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CHEMISTRY & INDUSTRY

Official Organ of the Institution of Chemical Engineers, of the Coke Oven Managers' Association, and of the Federal Council for Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Oil and Colour Chemists' Association, the Institute of Metals and the Royal Agricultural Society.

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EDITORIAL

British Industries Fair

ON Monday next the 20th inst. the British Industries Fair for the year 1933 opens at Olympia and the White City in London and at Castle Bromwich in Birmingham and it will be duly honoured by state visits by a number of distinguished people and by unofficial visits by a much larger number of people whose importance is derived from the fact that they are buyers of British goods. So far as we can judge from the official notices about the Fair and from the accounts of the exhibits furnished to us by the exhibitors the Fair this year will be as full of interest and beauty as its many predecessors. Fairs of this sort are a novelty in Great Britain, and a very pleasant and useful novelty too. They derive their inspiration and world-wide importance in the main from the Department of Overseas Trade but this department has been nobly assisted, so far as Birmingham is concerned, by the energetic Birmingham Chamber of Commerce and so far as London is concerned by the activity of several powerful organizations one of which, the Association of British Chemical Manufacturers, is particularly dear to the hearts of chemists, for it has done much during the last sixteen years to promote the prosperity of the chemical industry of this country. Those who visit the exhibits of chemical manufacturers and of manufacturers of chemical plant at the Fair will be greatly impressed by the many novel features that indicate our recent progress in both these industries. The organization of these sections in the Fair has always been a matter for sincere congratulation and the visitors to the Fair and the readers of this JOURNAL should be very grateful for the trouble taken on their behalf and for the zeal and skill that accompanied such trouble. In former years we used to thank and congratulate the Association of British Chemical Manufacturers in general and Mr. Woolcock in particular. During recent years gratitude should be equally displayed to the Association in general and to Mr. Davidson Pratt in particular. It is only our slavish adherence to precedent that prevents us from mentioning by name several distinguished Civil Servants whose labours have contributed so much to the usefulness of the Fair and the comfort of the visitors.

Hydroquinone

The camera has been so much an everyday possession of most of us that it is of no little interest that the slogan "you press the button and we do the rest" is becoming not only venerable but, what is more important, all-British in its import. Thanks to the labours of Sir Herbert Jackson and his numerous associates in the field of optical glass, the lenses of our cameras no longer have to be supplied from abroad, whilst for some time films and emulsions have been made in this country: it was only for some of the ingredients of the developer that we have had perforce to cross the seas. At this year's British Industries Fair there is shown at the stand of the Association of British Chemical Manufacturers an exhibit of hydroquinone to signify and commemorate the manufacture of this chemical for the first time in England. This is in accord with the practice of the Association of British Chemical Manufacturers, begun at the suggestion of their Chairman of Council, to display each year the outstanding achievement in the production of new chemicals. Hydroquinone is not one of the chemicals with a long and fascinating history. First prepared by Caventou and Pelletier of quinine fame, and subsequently by Wöhler, it has been more of theoretical than of practical interest, especially in view of its relation to quinone and the theories of quinoid structure and its bearing on colour formation. As a glucoside it is known as arbutin, and is widely distributed in plants, particularly in the pear and allied species, and in the heaths: it is a powerful antiseptic, though its precise function in plants is not known. Our moors and orchards may thus claim priority over the chemical manufacturer in effecting the synthesis; but once again coal tar has beaten the plant as a source of an industrial organic compound, and we would have it so, for it would be a sad thought were we to have to destroy the moors in order to obtain the material to develop our photographs. Few legislative measures designed both to protect and to develop industry have been attended with a greater measure of success than has the Safeguarding Act in its application to the fine chemical industry. Within a few years there has developed out of a few firms who were hard pressed to hold their own in a restricted range of products, a

powerful industry with world-wide connexions, freely competing in Empire and overseas markets. The range of British made products is now a wide one and new ones are constantly being added, as in the instance we now cite. It is understood that the hydroquinone market is a valuable one amounting to £30,000 per annum: this in itself is a substantial item to avoid having to send abroad to the detriment of our purchasing power of more vital necessities. The chemical industry affords an example of the advantages of scientific and co-operative effort, in that its progress has been achieved with the goodwill of the customer and not at his expense.

Rubber Research

It seems that there is a grave danger that the Research Association of British Rubber Manufacturers will come to an end in the near future. The Association was founded in 1919 and has a membership of eighty-six firms, but the provision of the necessary finance has become very difficult during the last few years. Rubber has fallen to a very low price and some firms find that it is a hardship to provide funds for research; other firms find it convenient to do their own research, and though they are willing to contribute to the cost of the Association they feel that such contributions should be made on a scale proportionate to the magnitude of the interest of the firm in the consumption of rubber. A scheme has therefore been devised for a levy of one forty-fifth of a penny per pound on all raw rubber imported into this country. The majority of the firms assisting the Association favour such a scheme but some firms do not, and legislation seems to be the only means of achieving the desired result. Whether such legislation can be forced through Parliament at the present time seems to be a little doubtful, and it has been represented to us that there is no other possible way of keeping the Association in existence. We are aware that large firms who must maintain their own research organisations sometimes feel that their support of a Research Association common to the whole industry puts them in a delicate position. When directors feel that their duty to their shareholders conflicts with their duty to the industry as a whole they are bound to give the preference to their own shareholders. On the other hand, there are many problems of a fundamental nature that can be more economically and more expeditiously carried out by the industry as a whole than by any one unit, and it cannot be denied that the Research Association of British Rubber Manufacturers has already done a great deal of really valuable work. It would be a pity if its activities came to an end or were greatly diminished, and the chemical industry as a whole is largely dependent on research of all kinds for its prosperity. On the broadest grounds all chemists will desire that research shall grow and flourish; as we lack that knowledge of the details of the organization and finance of this particular Association that is necessary to the formation of a sound judgment on any scheme for its maintenance we can only hope that those who know the facts and are directly concerned with the great rubber industry will be able to take the steps that promise to make that industry as successful, and profitable, and scientific as is possible.

