61% it increases in weight by 0.2%. For constant relative humidity the increase in weight is not affected by change of temperature between 5° and 60°. Since it is thin, and permeable to water, cellophane reacts very quickly to changes in humidity, and is therefore suitable for making weight hygrometers, especially if it has been previously "aged" by exposure to varying degrees of humidity. It can also be impregnated with cobalt chloride and is then an excellent "weather prophet," turning blue in dry and pink in damp weather. This change takes place much more quickly than with ordinary cobalt paper, and cellophane can be used with scientific precision by determining the limits of absorption of ultra-violet light of the material impregnated with cobalt chloride.

Cellophane alters in length on exposure to dampness. Use can be made of this change in a portable hygrometer, the extension of a strip of the material being measured. The strength of the material also varies with humidity, and by determining the pressure required to burst a cellophane membrane and the curvature that results from such pressure, it is possible to compare humidities if the same specimen of cellophane is used for such comparison.

Cellophane is also of use in standardizing hygrometers. In hygrometers using salt solutions the section into which the solution is introduced can be separated from the rest by a cellophane sheet, which is permeable to the water vapour, but which prevents the salt from getting through.

SOCIETY OF CHEMICAL INDUSTRY

OFFICIAL NOTICES

Plastics Group. Change in place and time of meeting. Members and others interested are requested to note that Mr. Foster Sproxtton's paper on "Celluloid and Casein Plastics" will be held in the Council Room of the Federation of British Industries, 21, Tothill Street, Westminster, at 7.30 p.m., and not at Burlington House at the earlier hour previously published.

The recent postal census of opinions of members has disclosed a heavy majority in favour of holding the London meetings at 7.30 p.m. in future, and in changing the time of this meeting the committee is giving expression to that majority wish.

Subscriptions, 1934. It will assist the work of the Accounts Department, which is very heavy in the early year, if members will remit their dues for 1934 as soon as possible.

Resignations. Any member wishing to terminate his membership must give notice in writing to the General Secretary before December 31. It is hoped that members who may have considered resignation will give careful thought to the heavy financial commitments of the Society and continue their membership in support of the essential work for which the Society is responsible.

MANCHESTER SECTION

At a meeting of the Manchester Section of the Society, which was held at the Engineers' Club, Manchester, on December 1, under the chairmanship of Dr. A. Schedler, Prof. I. M. Heilbron, D.S.O., F.R.S., delivered an address on "The Chemistry of Certain Physiologically Active Natural Products."

Prof. Heilbron dealt in the first place with the structure of carotinoid pigments, and explained the methods whereby the various carotene isomerides and their oxygen derivatives had been isolated and their structures determined in the Zurich and the Heidelberg laboratories.

Turning to the problem of vitamin-A, the lecturer pointed out that, as first demonstrated by Steenbock, a distinct parallelism appeared to exist between the carotinoid content of plants and vitamin-A activity, and that the effect of this had for some time hindered advance in this field. It was only after von Euler and his collaborators had demonstrated that carotene itself possesses vitamin activity and Moore had shown that the yellow pigment passes in the animal liver into the colourless vitamin that the stage was set for a final attack on the problem of the antixerophthalmic factor of animal liver oils.

Prof. Heilbron next described the methods by means of which concentrates rich in vitamin-A had been prepared from halibut liver oil and the nearly pure

vitamin finally obtained by methods depending, on the one hand, on adsorption on alumina as also by distillation in high vacuum. He also described how spectrographic analysis had successfully been applied in following the concentration of the vitamin.

The lecturer next dealt with the question of the structure of vitamin-D (calciferol) and of ergosterol, and pointed out the relationship of these compounds to the oestrus hormone, the structure of which had been so successfully elucidated.

Turning to the water-soluble vitamins, a description was given of the method of isolation of ascorbic acid (vitamin-C), while the recent brilliant synthesis of this substance in the University of Birmingham was examined in detail.

Prof. Heilbron concluded his lecture with the description of Kögl's work on the plant hormone, auxin. During the course of his address Prof. Heilbron laid special stress on the importance of modern laboratory technique as a method of approach to the isolation of such physiologically active substances as are present in Nature in only minute amount. In this connexion he mentioned the valuable information which is obtained by spectrographic and X-ray analysis, as also by the recent development of the Tswett adsorption method and microanalysis.

MONTREAL SECTION

The monthly meeting of the Montreal Section of the Society was held on November 8 in the Windsor Hotel, when over two hundred attended: ninety-five members were present at the dinner which preceded the meeting. The chairman of the Section, Mr. R. A. Witherspoon, presided and introduced Dr. J. Langmuir, chief research chemist, General Electric Co., Schenectady, who presented a paper on "Monomolecular Oil Films and Oil Lenses on Water," in the course of which he said:

A small amount of an oily material like oleic acid placed on a clean surface of water spreads over the water in a thin film. The extent of this film can be observed by dusting talc powder over the surface. The oil film may be held within barriers formed by the parallel sides of a tray and movable paper strips placed across the tray and the area of the oil film may then be accurately measured. In order to obtain a film which will be limited in area, only a minute amount of oleic acid must be used. This may be obtained by applying a few drops of a dilute solution of oleic acid in some volatile solvent. The solvent evaporates, leaving a small but measured weight of oleic acid in the form of a film on the surface of the water. Using Avogadro's number to calculate the number of molecules in the oleic acid used and assuming the film is only one molecule thick it is then a simple arithmetical calculation to obtain the area occupied by each molecule on the surface of the water and the third dimension of the molecule is equal to the thickness of the film. For a large number of fatty acids, independent of the length of the carbon chain, the area per molecule was found to be the same value, i.e., 20.5×10^{-16} sq. cm. This has led to the idea that the molecules of such substances in monomolecular films are actually straight chains which are orientated so that all of them stand up

vertically from the surface of the water, held up in this position by the presence of their neighbours.

Pure paraffin hydrocarbon oils do not spread out to form thin films on water and the ability to spread on water, possessed by fatty acids, esters, ketones, etc., is believed to be due to the presence of the characteristic polar group in the molecule which is attracted by the water and held by it. N. K. Adam, by confining oil films between movable barriers, has been able to measure the force required to compress the film from the original area it assumes when spread on water to some smaller area. If too much force is applied the film crumples up and becomes no longer monomolecular.

Acids such as stearic acid form films on water which are almost non-compressible and the film thus resembles a solid. Such acids at slightly elevated temperatures and spread on very dilute hydrochloric acid behave in a manner analogous to a liquid. They contract measurably as force is applied and appear gradually to crystallize out into a solid film which suffers only slight contraction in area under applied pressure before crumpling up.

To explain the larger area occupied by the molecules of fatty acid films at these elevated temperatures, Dr. Langmuir has put forward the hypothesis that the hydrocarbon ends of the acids form a liquid surface on the top of the monomolecular film with the carboxyl groups on the water forming another surface with its own interfacial surface tension. The force required to spread or compress such a film on water may then be treated in a manner akin to that developed by Harkins in considering the spreading of lenses of one liquid on the surface of another.

N. K. Adam has plotted curves showing the relationship between the pressure applied and the area occupied by the molecules. Dr. Langmuir has from these curves been able to apply an equation of state to these expanded films. On compressing these expanded films certain kinks in the curve have been explained by Dr. Langmuir as due to the sudden appearance of micelles of molecules in a solid state. The number of molecules in a micelle is, in some cases, about 12. These micelles increase in number as pressure is applied until all fluid characteristics in the film disappear and a rigid solid film is formed. Dr. Langmuir has been able to calculate the heat of formation of the solid state of the film as it changes from the fluid state.

At the conclusion of the meeting a vote of thanks to Dr. Langmuir was proposed by Dr. F. M. G. Johnson.

BRITISH ASSOCIATION OF CHEMISTS

The 16th annual general meeting of the British Association of Chemists was held on Saturday, November 25, at the Manchester College of Technology, at 3 p.m. Prof. E. C. C. Baly presided, and there was a very good attendance.

SOUND FINANCIAL POSITION

Mr. W. H. Woodcock, the Hon. Treasurer, stated in his report that in spite of increased expenditure on publicity, which increased the membership, and, on the new lease for offices and redecoration, the accounts showed a balance of £54.

In regard to the Unemployment Benefit Fund, there had been a drop in benefits paid to members owing to improved conditions. £9,500 had been paid out in benefits to members since the inception of the fund. He thought the fund was now in so strong a position as to be absolutely unassailable.

The very large sum of £3,800 had been recovered for members through the offices of the Legal Aid Department. He thought this was an excellent record.

The adoption of the report was carried unanimously.

ANNUAL REPORT

Mr. S. R. Price, Chairman of Council, presented the report. He said that in spite of a difficult year the net increase in membership was 89. Not only was the future of the Association assured, but he believed a great increase in its influence and prestige was imminent. More appointments than ever had been found for members. The legal cases with which the Association was concerned increased in number and importance.

The adoption of the Annual Report was carried unanimously.

ELECTION OF OFFICERS

President: Prof. E. C. C. Baly, C.B.E., F.R.S.; *Vice-Presidents:* Sir Max Muspratt, Bart., Wm. E. Kay, C. S. Garland, B.Sc., M.I.Chem.E., J. Bristowe, P. Harrison, F.I.C., F.R.S., Prof. I. M. Heilbron, D.S.O., F.R.S., Prof. A. G. Green, F.R.S., M.Sc.; *Hon. Treasurer:* W. H. Woodcock; *Hon. Registrar:* E. H. Rodd, D.Sc.; *Hon. Editor:* H. T. F. Rhodes, M.I.E.I.

RESOLUTIONS

There was a full and animated discussion regarding the recommendation of the Council to elect as Fellows persons of eminence interested in the objects of the Association and to elect as Associates chemists of non-British nationality temporarily resident in this country.

Prof. E. C. C. Baly (President), said that a new grade of membership within the Association was necessary. Chemists of eminence could not be expected to enter the Association as ordinary members which required subscription to the Unemployment Benefit Fund. But the Association wished to elect chemists of eminence by other means than through honorary membership, which was the highest privilege the Council could bestow. He thought the election of Fellows would meet the case.

Mr. Marchant was of opinion that honorary membership could be made to cover all cases. Mr. Horner was of opinion that since many chemists of eminence had, in fact, joined as ordinary members, many others could be induced to do so. Mr. Johnson supported the resolution. He thought Fellows could also be represented on the Council, but that the normal representation of the Council through the Sections would, of course, continue. It was suggested that some other title than Fellow might be adopted, and it was proposed that such members might be elected by special vote of the Council without the necessity for the submission of full details of qualifications required of all applicants for membership. Miss Robinson accepted the principle of the resolution, but considered there were difficulties about title. The Association was primarily intended for ordinary members.

The President asked the meeting to approve the resolution in principle, and leave the question of title for further consideration. A resolution proposed by Mr. Cosbie approving the principle was accordingly put and carried.

The second resolution relating to the admission of foreign chemists as Associates was then discussed. After some discussion the President said that he thought total exclusion of foreign chemists would not be in the interests of the society. It was necessary, on account of the Unemployment Benefit Fund, that foreign chemists should be excluded from ordinary membership, but he thought that the Council should have discretionary powers to admit non-British chemists into a special grade of membership. He put the resolution to the meeting, which was carried.

A resolution confining ordinary membership to chemists of British nationality was, after a brief discussion, carried unanimously.

Votes of thanks to the President and the officers were duly carried.

THE DINNER

The Dinner took place at the Queen's Hotel, Piccadilly, Manchester, at 7 p.m. Prof. E. C. C. Baly presided. Principal B. Mout Jones, D.S.O., M.A., and Prof. A. Lapworth, F.R.S., were the guests.

Proposing the toast of the Association, Mr. S. R. Price said that thirty years ago the chemist was almost unknown to the public. Since the war chemical engineers and chemists had built up huge industries. It was even being said that they had been too successful, and had produced more than could be consumed. This was absurd. It was scientific control that was necessary, and when this became a reality the real value and achievements of science would be understood and the problems of production and distribution solved. A greater unity among chemists was necessary and it was in this direction that the B.A.C. had a tremendous future. It would be the beginning of that scientific movement which would become big enough and powerful enough to right the difficulties of the modern world.

Mr. Horner proposed the toast of "The Guests," and welcomed Principal Mout Jones and Prof. Lapworth. Principal Mout Jones replied for the guests.

Proposing the toast of "The Chemical Profession," Prof. Baly said that he felt that this year marked a turning point in the history of the Association. The increase in membership continued, but it ought to be much greater. He believed that a large increase would be achieved in the near future.

Prof. Lapworth replied.

CORRESPONDENCE

LEAD-LINED AND CHEMICAL STONWARE

SIR,—In his letters of September 25 and October 17, Mr. Maurice Barrett expresses doubt as to the possibility of attaining a porosity below 1% in large chemical stoneware plant. I can assure him that 6-ft. "headers," 6 in. diam. for the Hart condensing plant for nitric acid, 8-in. "S" bends for ditto, receivers up to 120 gal. capacity, 6-ft. pipes 6 in. diam., and many other articles,

were made during the years 1917–18 with a porosity well below 1%—determined by *Government Inspectors*. These articles were certainly "free from laminations, holes, and fissures." They were all slip cast. *Absolute* uniformity of temperature in the kiln may be unattainable, but for all practical purposes, uniformly fired pieces were regularly produced.

I am, Sir, etc.,

J. G. ROBERTS

Barrhead,
near Glasgow
Nov. 30, 1933

PERSONAL AND OTHER ITEMS

Mr. J. Edgar Walker, who has for some time past been the assistant editor of CHEMISTRY AND INDUSTRY, has been appointed to a more important post, that of Publicity Officer of the National Farmers' Union. He leaves this JOURNAL with the regret of all those with whom he has worked and with their good wishes for the future.

We regret to learn of the death, in his 82nd year, of Mr. Frederick W. Branson, F.I.C., formerly managing director of Messrs. Reynolds & Branson, Ltd., pharmaceutical chemists and scientific instrument makers, Leeds, an old-established firm founded in 1816 by William West, F.R.S. Educated, and later demonstrator, at King's College, London, Mr. Branson was an original member of the Society, and during 1906–08 was chairman of its Yorkshire Section, in the activities of which he was, until prevented by failing health, an enthusiastic co-operator. During the war Mr. Branson served on the Committee set up to organize research work in the manufacture of glass required for the equipment of laboratories in munition factories. He was an active member, and one time President, of the Leeds Geological Society; he also took a keen interest in the Leeds Naturalists' Field Club and other local organizations. At the service which was held at St. Chad's, Headingley, on Saturday, December 2, the Society was represented by the chairman and hon. secretary of the Yorkshire Section, Prof. N. M. Comber and Mr. H. J. Hodsman.

The death is announced at the age of 75 of Mr. R. B. Mellon, who, together with his brother Andrew, founded the Mellon Institute of Industrial Research, Pittsburgh; the University of Pittsburgh also owes much to their support. Mr. Mellon was connected with a number of important industrial concerns in the United States, including the Aluminum Company of America, Standard Steel Car Company, Pittsburgh Plate Glass Company, Westinghouse Electric & Manufacturing Company, Gulf Oil Corporation, and Pittsburgh Coal Company.