A NOTE ON THE VISCOSITY OF CELLULOSE ACETATE SOLUTIONS

By T. E. ELLISON

The formation of acetone-soluble cellulose acetate such as is used in the manufacture of "acetate silk," by the acetylation of cotton linters with acetic anhydride in the presence of sulphuric acid and a diluent *e.g.*, acetic acid, is a complex process. In the first stage cellulose triacetate is formed, having an acetyl value of approximately 62·5%. That is to say, complete acetylation is effected, so far as is practically possible, but the product is not free from combined sulphuric acid, and the essential mechanism of the process involves the formation of cellulose sulphates and interaction of these with acetic anhydride, reaction proceeding in this way until almost the whole of the hydroxyl groups are acetylated. At the same time chain-fission occurs to an extent depending more on the temperature than on any other single factor. In the second stage, water is added to the cellulose triacetate dispersion to decompose the excess of acetic anhydride (necessarily present to bring the first stage to completion) and in sufficient excess to form about 5% by weight of the total solvent. Sodium acetate may also be added to neutralize part of the sulphuric acid. Under these conditions, at about 20° C., the triacetate slowly hydrolyzes. Combined sulphuric acid is very largely but not completely eliminated, and when the acetyl value has fallen to about 56% the product is precipitated, washed, and treated with very dilute boiling sulphuric acid ("stabilization"). All but traces of combined sulphuric acid are removed in this process and further hydrolysis occurs, reaction being stopped when the acetyl value has reached, say, 54%, as determined by the so-called chloroform plasticity test (the behaviour of the product in pure chloroform being strictly dependent on the acetyl value). During the second main stage of the manufacture ("hydratizing") there is then a loss of acetyl-radicles, elimination of sulphates, and further some degree of chain-fission. Small temperature changes during acetylation and hydratizing have a marked effect on the viscosity (in any solvent) of the product.

It will be evident from this description, that there will be considerable practical difficulty in the way of an attempt to show that the viscosity in acetone, for example, of a secondary cellulose acetate bears any clear relation to the viscosity of the initial cellulose as determined by some simpler method of dispersion, as for example in cuprammonium. Cellulose acetate technologists have indeed long doubted whether there is any such clear relation and it has only recently been stated (Werner, Celluloschem., 1931, **12**, 320; **I** 1932, **51**, 302) that the viscosity of a solution of acetyl cellulose has no relation to the viscosity of the cellulose from which it has been prepared. It is however the purpose of this paper to bring evidence to the contrary.

Disregarding the "association theory" of the constitution of cellulose and interpreting its behaviour along the lines of Haworth's chain-theory, it is clear that the viscosity of any dispersion of cellulose or cellulose derivative whatever must be related, however remotely, to the average chain-size of the cellulose from which it was formed. It has recently been shown for example

by Okada and Hayakawa (Cellulosechemie, 1931, **12**, 153) that the viscosity of cellulose nitrate in acetone solution is related to that of the original cellulose in cuprammonium. In the formation of cellulose acetate, particularly if the reaction is carried as far as the formation of the secondary or acetone-soluble acetate, the number of factors having an effect on the viscosity of the ultimate product are so many and so difficult to control, that the relation to the viscosity (in, say, cuprammonium) of the cellulose used is likely to be entirely obscured. By measuring the viscosity however at the primary or triacetate stage a considerable simplification is effected, and by suitable choice of conditions it is possible to obtain easily reproducible viscosity figures. These have been compared with the viscosities of the cellulose samples used when dispersed under standard conditions by the xanthate process. The methods used and the results obtained are outlined below. It was immaterial whether this method or the cuprammonium method was used, and the viscose method was chosen on account of its simplicity, Küng and Seger's procedure (Pap.-Fabr., 1929, **28**, 433) being followed with slight but not material modifications. Considerable experience with the xanthate method had shown that the results are very closely connected with those obtained by the cuprammonium viscosity process. It should be stated that the acetate viscosity process was devised as a routine method of analysis, for control purposes in the manufacture of cellulose acetate.

Acetylation Process for Determining the Viscosity of Cellulose

The sample of cotton linters is thoroughly mixed and left for 24 hrs. in a box at room temperature for the moisture content to become uniform. A portion is then taken for a moisture estimation (loss of weight in 6 hrs. at 103° C. ± 2°), and the equivalent of 3 g. of dry linters weighed into a 200-c.c. conical flask and dehydrated during 48 hrs. *in vacuo* over sulphuric acid (Note 1). To 1000 g. of 8% Ac_2O (in HAc) is added 2·5 c.c. of concentrated H_2SO_4 (Note 2). Of this mixture 97 ±0·1 g. is added to the dry cotton, the flask corked and left for 23½ hrs. in the thermostat at 20° C. (Note 3). The flask is then removed and the contents made uniform, without coming into contact with the cork by shaking round. Rather more than the required amount is at once drawn into a viscometer, which is returned to the thermostat and the level adjusted. The viscometer is protected against the entry of moist air. After exactly 24 hrs. from the time the acetylation mixture was added, the time of flow is measured. The relative viscosity is given as the time of flow in seconds.

In using this process all measurements were carried out in a British Engineering Standard Viscometer, No. 4 size, with a castor oil time at 20° of 9 min. 15 secs.