Mr. James Tennant, who was for many years a director of the United Alkali Co., Ltd., and of Alexander Fergusson & Co., Ltd., left personal estate in Great Britain valued at £75,404.

Dr. R. Ramsay Wright, formerly of Toronto and Edinburgh Universities, left estate in Great Britain of the gross value of £12,644 with net personalty £9285.

He left the residue of the property to the Universities of Toronto and Edinburgh for the establishment of research scholarships.

University of London

The Middlesex County Council is to give a grant of £100,000 towards the cost of the new London University buildings in Bloomsbury. The money will be devoted to the University's new library, which will be named after the county of Middlesex.

Trade Delegation to Holland

Representatives of the Federation of British Industries recently travelled to Holland to discuss with the Federation of Dutch Industries certain questions in which both are interested, in particular the problem of Japanese competition as it affects home markets and those in colonies and dependencies. The delegates included Mr. W. J. U. Woolcock and Sir William Larkie.

A New Cannery

It is reported that a private company has been formed by a group of Nuneaton farmers with a view to erecting a cannery and packing produce grown in the district. The policy of the company will be to can produce which is not packed elsewhere in the country, and an endeavour will be made to keep the factory in operation all the year round. Produce being considered for packing includes pork, veal, beef, and poultry, eggs and milk, and certain fruits and vegetables.

British Pharmaceutical Codex

The Pharmaceutical Society of Great Britain has published the report which gives a summary of the principal standards for chemical substances recommended by the *Pharmaceutical Chemistry Sub-Committee* and provisionally accepted for inclusion in the British Pharmaceutical Codex, 1934.

The chemical substances for inclusion in the Codex fall into three groups, those for which standards are laid down by the British Pharmacopoeia and for which the sub-committee has provided only additional and useful descriptive matter, those for which the sub-committee has worked out a series of tests to form standards, and those for which particular standards are not recommended but have been included to provide necessary and useful information. It is to the more important substances of the second group that this report relates.

It has been prepared in the hope that it will supply manufacturers and others with useful information, and that comments on the proposed standards will be sent to the editor of the Codex at 17, Bloomsbury Square, London.

Copies of the report, price 2s. 6d. are obtainable from the Pharmaceutical Press, 23, Bloomsbury Square, London, W.C.1.

New Specification for Insulating Varnish

The second of a series of B.S. Specifications for insulating varnish has just been issued by the British Standards Institution. This deals with baking varnish of the bitumen type, which gives a finished film that is lexible, moisture-resisting and capable of withstanding vibration without chipping or cracking. The varnish

covered by the specification is suitable for the impregnation of coils, including those of electric traction plant, and for use in any situation where apparatus is subjected to vibration. The specification is based on the results of considerable investigations made by the British Electrical and Allied Industries Research Association, and is drafted in the usual form of clauses defining the performance limits, followed by appendices describing in detail the methods of testing to be employed.

Copies of this new British Standard (No. 514—1933) may be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2s. 2d. post free.

A Microchemical Club

A microchemical club is being formed by a number of scientific workers who hope to foster the development of microchemical technique in pure chemistry, metallurgy, geology, biochemistry, and other branches of science. The secretary, Dr. M. Healey of the Wellcome Physiological Research Laboratory, Beckenham, Kent, will be pleased to answer inquiries from interested persons.

Rayon Manufacture

A new record for rayon production in England was set up during October, the total output being 8,520,000 lb. as compared with 6,320,000 in October, 1932. The total production for the first ten months of 1933 was 68,700,000 lb., an increase of about 19% compared with the same period in 1932.

"Coalite" Plants for France

An agreement is announced between Low Temperature Carbonisation, Ltd., which manufactures smokeless fuel, oil, and motor-spirit from British coal, and S.A. de Carbonization et de Distillation des Combustibles, one of the largest firms of coke-oven builders in France. Under this agreement the latter company is to acquire the constructional and licensing rights for "Coalite" in France, and will erect plants for approved collieries and other interested concerns, under the supervision of the British company. All revenue from these sources will accrue to Low Temperature Carbonisation, Ltd.

Hydrogenation Development in Germany

Many of the problems of producing light mineral oils by hydrogenation from coal and other materials have recently been solved by I. G. Farbenindustrie A.-G., states the *Financial Times*. A full-scale plant at Leuna has been working since 1927 on the problem of hydrogenating coal by means of a catalyst, and the new development consists in the successful use of sulphide catalysts, which unlike those formerly used are not affected by sulphur in the coal. The Leuna process can start from any kind of raw material containing hydrocarbons; the action of water-gas on this is carried out in two stages, the first producing a mixture of light and medium oils, so that it is possible by this process to produce the desired quantities of any product from lubricating oil to light benzene. The development is considered to be of considerable economic importance to Germany.

Sulphur Recovery in Germany

The German consumption of sulphur amounts to between 35,000 tons and 45,000 t. a year (Die Chemische Fabrik), and there is every indication that this will soon be entirely covered by the output of recovery plants operated in connexion with gasworks and coke ovens.

Laboratory Tables for Qualitative Analysis

We have received from the Manchester University Press a copy of the laboratory tables for qualitative analysis drawn up by the demonstrators in chemistry in the University of Manchester. The scheme, which is clearly printed on seventeen sheets of card, is in its fourth edition, having been revised by Dr. C. Campbell and Mr. J. B. M. Herbert. It follows conventional lines, except that the table for the examination of groups III or IV in presence of phosphoric acid is adapted from that of Dr. T. B. Smith, a formate buffer solution being employed. The last two sheets give guidance in the identification of some of the less common metals. The tables are provided with explanatory footnotes.

World Nitrogen Output

An early estimate of the production and consumption of nitrogen, by the United States Department of Commerce, indicates an upward trend during 1932-33. Production is estimated at 1,700,000 tons with consumption of 1,660,000 t., as compared with figures of 1,554,000 t. and 1,560,000 t. for 1931-32.

World Petroleum Congress

The Proceedings of the World Petroleum Congress which was held in London during July are to be issued before the end of the year in two volumes, the first dealing with the Geological and Production Sections of the Congress, and the second with the Refining, Chemical, and Testing Section. Each volume will also contain the lectures by Sir John Cadman on "Science in the Petroleum Industry," and by Mr. J. B. A. Kessler on "Rationalization of the World Oil Industry," the report of the final session, and the speeches at the banquet.

Special sectional volumes will also be available dealing with hydrogenation, bituminous materials, refining of cracked gasolines, and similar subjects which were discussed. Full particulars can be obtained from the Joint Editors, World Petroleum Congress, Aldine House, Bedford Street, London, W.C.2.

Exhibition of Scientific Instruments

The 24th annual exhibition of Scientific Instruments will be held at the Imperial College of Science and Technology from January 9 to 11, 1934. Evening discourses during the exhibition will include "The Instrumental Side of Colorimetry," by Mr. J. Guild, and "The History and Development of the Thermionic Valve," by Mr. Ambrose Fleming.

The Royal Institute of Public Health

The next annual Congress of the Royal Institute of Public Health will be held in Norwich from May 15 to 20, 1934. The work of the Congress will be conducted in several sections, one of which will deal with "State

Medicine and the Public Health." Full particulars may be obtained from the honorary secretaries of the Congress, at 23, Queen Square, London, W.C.1.

The Use of Tin

Figures published in *Die Chemische Fabrik* give the amount of tin used for the year ending July 31, 1933, as 111,200 tons, an increase of 11.2001, compared with the previous year. The chief countries showing an increased use of the metal are Holland, the United States, and France.

Low-Temperature Carbonization in Spain

An experimental plant of the Compañía Española de Destilación de Carbones, with a capacity of 100 tons of coal a day, has now been closed as a result of the low price of petroleum (*Die Chemische Industrie*). A new high-pressure process was introduced recently by this company, and was thought likely to be commercially successful.

Notes from India

Industry in the Punjab. In a review of the work of the Department of Industries in Punjab, the local government states that protection afforded to the sugar industry led to the opening of 35 new factories, mostly, however, small ones employing the open pan system. Several industries were affected by outside competition, amongst these being the steel-rolling, glass-making, textiles, and aluminium ware industries. The Industrial Chemist of Government has been investigating the industrial possibilities of Punjab lac and the production of camphor from Punjab turpentine; progress has been made with the purification and deodorizing of other Punjab oils.

Fuel Research.—Speaking at a meeting of the Geological, Mining, and Metallurgical Society of India in Calcutta recently the president, Mr. K. Dutt, advocated the formation of a Fuel Research Board to consider the possibility of manufacturing petrol from coal in India. He estimated the present consumption of petrol in India, including Burma, at 76,000,000 gal. for motor cars alone.

Mysore Iron Works.—It is reported in *The Times Trade and Engineering Supplement* that the Government of Mysore is considering the imposition of protective duties on iron and steel products. The Mysore Iron Works, which has already cost the Government Rs. 210,00,000 (about £1,600,000) has been losing about Rs. 2,00,000 every year. The market has been much disturbed recently by the offer of Japanese pipes in the Calcutta market at very low rates.

Japanese Production of Chemicals

Figures for the first quarter of 1933 show a definite increase over the corresponding period last year. According to *Die Chemische Industrie* the output (in tons) for the two quarters was as follows: Caustic soda 22,259 (9851); bleaching powder 16,484 (9613); anilins, 832 (732); ammonium sulphate, 146,000 (112,000); superphosphate, 313,000 (300,000); calcium cyanamide, 36,000 (21,000).

Production of Aluminium and Beryllium in Hungary

The fall in Hungarian export of bauxite from 235,000 tons in 1927 to 68,000 t. in 1932, due largely to competition from Yugoslavia, has led to the erection of two plants for aluminium production in Hungary. These are situated, according to *Die Chemische Industrie*, at Csepel and Gaut. Beryllium is to be manufactured in addition, with a view to replacing zinc, tin, nickel, and other metals which are being imported at present.

Compressed Propane for Domestic Gas Supply

Propane is being produced in considerable quantities as a by-product of the synthetic preparation of benzene at the Leuna Works. According to *Die Chemische Fabrik* it is compressed in steel flasks to a liquid at 10 atmospheres, and is used in place of town gas in outlying districts. One flask, as prepared at present, contains propane equivalent in heating value to 50 cb. m. of town gas.

Mineral Statistics

The 1930-1932 edition of the Imperial Institute "Statistical Summary of the Mineral Industry of the British Empire and Foreign Countries" (6s. 6d.) has recently been issued by H.M. Stationery Office. As in previous years this volume contains statistics of the production, imports, and exports by the different countries of the world of 48 minerals, about half of which are metallic. The trade tables refer to the crude materials and the chief semi-manufactured products and in some cases the principal chemicals and derivatives.

Chemical Standards in Canada

According to *Industrial and Engineering Chemistry*, a committee has been formed by the National Research Council of Canada to determine the extent to which chemical standards are used in the purchase or testing of industrial materials. The committee will ascertain the views of industrialists as to the advisability of establishing national standards for commodities in which chemical composition is a significant factor in the determination of quality or grade.

Canadian Mining

According to a recent statement by Dr. C. Camsell, Deputy Minister of Mines at Ottawa, the value of Canada's gold output this year, inclusive of exchange compensation, will probably reach \$90,000,000 in spite of some reduction in the volume of output.

The production of bismuth metal in Canada was increased to a notable extent during the first half of 1933, the output amounting to 74,000 lb. valued at \$70,000 as compared with 10,939 lb. worth \$9626 in the first six months of 1932.

The *Financial Times* (Montreal) states that favourable developments are taking place at the property of the British Columbia Nickel Mines in the Yale district (B.C.). Plans are in progress for the driving of a 4200-ft. tunnel and for the construction of a hydro-electric power plant. Mining operations are at an elevation of 4000 ft., so that gravity transportation of ore to the Canadian

National and Canadian Pacific lines is possible, whilst the property is within easy reach of water transportation on the Fraser River. The presence of chromium in association with nickel in the ore is regarded as of particular importance.

The Dominion Bureau of Statistics at Ottawa reports that finally revised statistics on the output of metals of the platinum group in 1932 show a total of 64,956 fine oz. of new platinum, palladium, and other platinum group metals valued at \$2,001,283 were recovered from Canadian ores in 1932, as compared with 91,693 fine oz. worth \$2,814,617 in 1931.

Zinc production in Canada during the first six months of this year totalled 84,863,001 lb. valued at \$2,425,639, as against 89,065,149 lb. worth \$2,075,485 for the first half of 1932.

According to the *Financial Times* (Montreal), operations at the plant of the Ontario Refining Co. are now on the basis of 55% of capacity, as compared with less than 20% six months ago. Current production of copper, drawn principally from the Frood Mine, is at the rate of 5,500 tons monthly. More than 60% of the copper produced at the refinery is being marketed in England at prices varying between 8 and 9 cents a pound, while a considerable tonnage is marketed in France and other Continental countries.

The Dominion Bureau of Statistics at Ottawa reports that 309 tons of mica were produced in Canada last year, the value of which was \$6828. The figures for 1931 were 1339 tons worth \$54,066 and those for 1930 were 1170 t. valued at \$96,004.

During the first half of 1933, silver production in Canada totalled 7,307,948 fine oz. valued at \$2,539,563, as against 9,451,611 fine oz. worth \$3,108,191 during the first six months of 1932.

Canada is now one of the largest world producers of aluminium metal, most of which is exported. There were in 1932 fourteen plants turning out various aluminium products valued at \$2,703,212. Aluminium kitchenware was made in nine different plants.

Exports of aluminium bars and blocks last year were valued at \$2,797,257; whilst exports of manufactures were valued at \$970,586.

Canadian production of cobalt during the six months ended June 30 totalled 193,150 lb. valued at \$280,359, as compared with 210,282 lb. valued at \$238,268 during the corresponding period of 1932.

Field investigations by the Department of Mines appear to indicate that at least 750,000,000 tons of bituminous sand can be mined by open-cut methods in the northern portion of the province of Alberta. On a basis of 12% bitumen content this is equivalent to 90,000,000 t. of bitumen.

Printed Cellophane in the Post

The Post Office announces, in reply to a suggestion by the London Chamber of Commerce, that in future cellophane and similar substances when used in place of paper as a medium for print may be sent at the inland printed paper rate. Transmission to places abroad will be at the sender's risk, as there is no guarantee that such packets will not be surcharged in other countries.

Heating Research at Mellon Institute

Work has been proceeding since 1929 at the Mellon Institute of Industrial Research, Pittsburgh, on matters of interest to heating specialists and users of heating equipment. Some of the work has been concerned with the development of corrosion-resistant materials, especially for use in the petroleum and other process industries. During the course of these studies the findings of the International Nickel Company respecting the place and utility of "Ni-Resist" have been corroborated. The Institute proposes to publish the full results of this work as soon as possible.