The density of the acetate solutions is 1·066 at 20°.

Note 1. *Moisture content.*—It is essential in these acetylations for the cotton to have a fixed moisture content, as is shown by the fact that a sample with a moisture content of 2·7% had a time of flow of 193 secs., whilst with moisture content reduced to 0·5% the time of flow was increased to 260 secs. The cotton must be dried at a low temperature, since drying at 100° appears to close the capillary entrances to the fibre. Whether or not this is the correct explanation, such cotton has a very slow rate of reaction, and the effect persists even after exposure to moist air; so that cotton for acetylation must never be exposed to high temperatures. (It is interesting to compare this effect with the action on cotton of cold concentrated caustic alkali solutions which have a profound inhibiting effect on acetylation.) By drying *in vacuo* at room temperature over sulphuric acid the moisture is largely removed without the rate of reaction being lowered. In these experiments the moisture content was reduced to about 0·7%, the weight of the cotton (3 g. when dry) being 3·02 ±0·005 g.

Note 2. *The acetylation mixture.*—(*a*) Shawinigan acetic acid (99·2—99·7% HAc) is distilled with $K_2Cr_2O_7$, H_2SO_4 and sufficient Ac_2O to combine with the H_2O in the HAc, the distillate analysed and made up to 8% Ac_2O by addition of the required weight of Ac_2O. The distillation serves to remove formic acid and other impurities. It is very necessary to use a pure acetylation mixture, as quite small amounts of impurities can completely upset the results if they are able to react with the catalyst, whose concentration in the reaction mixture is only 0·45%.

(*b*) The amount of H_2SO_4 used admits of variation within certain limits. The most favourable concentration is such that the H_2SO_4 present is about one-seventh of the weight of the cellulose. With between one-fifth and one-eleventh it has been found that acetylation will proceed normally at 20° C. Lower values have not been examined, but if the weight of sulphuric acid is raised to one-third of that of the cotton, insoluble sulpho-acetates are formed. Whatever amount is used must be added accurately, as the following figures show, the standard method being used and the H_2SO_4 content alone varied.

Weight of catalyst	(g.)	0·63	0·54	0·45	0·36	0·27
Time of flow	(secs.)	183	250	368	579	737

As small volumes of H_2SO_4 cannot easily be measured out accurately, 2·5 c.c. is added to 1000 g. of the 8% anhydride. This volume of acetylation mixture suffices for as many acetylations as the analyst can conveniently start on one day and complete on the next.

(*c*) The H_2SO_4 and Ac_2O in the acetylation mixture react slowly, probably to form acetyl-sulphuric acid, which differs from H_2SO_4 in its catalytic activity. It is in consequence impossible to make up a stock acetylation mixture. The catalyst is preferably added shortly before acetylation is carried out. The following figures show how the apparent viscosity of a cotton sample varied with the age of the acetylation mixture.

Age	(days)	0	5	14
Time of flow	(secs.)	222	243	271

This slow increase in apparent viscosity has been found to continue for much longer periods—7 weeks in one set of experiments. This rate of change is not enough to introduce any difficulty in routine estimation, the error introduced at the end of 8 hrs. being less than the average experimental error. A fresh acetylation mixture must however be made up each day.

(*d*) Each acetylation is carried out with about 2 g. of Ac_2O in excess of the theoretical quantity. A slight

excess is essential. The anhydride content of the mixture requires to be accurately adjusted, as the viscosity varies rapidly with alteration in this factor. Thus with 8·0% and 12·6% of Ac_2O a sample had a time of flow of 138 and 240 secs. respectively. If sufficient water is added to decompose the excess of anhydride after acetylation is complete, the second dispersion retains its enhanced viscosity, showing that we are dealing with a true increase in the viscosity of the cellulose triacetate, and not an apparent increase due to alteration in the composition of the solvent.

(*e*) A convenient method for the estimation of Ac_2O,HAc or HAc—Ac_2O mixtures is to add about 5 g. to an excess of 2N carbonate-free NaOH and back titrate with $\frac{N}{10}$ H_2SO_4, the NaOH being itself titrated against N H_2SO_4. Preferably measurements are carried out under constant temperature conditions, and if not, the 2N and N solutions must be corrected for change of volume with temperature. A burette calibrated for a given drainage period and readings to 0·01 c.c. are essential. Estimations of HAc should agree within 0·03% and of Ac_2O within 0·2%.

Note 3. *Temperature of reaction.*—With the standard conditions chosen, acetylation is relatively slow. The temperature of the reaction mixture rises gradually from 20° C. to about 20·8° C. and slowly falls again. In general the rate of acetylation with sulphuric acid as catalyst is practically zero below 15° C. and it becomes very rapid and uncontrollable above 30° C. For the standard method 20° C. is chosen because the reaction completes itself without any shaking or stirring within 24 hrs. (making it suitable for routine work), and any important temperature change is avoided during transference from reaction-flask to viscometer.

Viscose process for determining the viscosity of cellulose.—The equivalent of 0·9 g. of dry cotton is treated with 10 c.c. of 17·5% NaOH at 20° C. for 2 hours, the excess alkali removed on a sintered-glass funnel, and the sample pressed out between filter papers until the weight is 3·1 ± 0·05 g. It is transferred to a 250-c.c. glass-stoppered bottle and left for 6 hours at 20° C. with 0·7 c.c. CS_2, after which 100 c.c. of 4% NaOH is added and the bottle left without shaking for 16½ hours at 20° C. During the next 15 minutes the dispersion is well mixed with the aid of a glass rod, transferred to a No. 2 B.E.S.A. Viscometer, and the time of flow at 20° C. measured exactly 17 hours after the addition of the 4% NaOH.