British Industries Fair

Although the British Industries Fair of 1934 is not due to open for some months, bookings of space are heavy, and at Birmingham extensive additions to the Fair buildings have again become necessary to cope with the demand. A preliminary list of exhibitors in the chemical section shows that 30 concerns have taken space, whilst there are 46 firms already listed to exhibit in the druggists' sundries section.

Industrial Psychology

The December issue of *The Human Factor*, published by the National Institute of Industrial Psychology, Aldwych House, London, contains the annual report of the Institute for 1933. This report is of interest to manufacturers by reason of the many instances it gives of investigations of industrial processes and economies effected. One example is given of the reorganization of the accounts department of a chemical manufacturing company; the new system has involved an outlay of £2000, but will effect savings of £700 a year and at the same time will enable statements to be delivered 10 days earlier than at present. Movement studies of operations such as the stamping of soap tablets are cited, by means of which quicker and less fatiguing methods have been adopted.

The Chemical Industry in Germany

The report of the I. G. Farbenindustrie A.-G. for the third quarter of 1933 states that there has been a continued improvement in chemical production and trade for the home market, though conditions in the export business are unchanged. Orders for industrial chemicals were substantially higher, and for nitrogen fertilizers slightly higher, than during the third quarter of 1932. There was no distinct change in the dyestuffs trade, but sales of pharmaceuticals and insecticides showed important improvement. Motor-fuel production was increased further, with increased relative importance of direct production from lignite.

Coal Industry Reorganization

Coal-owners in West Yorkshire have informed the Coal Mines Reorganization Commission that they cannot proceed with their voluntary scheme for partial amalgamation as the owners responsible for 30% of output in the district have refused to join the scheme. The Commission has formally notified the owners that if an agreed scheme is not submitted within one month it will take steps to apply the scheme compulsorily. In the districts of Durham, South Yorkshire, and Notts & North Derbyshire, where the Commission's efforts to encourage voluntary schemes have not been successful, similar steps will be taken if agreement is not reached within two months.

REVIEWS

TABLES SHOWING THE RELATION BETWEEN THE SPECIFIC

GRAVITY OF SPIRITS AT 80° FAHRENHEIT, THE CORRESPONDING PERCENTAGE OF PROOF SPIRIT AND THE PERCENTAGE OF ALCOHOL BY WEIGHT. Pp. 47. London: H.M. Stationery Office, 1933. 2s. 6d.

This book, compiled by Mr. F. G. H. Tate, of the Government Laboratory, gives in a clear and convenient form the specific gravity of spirit in air at $80^{\circ}/80^{\circ}$ F., the percentage of proof spirit, and the percentage of alcohol by weight for all gravities between 0.7860, 0.7861, and so on up to 0.9999 and 1.000. It will be extremely useful to those engaged in alcoholometry, especially in warm weather or warm countries.

STANDARD METHODS OF ANALYSIS: OF IRON, STEEL, AND FERRO-ALLOYS. Pp. 36. Sheffield: The United Steel Companies, Ltd., 1933. 4s. 6d.

It is somewhat unusual for an organization to make public its internal methods, even in a small degree, and it is a welcome sign of the times when The United Steel Companies, Ltd. sponsors the publication of a work of this kind. "Standard Methods of Analysis," which is well produced and bound with interleaving of fount-ruled paper for additional notes by the reader, is interesting on account of the circumstances under which it came to be compiled. The various laboratories of The United Steel Companies, Ltd., in different parts of the country, are continuously engaged in tests and analyses of every grade of iron, steel and ferro-alloys, either as finished or semi-finished products, or as raw materials. It became apparent that it would be convenient to standardize the procedure adopted by these various laboratories, and to this end a committee of chemists and metallurgists was appointed to scrutinize carefully the various methods available and to pronounce upon those which they considered best for adoption throughout the whole group of companies. This volume contains the selected standard methods determined by that committee; no "short" or approximate methods are included, as it was considered that these, however useful, do not fall within the scope of the word "standard."

CHEMIE DER ZEMENTE (CHEMIE DER HYDRAULISCHEN BINDEMITTEL). By Dr. K. E. Dorsch. Pp. v + 277. Berlin: J. Springer, 1932. Paper, 23.50 rm.; bound, 25 rm.

A critical summary of the present state of knowledge of the chemistry of the cements is greatly needed, as many incompatible theories are in existence relating to the constitution of Portland cement, the various chemical changes which occur during the production of cement, and the nature of the reactions which accompany its setting and hardening. No finality can yet be reached, notwithstanding the large amount of research which has been done, but the subject as a whole is being slowly clarified.

The present volume contains only 262 pages of text and is therefore far from exhaustive, but within a small compass the subject is well summarized. The chemical composition and properties of lime, alumina, and silica

are considered first separately and then in groups of binary and ternary mixtures. There is a short and inconclusive chapter on the constitution of Portland cement, a rather longer one on the production of this cement, followed by a short series of chapters on mixed and aluminous cements and their properties.

The sections on setting and hardening are disappointing in their lack of information on the causes of setting and hardening, though the part of it which deals with the constancy of volume is well written. The author wisely recommends that, in comparing the quality of various Portland cements, the ratio of compressive to tensile strength should always be considered.

There is very little reference to English research work, though American and French investigations are freely quoted. The book is written in a pleasant style and is very readable. It forms an excellent introduction to the subject, though it leaves the reader uncertain as to which (if any) of several conflicting theories to adopt, and, consequently, is unsatisfactory to those who like definite conclusions and "pat" statements of fact. To the serious student who desires to become a specialist it can be recommended as one of the books he ought not to miss.

A. B. SEARLE

DER CHEMIE-INGENIEUR: EIN HANDBUCH DER PHYSIKALISCHEN ARBEITSMETHODEN IN CHEMISCHEN UND VERWANDTEN INDUSTRIEBETRIEBEN. Edited by A. Eucken and M. Jakob. With a Preface by F. Haber. Vol. I. PHYSIKALISCHE ARBEITSPROZESSE DES BETRIEBES. 2nd Part. MECHANISCHE MATERIALTRENNUNG. Edited by A. Eucken. Revised by C. Nasko, H. Madel, and W. Siegel. Pp. x + 385. Leipzig: Akademische Verlagsges., 1933. Paper. 36 m.; bound, 38 m.

This volume is the first of the series comprising the handbook to deal with the treatment of materials. It covers the subjects of size reduction and the separation processes which do not involve a change of phase or physical state. The first section discusses the principles underlying processes of size reduction, so far as they are at present elucidated, and describes the characteristic features of the main types of crushing and grinding plant. The second section deals with processes of separation dependent on gravity and covers sedimentation and hydraulic and air separation. The third section is a very complete study of the physical principles governing the filtration processes and their quantitative application. No attempt is made to deal with methods of carrying out filtration in practice and the types of plant used for the purpose. The fourth section deals briefly with centrifuging and the fifth with dust removal from gases. As is unavoidable in a work due to a number of authors, the treatment of different sections is rather uneven. A balance has not always been kept between the presentation of the theory of a process and of the practical methods for carrying it out. In spite of these defects, however, the work will undoubtedly be found useful for study or for reference.

A. J. V. UNDERWOOD

DER CHEMIE-INGENIEUR. Edited by A. Eucken and M. Jakob. Vol. I. PHYSIKALISCHE ARBEITSPROZESSE DES BETRIEBES. Part 3. THERMISCH-MECHANISCHE MATERIALTRENNUNG. Edited by A. Eucken. Revised by S. Erk and others. Pp. x + 327. Leipzig: Akademische Verlagsges., 1933. Paper, 30 m.; bound, 31.50 m.