Then "Apparent viscosity" $= \frac{3 \cdot 73A}{B}$ poises

where A = time of flow of viscose and
B = time of flow of aniline at 20° C.

Viscosity of cotton cellulose

Viscose method Poises	*Acetate method* Seconds
8	105
10·9	130
16·7	135, 138
20	153, 157
26·5	190
27·5	190
31	187, 192
31·5	196
33	192
39·4	219
44·2	231
56	243
60	246, 250
70	256
70	258

Viscosity estimations.—The viscose and acetate viscosities as obtained by the methods described, of 1[illegible] samples of cotton linters—originating from five different commercial sources—are shown in the table in the previous column.

Discussion of Results

Although the agreement is not everywhere exact the table reveals a clear relationship between the two sets of viscosity figures. The only possible explanation of this relationship is that the viscosity in both cases directly depends on the degree to which the cellulose is degraded, or the extent by which the average particle size is reduced, by the various physical and chemical treatments through which the cotton linters passes in preparation. There is no reason therefore to suppose that cellulose acetate dispersions are in any way anomalous. As with any other cellulose dispersion, the viscosity of the solution is directly related to the degree of degradation of the cellulose from which it was prepared, using the term "degradation" to mean hydrolytic fission of the cellulose chain. The effects of oxidation have not been studied.

It will be noticed that the relation between the viscose and acetate viscosities is not a straight-line relation. Between the top and bottom of the table the viscose viscosity has increased 9 times and the acetate viscosity *only about 2½ times.* The reason for this is not clearly understood, but it is evidently connected with the fact that active degradation is going on during the process used for estimating the viscosity and that this is greater in acetylation than in xanthation. In the acetylation method the viscosity at the time of measurement in the above process falls at the rate of about 5% per hour. But until more is known of the relation between particle size and viscosity, a full explanation cannot be given.

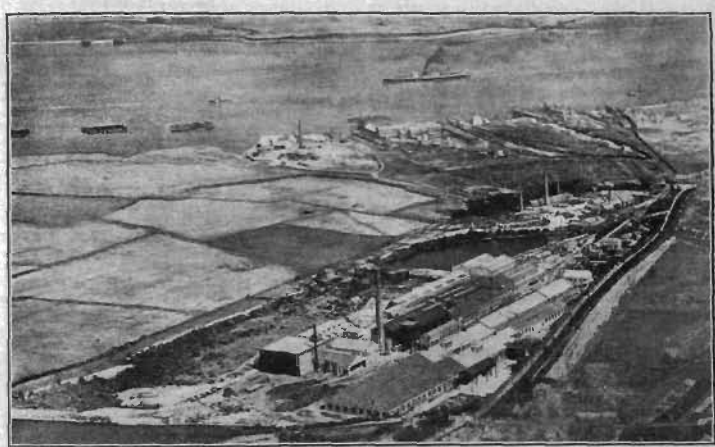
It should be remarked that the rate of acetylation of all the samples of cotton linters examined was, so far as could be observed visually, very much the same. If it were not so, no purpose would be served by comparing the viscosities after a given time as in the above method, and the only possible method of comparison would be to measure the viscosities at the point of complete acetylation, a point by no means easy to determine at all accurately, without disturbing the solution. In using this method for example for studying the effect on the viscosity of various so-called pre-treatment processes it was necessary to carry out the viscosity measurement at the point of complete acetylation, as these processes in general greatly alter the rate of acetylation.

The work described was carried out in 1929 in the laboratories of the British Acetate Silk Corporation Ltd., and the author is indebted to Dr. F. W. Stoyle B.A., B.Sc., and to Mr. G. A. Edwards, B.A., B.Sc., for their interest in the work, and to Mr. G. W. Cowdrey M.Sc., for carrying out the viscose viscosity estimations.

BRITISH VEGETABLE PARCHMENT MILLS, LTD.

It is now eighty years since vegetable parchment was discovered, for it was in 1853 that an Englishman, W. E. Gaine, found that by dipping a sheet of ordinary white paper into sulphuric acid and then washing in cold water it was changed to a translucent tough material resembling true parchment made from goat-skin. Yet it is only during the last few years that this parchment has been manufactured on an extensive commercial scale in this country. This is surprising, for the non-porous property of such parchment makes it ideal for packing greasy foodstuffs such as butter and lard, moist materials such as sausages and ice-cream, and a hundred and one other articles ranging from cocoa and casein to tobacco and chemicals, for which the prevention of the access of air and moisture is essential. Yet if this country has been tardy in manufacturing vegetable parchment, whilst every other European country was producing it in appreciable quantities, we can perhaps congratulate ourselves for having now in the British Vegetable Parchment Mills at Northfleet a unit of production which is as up-to-date and bigger than any other unit of its kind in the world. Recently we had the pleasure of going through these mills in company with Mr. James Strachan, manager of the works, whose connexion with the paper industry goes back more than thirty years to a time when he was one of the three chemists employed in the industry, and we found the visit very interesting.

The basic material from which the vegetable parchment is made is pure white cellulose, even more pure than that used in the manufacture of artificial silk; it is derived from wood pulp, esparto grass, and other sources, and is specially treated to free it from lignin and resinous material. This cellulose is received in the mill in the form of pulp, rather like blotting paper, and this is soaked in water and agitated in "beaters" which disintegrate the fibrous aggregates so that on subsequent dilution a milky suspension of minute fibres is obtained. A paper is then formed by allowing the suspension to run on to one end of a travelling band of fine wire mesh in a special paper-making machine. The water drains through the mesh and the fibres are deposited on it, being then partially dried by air drawn through the mesh, so merging to form a sheet of paper which is run off at the farther end of the travelling band, from whence it is taken through a series of steam-heated drying cylinders ultimately to form a roll of paper containing some 10,000 yards. This paper must be of the utmost purity, with complete freedom from mechanical flaws, in order that the next stage of parchmentizing may proceed efficiently and without a hitch, and though soft and absorbent, this paper must have sufficient strength to go through the parchmentizer without damage.