The subject of this volume is the group of separation processes which generally involve thermal changes and which might be better described as those which involve a change of phase or physical state. The first section of the book deals with evaporation and drying. This section, particularly that part of it which deals with evaporation is rather scanty and hardly reaches the general standard of the handbook. The second section on distillation deals very thoroughly with the principles of the distillation process and briefly illustrates their practical application by reference to the alcohol and liquid air industries. The third section deals with crystallisation and brings together a good deal of scattered material concerning crystal formation and crystal growth. This chapter is particularly well done. The fourth section is entitled "Separation processes based on surface phenomena" and deals with adsorption and flotation. An important omission to be noted in this volume is that the processes of absorption and extraction, which obviously fall within its scope, are not discussed at all. Nevertheless the book forms a useful contribution to the scanty literature of chemical engineering. The main criticism to be offered is that, while the fundamental principles are well presented, the application of these principles to practice is treated qualitatively rather than in the quantitative manner which the chemical engineer requires.

A. J. V. UNDERWOOD

THE SCIENTIFIC JOURNAL OF THE ROYAL COLLEGE OF SCIENCE. Vol. III. Pp. 120. London: E. Arnold & Co., 1933. 7s. 6d.

This publication contains papers read before the Imperial College Chemical Society and the Natural History, and Mathematical and Physical Societies of the Royal College of Science. The five chemical papers are on "The Contribution of the Chemist to Industry" by Prof. H. V. A. Briscoe, "Surface Reaction," by Prof. E. K. Rideal, F.R.S., "The Structure of Dyestuffs," by Prof. J. T. Hewitt, F.R.S., "Some Methods adopted in the Treatment of Mineral Oils," by Dr. A. E. Dunstan, and "Some Aspects of Chemical Synthesis in Plants," by Dr. E. F. Armstrong, F.R.S.

Prof. Briscoe's paper was obviously read before an audience of young chemists. In it he shows how industry is nowadays entirely dependent on the chemist and he gives a list of qualifications for the industrial chemist, amongst which he includes knowledge of physical instruments and machines and "absolutely bullet-proof common sense." Prof. Hewitt's paper is mainly occupied in a discussion on the types of organic compounds that produce absorption in the visible spectrum and on the methods of deciding the structure of substances liable to exist in tautomeric forms. Dr. Dunstan discusses the methods for removing sulphur compounds from mineral oils and shows the advantages of using sodium hypochlorite for this purpose. Dr. Armstrong tells how the

plant may synthesize carbohydrates from carbon dioxide and water via formaldehyde and he suggests that anthocyanins and flavones may be formed from sugars via the inositols. The whole volume provides interesting reading, so long as the reader does not desire too technical a treatment of any one subject. L. M. M.

EVAPORATING, CONDENSING, AND COOLING APPARATUS: EXPLANATIONS, FORMULE, AND TABLES FOR USE IN PRACTICE. By E. Hausbrand. Translated from the 2nd revised German edition by A. C. Wright, M.A., B.Sc. 5th English ed., revised and enlarged by B. Heastie. Pp. xxi + 503. London: E. Benn, Ltd., 1933. 25s.

In the review of the fourth English edition of this book, which appeared in the *JOURNAL* of May 3, 1929, the new matter incorporated by Heastie was described, so that it is only necessary in dealing with such a well-known and much-appreciated work to consider the additional material of the fifth edition. This is to be found in the last chapter, in which Heastie, after discussing generally the transmission of heat across metal surfaces, gives Hinton's modification of the well-known formula for the liquid film conductivity by including a factor for the specific heat. In the remainder of this chapter such subjects as the rates of heat transfer between steam, condensable gases and vapours, and a metal wall are discussed and then the A.P.V. heat exchanger, the Stanton oil cooler, and the Jenkins heat reclaimer are described. These examples are selected to show the modern trend in industrial pieces of plant of this type.

The work of Morris and Whitman who, using a double tube heat exchanger, determined data relating to heat transmission for different types of oil as well as water, also forms a part of this chapter and there are sections dealing with the transfer of heat from the outer surface of tubes to a liquid both when the flow is viscous and stream line. Reference is made at the end of this chapter to the recent work on the flow of heat through the walls of helical coil tubes. Another useful addition to the book is a list of the outstanding papers on this subject published prior to 1932. The additional chapter certainly adds to the value of this well-known work, which has been reduced in size and weight by the adoption of a thinner paper.

REPORT OF THE ROTHAMSTED EXPERIMENTAL STATION, 1932. Pp. 227. St. Albans: Gibbs & Bamforth, Ltd. 2s. 6d.

In this report Sir John Russell says: "It is in times of difficulty that expert information about soils, crops, and animals is most valuable to farmers, for it enables them rapidly to alter their methods in accordance with the rapidly changing economic conditions." The work described in the report shows the type of information that is being gained in order to deal with changes in modern conditions.

Improvements in field experiments through the further application of statistical methods are recorded and illustrated by the results obtained with a number of crops. In connexion with the manuring of sugar-beet, the value of ordinary agricultural salt has proved un-

expectedly high, being no less than that of potash. Experiments with other crops, potato, fodder mixtures, kale, grassland, wheat and rotations, are described, and the inoculation of lucerne, and now of clover, is being closely studied in field and laboratory.

Barley receives especial attention in a summary of the striking results of ten years' investigations conducted in the laboratory and in the field all over England under the research scheme of the Institute of Brewing. The practical applications of the results are clearly set out in reference to methods of cultivation, manuring, and the effects of weather and season.

In the laboratory section of the report the soil physics department describes further progress in the comparison of rotary with other forms of cultivation, and in the interpretation of soil "tilth." The chemical properties of the soil are being studied by new methods, applied in particular to changes in soil organic matter as a result of different cropping or manorial treatments. The biological decomposition of organic matter is still under investigation, new information being obtained about the rotting down of straw, a surplus material that may be troublesome to deal with under mechanised farming. The purification of the effluent of sugar beet factories by biological oxidation in filters has been carried satisfactorily to the semi-commercial scale; the effluent of milk factories is now being studied.

Methods of insect control by the use of vegetable products as insecticides continue to be studied. Pyrethrum, a very potent agent which can be grown in this country, offers problems both in cultivation and in the preservation of the toxic principle; tropical plants that are used by natives as fish poisons are often valuable insecticides, but it is important to be able to measure their toxicity readily, and methods for doing this are being compared.

BASIC GERMAN FOR SCIENCE STUDENTS: WITH VOCABULARY AND ENGLISH TRANSLATIONS OF THE GERMAN PASSAGES. By M. L. Barker, M.A., Ph.D. Pp. xi + 164. Cambridge: W. Heffer & Sons, 1933. 6s.

A knowledge of German, or at least ability to read it, is necessary to the student and research worker in most branches of science. It is unfortunate that German is not taught at schools to all reading science as part of the normal curriculum. As it is the student has normally to acquire his knowledge of the language from books and hence acquires the ability to read it, but very little knowledge of grammar and pronunciation and probably no skill in writing. This book is one of the best for this purpose. It is divided into two parts, of which the first contains lessons in grammar and general passages for acquiring a basic vocabulary. The early passages are taken from the Book of Genesis and the later ones relate to the history of civilization.

The second part consists of scientific passages, taken from German textbooks, under the headings of chemistry, zoology, botany, physics, mathematics, and medicine. Every passage is accompanied by an English translation on the opposite page. After working through this book, which the author considers should take at a minimum two University terms, the student ought to have acquired a knowledge of about a thousand basic

German words and in addition should be well equipped to understand the German he has to read in connexion with his work. Included as an appendix are the German passages set in the chemistry papers of the honours B.Sc. of the University of Edinburgh for the years 1923 to 1932. The book is attractively produced and is to be recommended to all scientists wishing to learn German in their spare time though it should also be very helpful to those knowing the language slightly and wishing to get practice in its use. L. M. M.