Aerial view of Northfleet Mills

A roll of the paper is now transferred to one of the four parchmentizing machines, by which it is first of all taken through a bath of strong sulphuric acid, which is of specially pure quality, free from arsenic, since much of the paper is eventually used for food packaging. From the acid bath the paper passes through acid-proof rollers which squeeze out the excess acid. The paper is actually immersed in the acid only for a second or two, the action of the acid being physical rather than chemical, causing the fibres to swell up and become gelatinous so that they coalesce and in the passage through the rollers are firmly cemented together. From the rollers the sheet of parchmented paper is taken quickly through a series of water baths to remove all the excess acid, and

after the final traces of acid have been removed by water sprays, the parchment is dried by steam-heated rollers. In this way a roll of vegetable parchment is obtained which is three to four times as strong as the original paper, whilst it is now completely proof against the passage of water, air, and oil. The four machines in the mill have a capacity of some 300 tons of parchment per week.

In this account it has been possible to give only a bare outline of the process, but considerable care and skill have to be exercised by the operatives on both the paper-making and parchmentizing machines to maintain the desired speed, tension, etc. necessary to produce a uniform product of specified weight. Some of the parchment is taken to further stages to make it suitable for special purposes: thus some is made more pliable by washing with glycerin, some may be glazed or waxed, impregnated with antiseptic material, or dyed to attractive shades. By far the greater part of the parchment is used however without further treatment for packing oily foodstuffs such as butter and lard, and for this reason the factory is maintained in a state of spotless cleanliness that one mainly associates with food processing works. Great care is taken in handling, when the rolls of parchment are cut into large sheets, each of which is examined for flaws, and then "guillotined" into smaller sheets ready for the packing trade. The work of the mill does not stop at this point, for these sheets may be folded in special machines to desired shapes, or printed in bright colours with customers' designs—a very attractive effect being obtained. Finally the sheets are packed, in cases for the home market, or in steel-bound bales for export.

Chemists will be interested to know that the staff of the mills includes, for process control and research, seven chemists. In addition to the well-equipped laboratory, there is also a testing house in which the various grades of parchment are periodically put through every variety of test under tensile, folding, and tearing strain, to ensure that they are up to standard. We were interested to hear from Mr. Strachan something of a eulogy of the British manufacturer. The original plant installed in the factory was obtained from the Continent, but recent additions to the plant have been designed on the spot, and constructed throughout of British materials. Lead-covered wooden structures have given place to rubber-lined brickwork, unsatisfactory tiled floors have been replaced with really acid-proof brick, and improvements in the power transmission and its operation have made the newer parchmentizing machines far more economical and productive than those originally installed.

CANADIAN MINING

Until recently Canadian coke was made exclusively from imported bituminous coals, but tests carried out in the Fuel Research Laboratories at Ottawa have demonstrated the suitability of Canadian coal for the production of a satisfactory coke. Many plants are now using anadian coal exclusively for the production of gas and coke, while others, operating under more difficult conditions, are using proportions, varying from 35% to 50%.

SOCIETY OF CHEMICAL INDUSTRY

OFFICIAL NOTICES

British Industries Fair. Members visiting the British Industries Fair at Olympia which opens next Monday, February 20, are reminded that the Society's Stand Number is A.14 in the Chemical Section.

The Stand will make an excellent rendezvous while visiting the exhibits and it should be noted that the Society's telephone number at the Exhibition is Shepherds Bush 4745. The Society has no admission tickets but cheap railway vouchers may be obtained from the General Secretary.

MEMBERS ELECTED

February 10, 1933

Aufenast, Frederick, The Ever Ready Co., Ltd., Hercules Place, Holloway, N.7. Chemist.

Davies, Trefor, Bantam Products, Ltd., Bantam Works, Leeds, 12. Works manager.

Dhingra, Das Ram (Dr.), c/o Lloyds Bank, The Mall, Lahore, India. Lecturer in F.C. College, Lahore.

Dove, Allan Burgess, 31, East 19th Street, Hamilton, Ontario. Chemical engineer.

Fraser, Hugh Bouvard, British Drug Houses, Ltd., Graham Street, London, N.1. Research chemist.

Gabe, A. Morgan, 27, Penvilia Road, Brynbyfryd, Swansea. Fuel technologist.

Gordon, P. F. (Dr.) (restoration), The Royal Technical College, Glasgow, C.1. Lecturer.

Gosling, Frederick, Stirling Chemical Works, Stratford, London. E.15. Chief chemist and works manager.

Graham, David, The Teluk Anson Cash Chemists, No. 1, Anson Road, Teluk Anson. F.M.S. Chemist and druggist, Pharmaceutical Society of Great Britain.

Green, Frederick Gordon, Division of Chemistry, National Research Council, Ottawa, Canada. Chemical engineer.

Harrower, John (Dr.), 12, Belmont Terrace, Murrayfield, Edinburgh, 12. Research chemist, Morton Sundour Fabrics, Ltd.

Hart, Gerard, "Hillcrest," Radcliffe New Road, Whitefield, near Manchester. Dyeworks chemist.

Hayhurst, William (*restoration*), 8, St. James's Chambers, Accrington. Technical chemist.

Holroyd, G. W. F., The Municipal Technical College, Blackburn, Lancs. Head of Science Department, Technical College.