COMPANY NEWS

MOND NICKEL CO., LTD.

The company, a subsidiary of the International Nickel Co. of Canada, Ltd., gives notice that on June 1, 1934, it will redeem the whole of its 5% first mortgage debenture stock then outstanding at the rate of £105 plus accrued interest for every £100 stock held.

Notice is also given that Henry Wiggin & Co., Ltd., a subsidiary of the Mond Nickel Co., Ltd., will on the same date redeem the whole of its 6½% first mortgage debentures then outstanding at the rate of £104 plus accrued interest for each £100 debenture held.

INTERNATIONAL NICKEL CO. OF CANADA

The net profit of the company for the third quarter of the year was \$3,773,130, which is nearly double the profit made during the second quarter. After a loss in the first quarter of \$80,158, the net profit for the first nine months of the year was \$5,636,019, equivalent to 28½ cents per share of common stock after allowing for preferred dividend. This figure is greater than for the whole of 1931, whilst in 1932 there was a loss of \$292,352.

BRITISH CYANIDES CO., LTD.

At the annual general meeting of the company (cf. CHEM. & IND., Dec. 1, for financial results) the chairman, Mr. K. M. Chance, said that the range of Beetlemare articles had been greatly extended and sales at Streely in the September quarter had been more than four times those of the same quarter in 1931. The purchase price of the Pollopat patents was stated to be £50,000, payable as £30,000 in ordinary shares at par and £20,000 in the form of the company's holdings in the Synthetic Plastics Co. In addition to the patents the company had obtained a business that was paying in profits a satisfactory interest on the investment.

BRITISH TAR PRODUCTS, LTD.

The net profit of the company for the year ended September 30 was £46,648, compared with £49,150 last year. It is proposed to maintain distribution of dividend on the preferred ordinary and ordinary shares at the rate of 10% plus a bonus of 5%.

BIRMINGHAM ALUMINIUM CASTING (1903), CO., LTD.

The company records a profit during 1932-33 of £18,504, as compared with £15,129 in the previous year. It is proposed to increase dividend from 5% to 7½% on the ordinary shares, and to transfer £5000 to special depreciation reserve.

MARKET REPORT

This Market Report is compiled from special information received from the manufacturers concerned.

Unless otherwise stated, the prices quoted below cover fair quantities net and naked at sellers' works.

The following alterations in prices are reported since the publication of the last Market Report (cf. CHEM. & IND., Dec. 1, 1933, p. 974).

GENERAL HEAVY CHEMICALS

Sodium Chromate.—4d. per lb., d/d U.K.

TAR PRODUCTS

Acid Cresylic, 99/100.—1s. 6d.—2s. 3d. per gal. Refined, 1s. 8d.—1s. 9d. per gal. Pale, 98%, 1s. 4d.—1s. 5d. per gal. 95%, 11d.—11½d. per gal. Dark, 10d. per gal.

Creosote.—B.S.I. specification, 3¼d.—3½d. per gal., d/d Heavy—4d. per gal.

Pitch, medium, soft.—70s.—72s. per ton, in bulk at makers' works.

PHARMACEUTICAL AND PHOTOGRAPHIC MATERIALS

Quinine Sulphate.—1s. 11d. per oz., for 100-oz. tins; tins free.

PATENT LIST

The following is a list of complete specifications of chemical interest which are open for inspection under section 91 (4) (c) of the Patent Act. Printed copies are not available, but photographic copies may be obtained at a charge of 8d. per page (minimum 1s.) from the Patent Office, Chancery Lane, W.C.2.

I. 4797 (1933). Houdry Process Corp. Regeneration or purification of catalytic and like contact masses. 13,160 (1933). Midden Europeesche Octrooimaats. See VII.

III. 12,612 (1933). Hoffmann-La Roche & Co. Derivatives of the dihydroxybenzenes.

13,992, 14,099 and 14,438 (1933). I. G. Farbenind. See XX.

IV. 14,061 (1933). Soc. Chem. Ind. in Basle. Manufacture of azo-dyestuffs.

14,333 (1933). Du Pont de Nemours & Co. Manufacture of azo-dyestuffs.

V. 11,670 (1933). Champion Coated Paper Co. Surface-filled paper.

VI. 14,314 (1933). Brit. Celanese, Ltd. Treatment of textile and other materials.

VII. 13,160 (1933). Midden Europeesche Octrooimaats. Production of carbon dioxide ice.

X. 13,690 (1933). Kodak, Ltd. Production of metal casts from gelatin and like heat-developable reliefs.

14,019 (1933). Titus. Aluminium alloys.

14,190 (1933). Hazelett Metals, Inc. Metal working.

14,254 (1933). Verein. Stahlwerke. Manufacture of steels and alloy steels.

XI. 14,080 (1933). Internat. Gen. Electric Co. Electric resistance materials.

XIII. 13,765 (1933). Du Pont de Nemours & Co. Manufacture of resinous products.

XIX. 13,173 (1933). Tres Gyogyszer Vegyeszeti Ipari es Kereskedelmi. Improving flours or dough prepared therefrom.

14,207 (1933). I. G. Farbenind. Manufacture of conversion products of casein.

XX. 13,992 (1933). I. G. Farbenind. Manufacture of neutral, water-soluble derivatives of aminoarylsensitibio compounds.

14,062 (1933). I. G. Farbenind. Manufacture of solutions of therapeutically-valuable compounds.

14,099 (1933). I. G. Farbenind. Manufacture of neutral water-soluble organo-metallic compounds.

14,438 (1933). I. G. Farbenind. Manufacture of water-soluble complex compounds of trivalent antimony.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence), 35, Old Queen Street, London, S.W.1, has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and stating the specific number. *Australia*: Tanning materia's, industrial chemicals, and dyes (601). *Austria*: Colours and varnishes, paper, cellulose (609). *Italy*: Markets for paper (B.Y. 7706). *United State*: Spring steel plates (G.Y. 13,167).

Import Duties Advisory Committee

The Import Duties Advisory Committee gives notice of the applications for an increase in the import duty on certain tools, not including machine tools other than the separable cutting, drilling, screwing, milling, forming, and holding parts used in machinery or in machine tools, and parts thereof; and for the addition to the Free List of Persian berries, quercitron bark, sumach leaves (other than ground), gum tragacanth, and cable cores produced by stripping used submarine electric cables. Representations in regard to these applications should be addressed in writing to The Secretary, Import Duties Advisory Committee, Caxton House, Tothill Street, London, S.W.1, not later than January 1, 1934.

The Committee announces that it has decided not to make any recommendation in respect of the application previously advertised for the imposition of an additional duty on carbon rods of all sizes for electric batteries.

Key Industries

Representations have been made to the Board of Trade under Section 10 (5) of the Finance Act, 1926, regarding amido ethyl alcohol (monoethanolamine). By Section 10 (5) of the Finance Act, 1926, the Treasury may by order exempt from the duty imposed by Section 1 of the Safeguarding of Industries Act, 1921, any article which the Board of Trade is satisfied is not made in any part of the Dominions in quantities which are substantial having regard to the consumption in the United Kingdom, and of which there is no reasonable probability of such substantial quantities being manufactured within a reasonable period.

Any communication should be addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1, not later than December 31, 1933.

Carriage of Dangerous Goods in Ships

The report of the committee appointed by the Board of Trade to consider the existing "Memorandum on the Carriage of Dangerous Goods in Ships" and to advise what alterations, if any, were desirable to make the rules

laid down in the Memorandum suitable for international adoption, has been published by H.M. Stationery Office, price 2s. net.