Jensen, H. R. (*restoration*), c/o Messrs. Geo. Kemp, Ltd., North Circular Road, N.W.2. Technical chemist.

Kurihara, Kanshi, The Central Laboratory, South Manchuria Railway Co., Fushimi-Dai, Dairen, Manchuria. Superintendent of the Central Laboratory.

Leduc, F. J., F. J. Leduc and Associates, 354, St. Catherine East (Corner St. Denis), Montreal. Consulting engineer.

Matthison, Arthur Llewellyn, Arthur Holden & Sons, Ltd., Bordesley Green Road, Birmingham. Varnish and lacquer manufacturer.

Michellepi, C., P.O.B. 1480, Alexandria, Egypt. Agricultural expert.

Pettett, Alfred Edward John, 44, Michelham Gardens, Strawberry Hill, Middlesex. Research chemist.

Queeny, E. M. (*restoration*), Monsanto Chemical Works, St. Louis, U.S.A. President of above.

Richards, Edwin Stuart, Chemistry Department, Working Men's College, Latrobe Street, Melbourne, Victoria, Australia. Head of chemistry department.

Riddell, George Low, The Printing Industry Research Association, St. Bride Institute, London, E.C.4. Technical director.

Simmonds, Vernon, South Suburban Gas Co., Lower Sydenham, S.E.26. Gas engineer.

Smith, Walter, North British Rubber Co., Ltd., Castle Mills, Edinburgh, 3. Chemist.

Sutermeister, Edwin, S. D. Warren Co., Cumberland Mills, Maine, U.S.A. Chief chemist.

Sweeten, John Langhorne, 15, Hilgrove Road, N.W.6. Research chemist.

Tindale, Harold, The Australian Gas Light Co., Pitt, Barlow and Parker Streets, Sydney, Australia. General manager.

Valton, Paul Alexander, Lynfield, W. Cranmore, near Shepton Mallet, Som. Technical adviser to Roads Reconstruction, Ltd., Bristol.

Waller, M. E. M. (Mrs.), 68, Elgin Crescent, W.11. Chemist.

Waddington, Arthur Hill, 23, Torver Road, Harrow, Middlesex. Chemist and bacteriologist.

Walker, Leslie Arthur, 75, City Road, Edgbaston, Birmingham. Works chemist.

Whyatt, Gilbert Henderson, Suffolk Chemical Co., Ltd., Cliff Quay, Ipswich, Suffolk. Chemical engineer.

Wiley, Samuel W., jun., Vice-President of Wiley & Co., Inc., *c/o Wiley & Co., Inc., Calvert and Read Streets*, Baltimore, U.S.A. Chemist (Student of Chemistry).

FOOD GROUP

The meeting of the Food Group of the Society at Burlington House on February 8 took the form of a joint discussion with the Institute of Metals on "The Use of Non-Ferrous Metals in the Food Industry." Dr. L. H. Lampitt, chairman of the Group, presided, *and extended a cordial welcome to the Institute of* Metals. Of the speakers who had promised to take part in the discussion, Dr. Ulick R. Evans was unfortunately prevented by illness from being present. Mr. Donald McDonald was also unable to attend, but a paper by him was read.

The discussion was opened with a joint paper by T. N. Morris and J. M. Bryan, of the Low-Temperature Research Station, Cambridge. In the first part of this *paper, which was illustrated by a number of slides and* photographs, Mr. Morris said:

In considering the non-ferrous metals in connexion with the food industry let me first of all mention some of the typical uses for which such metals are required. They are required for heating-pans—usually steam-jacketed, autoclaves and evaporators, heating coils and steam nozzles, pipe lines and troughs, tanks, pumps and taps, filling machines, mixing machines, moulds and *cutting tables and cutting machines, centrifuges*, filters and strainers and containers and wrapping materials for storage and transport. The metals available are copper, aluminium and nickel as pure metals; then there are a number of nickel and copper alloys such as monel metal, of nickel and chromium, german silvers, phosphor-bronzes, brasses, various aluminium alloys and solders. Also, since they usually contain between 20—30% of non-ferrous metals, we are entitled to mention the stainless steels, and, finally, we have to consider coatings of tin or silver on copper, tin on iron, nickel and chromium on copper or iron, and aluminium and zinc on iron.

The food materials with which these metals will come in contact may contain organic acids such as citric, tartaric, malic, lactic, acetic and amino acids, fats, essential oils, amines, and salts of organic acids. Common salt and traces of other inorganic salts may be present either in neutral or acid solution and, occasionally, mineral acids and alkalis, although they may be removed from the final product, may be used for certain processes. There may also be organic sulphur compounds. The contact between food and metal may be either short and intermittent or prolonged, air may be present or almost absent and the temperature may be high or low. There is thus a very wide range of conditions which one cannot hope to deal with in a short paper, but which must be taken carefully into consideration in choosing a metal for any particular process. In considering the use of a metal we have, to put it briefly, to concern ourselves with the physical characters, the resistance to corrosion, the toxicity of the metal and its effect on the food.

From the purely physical point of view it is found that while a metal like tin has a somewhat limited use owing to its soft nature, many of the other materials will serve for the same type of plant; *e.g.* copper is very suitable for steam-jacketed pans, evaporators, autoclaves and tanks, since it is sufficiently strong for these purposes and is easily worked. Aluminium, nickel, monel metal and stainless steel are also used for similar purposes since each metal has special features which may render it most suitable for the product to be handled.

The same metals are available for evaporator tubes, condenser tubes, steam coils and pipe lines. For steam nozzles, pumps and moving parts as in filling machines etc. we have phosphor-bronzes, brasses and duralumin and monel metal. For strainers and even filter-press cloths we have woven fabrics of wire from copper and monel metal or other copper nickel alloys, and for cutting tables, cutting machinery etc. we have stainless steel.