Attached to the report is an appendix which contains a full statement of the precautions which should be taken in the packing and stowage of dangerous goods and explosives. The Board of Trade has decided to adopt this appendix in substitution for the existing memorandum. There are, however, certain matters dealt with in the report and the appendix upon which no decision has yet been reached, and the Board has issued a notice (No. 130) which explains the position in detail. Copies of this notice can be obtained, free of charge, upon application to the Board of Trade.

Medicinal Vitamin-C Tablets

The British Drug Houses, Ltd. of Graham Street, City Road, London, N.1, who for some time past have been issuing for scientific purposes pure crystalline vitamin-C (ascorbic acid B.D.H.) manufactured from natural sources, are now issuing this pure vitamin for medicinal purposes in the form of tablets, each tablet containing 5 milligrams of pure crystalline vitamin-C, which is equivalent to about two teaspoonfuls of fresh orange juice. Physicians desirous of prescribing vitamin-C for their patients are thus able to ensure correct dosage by the use of these tablets.

Fredk. Boehm, Ltd.

In order to cope with increasing business Fredk. Boehm, Ltd. has erected a new factory with modern plant, at 48, High Street, Plaistow, London, E.13. Inquiries for copal ester gums, stand oils, cobalt linoleate, etc. should be addressed to the head office at 17, Jewry Street, London, E.C.3.

A Large Gas-Cleaning Plant

An electrostatic precipitation plant to be supplied by the Lodge-Cottrell Co. to the Tata Iron & Steel Co. of Bombay for its works at Jamshedpur, will be the largest blast-furnace gas-cleaning plant in the world. It is to work on the two-stage fine cleaning method, dealing with 14,000,000 cu. ft. an hour, and reducing the dust content to less than 0.0088 gm. per cu. ft. The situation makes economy of water essential, and the plant is so designed that the make-up will be only 5000 gal. per hour. This installation is the first step to be taken in a complete reorganization scheme at the Tata works to effect maximum fuel economy.

A New Case-hardening Process

A new case-hardening process which has been developed by Kasenit, Ltd. is described in the *Nickel Bulletin*, vol. vi, No. 10, published by the Mond Nickel Co. of Thames House, Millbank, London.

The "Dursapid" process, as it is called, differs from other methods in that the parts to be hardened are dipped directly into a bath consisting of a special mixture in the form of a thin paste, and are put into the furnace without any packing. When taken out of the furnace the pieces are plunged into an oil bath, where they are cooled off.

While the process is applicable to box-hardening in the usual manner, a sealed muffle or retort, offering protection from the oxygen in the air and the combustion

gas from the fuel, is recommended to obtain the best results. A suitable furnace is manufactured by Kascnit, Ltd., and comprises a retort case in "Cronite," the well-known nickel-chromium alloy. The furnace door and the trays for holding the work are also made of "Cronite," which, on account of its excellent heat-resisting qualities, does not distort or scale at the temperature of operation.

The chief advantage of the "Durapid" process is the short time necessary for the parts to remain in the carburizing furnace, the same depth of penetration being obtained in considerably less time than is required by ordinary methods. With plain carbon steels the carburizing time to obtain a depth of 1 mm. is from 60 to 80 minutes after the work has attained the furnace temperature. Steels of this type can be carburized at 930° to 940° C., while for alloy steels such as nickel-chromium steel, temperatures of 880° to 900° C. are suitable.

Hadfield's Ltd.

Hadfield's Ltd. of the East Hecla Works, Sheffield, has recently issued a pamphlet (No. 359) dealing with its equipment for breaking down "cullet" and other hard materials to small fragments. A "Granulator" is made by the firm and is a jaw-type breaker with the body made of steel in one piece and the crushing jaws of Hadfield's ERA manganese steel. This steel is also largely employed in the Hadfield crushing rolls.

Another pamphlet has been issued (No. 360) which gives full details of Hadfield's portable stone-breaking and screening plant, and the information given will be found of use and interest to all those concerned with road construction.

The Brush Homogenizer

The Brush Electrical Engineering Co., Ltd. of the Falcon Works, Loughborough, has recently published a leaflet describing a homogenizer which is constructed for use in the dairy, chemical, and other industries. The homogenizer consists of a three-throw pump delivering the working fluid under pressures adjustable up to 4000 lb. per sq. in., through the homogenizing valve to the delivery reservoir. The valve and valve seat are made of materials resistant to corrosion and the valve is not spring-loaded in the usual way, but is opened by the action of the high-pressure liquid in expanding a stainless steel tube and compressing a rod which is inside it. Stainless materials are used throughout where contact is made with the homogenized fluids, and adjustment of pressure etc. is simple and can be made while the homogenizing is in process. The machine is easily cleaned.

PUBLICATIONS RECEIVED

CRYSTALLINE STATE. Edited by Sir W. H. Bragg, O.M., K.B.E., D.Sc., F.R.S., and W. L. Bragg, D.Sc., F.R.S. Vol. 1. A GENERAL SURVEY. By W. L. Bragg. Pp. xiv + 352. London: G. Bell & Sons, Ltd., 1933. 26s.

HANDBOOK OF CHEMISTRY AND PHYSICS: A READY-REFERENCE BOOK OF CHEMICAL AND PHYSICAL DATA. Edited by C. D. Hodgman. 18th ed. Pp. xiii + 1818. Cleveland, Ohio, U.S.A.: Chemical Rubber Publishing Co., 1933. \$6.

CHEMISTRY OF FLESH FOODS AND THEIR LOSSES ON COOKING. By R. A. McCance and H. L. Shippey. Privy Council. Medical Research Council. Special Report Series No. 187. Pp. 146. London: H.M. Stationery Office, 1933. 2s. 6d.

YEAR-BOOK OF THE COKE OVEN MANAGERS' ASSOCIATION, 1933. Edited by the Editorial Committee. Pp. viii + 377. London: Benn Brothers, Ltd., 1933.

LABORATORY TABLES FOR QUALITATIVE ANALYSIS. Drawn up by the Demonstrators in Chemistry, University of Manchester. 4th ed., revised and rewritten by C. Campbell, D.Sc., and J. B. M. Herbert, M.Sc. 17 sheets. Manchester: University Press, 1933.

SWEET MANUFACTURE: A PRACTICAL HANDBOOK ON THE MANUFACTURE OF SUGAR CONFECTIONERY. By N. F. Scarborough, A.M.I.Mech.E. Pp. xi + 123. London: Leonard Hill, Ltd., 1933. 7s. 6d.

METALLURGICAL ANALYSIS BY THE SPECTROGRAPH: BEING SOME EXPERIENCES OF THE APPLICATION OF THE SPECTROGRAPH TO THE ANALYSIS OF NON-FERROUS METALS AND ALLOYS. By D. M. Smith, B.Sc. With a Foreword by Dr. H. W. Brownson, M.Sc. Pp. xi + 113. London: British Non-Ferrous Metals Research Association, 1933. 10s. 6d.

INFLUENCE OF TEMPERATURE UPON THE STRENGTH DEVELOPMENT OF CONCRETE. By N. Davey, B.Sc. Department of Scientific and Industrial Research. Building Research. Technical Paper No. 14. Pp. vi + 76. London: H.M. Stationery Office, 1933. 2s.

MANUFACTURE OF SODA. WITH SPECIAL REFERENCE TO THE AMMONIA PROCESS. A PRACTICAL TREATISE. By Te-Pang Hou. Ph.D. American Chemical Society Monograph Series. Pp. 365. New York: Chemical Catalog Co., 1933. \$8.

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