Broadly speaking the metals just enumerated fall into two main groups from the point of view of corrosion:

(*a*) Those which are protected from the action of acids, either by their position in the electrochemical series, or by a high overvoltage of hydrogen on their surface. Such are silver, copper, and tin, and perhaps nickel.

(*b*) Those which owe their protection to a film of the oxide of the metal which is insoluble and impervious to acids. Such are chromium and aluminium. These metals have the power of imparting a similar protection to their alloys, hence the stainless steels and the aluminium alloys come into this class.

If we consider the metals from this standpoint we have a key to their behaviour with food products. There are of course special peculiarities outside such a generalization with which we must deal later, but a classification on these lines makes it plain that we must avoid conditions in which copper or tin are in contact for any length of time with acid foods in the presence of air.

Where the protection is due to a film of oxide, as in the second class, there is a greater tendency for the metal to break down under air-free conditions than

when air is present. This is seen in an interesting way in some of the stainless steels and chromium-nickel alloy and also to some extent with aluminium. Heating may also cause a breakdown of protection in acid solutions and an oxide film may be penetrated and destroyed by chlorine ions leaving the underlying metal open to attack.

I had almost placed nickel and its alloys in a third or transitional class between the other two, but I think it should really be classed with copper or tin. It has, however, as Mr. Bryan will show, a greater tendency to corrosion of the hydrogen-evolution type in the absence of air than either of these metals, and it also shows a good deal of corrosion by cold citric acid in the presence of oxygen, in which it differs from metals of the second class, viz., those protected by a film of oxide. Monel metal, on the other hand, behaves more like copper, but in our experience suffers slightly less than copper in citric acid in the absence of air and about the same in its presence. Monel metal appears to be particularly resistant to brine, and on this account is used a good deal in marine construction. It should therefore be valuable with foods containing salt, although I do not know how far it resists acid brines.

As regards other considerations in the shape of special peculiarities, we can consider features associated with the amphoteric nature of certain of the metals. Aluminium and tin readily form aluminates and stannates respectively with the alkalis, and this means in practice that they must not be cleaned with alkaline solutions or allowed to come in contact with alkaline brines. This is serious, especially in the milk industry, because, unlike stainless steel, which is also highly recommended for milk and is easy to clean, tin and aluminium tend to become slightly coated with organic materials which are somewhat difficult to remove and readily set up bacterial contamination. The difficulty has been overcome, however, with tin by cleaning with a solution of tri-sodium phosphate containing a little sodium chromate and with aluminium by using sodium carbonate containing sodium silicate. It has also been shown that strong refrigerating brines will not attack aluminium if they contain sodium chromate. If these precautions are observed either of these metals is excellent for contact with milk as, even if they should be attacked slightly, they impart no bad flavour. Aluminium is also very useful for meats, as it is stated by Seligman that it is protected by fats and not attacked by milk or meat containing fat, even in the presence of lactic acid or salt. It is not recommended however, for strong solutions of gelatin, which may contain salts but no fat. Nickel and copper, on the other hand, are not attacked by alkalis in washing but are slightly attacked by stearic and oleic acids, and when present in traces, catalyze changes which bring about rancidity in fats. For this reason these two metals and monel are not highly favoured for milk unless heavily tinned.

With regard to toxicity, all the evidence points to the fact that traces of many of the heavy metals are, if not essential, at least beneficial in metabolism, and that they are almost always present in plants and animals. The conclusion is that none of the metals mentioned as being generally used is likely to do any harm when taken in the quantities in which they occur in foods prepared in contact with them.

We come now to the consideration of the coating metals viz., chromium, nickel, silver, zinc, aluminium and tin. Either silver-plated copper or double-silvered copper, or indeed solid-silver steam coils or pans are useful for contact with strong organic acids. On the whole it may be said that silver is well worth considering, especially at present prices, where special corrosion troubles exist. Zinc as a coating for iron is useful where there is no contact with acid. It is not to be recommended for fruits or milk. Tin is by far the most important metal for coatings at present used in the food industry. Its chief use is as a coating for mild steel in the manufacture of tinplate cans, and for this purpose it has at present no serious rival, at least among metals. Aluminium has been tried for fish and is said to have proved satisfactory for sardines in oil, but reports were not so good with fish and tomato products especially when salt was present. This material has, as stated previously, yet to prove itself, however, and meantime tin-plate holds the field and is really an excellent material for many products. No effort should be spared to improve the resistance of tin-plate to acid corrosion by directing attention both to the tin-coating and the steel-base and by attention to other matters which Mr. Bryan will perhaps touch upon.

The paper was continued by Mr. T. N. Bryan, who said:

The research on metals at the Low-Temperature Research Station has been mainly concerned with the spoilage problems of the canning industry, particularly those due to the corrosion of the tin-plate container. The aim has been to make a systematic study of the behaviour of tin, iron and the tin-steel couple towards a typical fruit acid, such as citric acid, and to determine, as far as possible, how this is affected by the various factors likely to operate in canning practice. Such factors are the presence of air or oxidizing agents, inhibitors and accelerators of corrosion, and other substances like sugars which are likely to be present in foods, the true acidity or hydrogen-ion concentration, the relative areas of tin and steel exposed in the couple, the nature of the steel base and the porosity of the tin-coating.

Most of the work so far has been carried out with solutions of citric acid buffered with sodium citrate over the range p_H 2·4 to p_H 5·5 at 25° C., which represents a warm storage temperature for cans. The results under these conditions have brought out points in connexion with the corrosion of tin and tin-plate which are of interest to food packers and manufacturers. These may be briefly enumerated as follows:—(1) It has been confirmed, as stated in the opening address, that tin suffers negligible attack by citric acid in the absence of air, but is severely attacked in its presence, the amount of the corrosion depending on the amount of oxygen present.

(2) In the presence of air the attack was generally speaking most rapid at high acidity (low p_H).

(3) Tin is most readily attacked by oxidizing substances in solution, the amount of corrosion being

proportional to the concentration of oxidizing material. The hydrogen-ion concentration had an influence not only on the rate of attack of tin but also on the efficiency of the oxidizing substance as a corroding medium. Initially, the rate of attack is greatest at high acidity, but ultimately there is slightly more corrosion at low than at high acidity. This is due to the fact that the dissolved tin remained entirely in the stannous condition at low acidity, whereas at high acidity some of the stannous tin was oxidized to the stannic condition; consequently, for a limited constant amount of oxidizing material there was finally less corrosion at high than at low acidity.

(4) The rate of corrosion of tin was greatly increased by the presence of a salt-like ferrous citrate in solution which could act as an oxygen-carrier. This was especially so at high acidity but was noticeable over the whole p_H-range studied. Possibly iron may also affect other metals in the same way.

(5) Abrasion of the surface of the tin usually increased the rate of corrosion. This increase amounted to as much as 32% with some of the samples. This is important as apart from the action of abrasives in wearing away the tin coating, it indicates that they actually increase its susceptibility to corrosion. It is in contrast, however, to the behaviour of metals like copper and monel metal which show decreased corrosion with a freshly-abraded bright surface. Hence it seems that there is an actual advantage in cleaning the surface of these metals with an abrasive. Moreover, since the tarnish on these metals is soluble they should always be kept bright. Aluminium showed a little increase in corrosion when freshly abraded.

Studies of the tin-steel couple at different H-ion concentrations in the absence of air or with very little air present show that the rate of corrosion of the tin increases with decreasing acidity while at the same time the rate of corrosion of the iron decreases. With increasing quantities of air the position of maximum corrosion of tin gradually shifts until it becomes greatest at high acidity and, as the corrosion of the tin increases, it is usual for the corrosion of the steel to show a corresponding decrease. The hydrogen-ion concentration thus has a very important influence on the corrosion of the tin-iron couple and no doubt this explains how it is that slight adjustments in the acidity of certain canned fruits have a great effect either, in increasing, or in decreasing the rate of formation of hydrogen swells and perforations.

A further important factor in the behaviour of the tin-iron couple is the effect of tin salts in inhibiting the acid corrosion of iron. It has been shown that 2 parts of tin per million, as citrate in solution, are nearly sufficient to halve the rate of corrosion of steel by citric acid, and there seems little doubt that this is a powerful influence in increasing the resistance of tin-plate to acids. Certain organic inhibitors have a similar effect and the addition of these is one line of attack towards reducing losses in canning. Other promising lines of attack lie in the direction of suitable improvements in the steel base and in the tin coating.

In our work on the effect of citric acid on a number of metals in the absence of air over a period of immersion of 28 days and in the presence of air over a period of immersion was 14 days, the samples of sheet metal were partially immersed in a 1% solution of citric acid after being cleaned with benzene and boiling alcohol. In most cases the effect of surface abrasion on the rate of corrosion was studied. The corrosion was studied at one temperature, viz., 25° C.

Stainless steels all showed excellent resistance in the presence of air whether the surface had been freshly abraded or not. In the complete absence of air, however, some of the samples corroded very badly after they had been freshly abraded. A stainless steel of this type does not appear to have a very wide margin of safety and might prove very unreliable under works conditions. A chromium-nickel alloy containing little iron showed more corrosion in the absence of air than in its presence but, in both cases, the figures are very low and it would almost appear that this is a very promising material. Monel metal also showed very little corrosion in the absence of air, but about the same as copper in its presence. Nickel, like the chromium nickel alloy, corroded in the absence of air; unlike the alloy it showed a considerable corrosion in the presence of air. Copper gave good results in the absence of air. With tin, there was little corrosion in the absence of air and considerable corrosion in its presence. Tinned copper was similar to tin—if anything the presence of the copper reduced the corrosion of the tin slightly. Pure silver gave splendid results under both conditions. It is interesting, however, that both the silver-plated copper and the double metal silver (welded to copper) have given a fair amount of corrosion of copper in the presence of air.

With aluminium the difference between air-free and air-present conditions is less than with most of the other materials; both it and the Al-Mg alloy are excellent metals for a typical fruit acid at this temperature. Fresh abrasion increased the corrosion a little but not very much and it is noteworthy that the so-called anodically oxidised material, which perhaps has better resistance to atmospheric conditions, shows a greater loss in weight in acid solutions than any of the other specimens.

Taking a general view of the results the outstanding features to remember are, first, the enormous effect of air in increasing the corrosion of nickel, copper and tin and their alloys and, second, the fact that air tends to be beneficial with the other group of metals, chromium, aluminium, etc. where the protection is due to a film of oxide. This particular research, however, only covers the effect of ½ or 1% solutions of citric acid at one temperature.

In the next paper, Mr. N. D. Sylvester, of Messrs. J. Lyons & Co., Ltd., said:

In laboratory corrosion experiments consideration must be given to the contamination of the food by the dissolved metal and the destruction of the plant itself by corrosive action of the food.

Among the factors which can affect the progress of corrosion the following may be mentioned: (*a*) Temperature. (*b*) Presence or absence of oxygen, or gases evolved by the food. (*c*) Relative motion between the metal and the food. (*d*) Formation of films on the metal surface—either films which protect the metal from

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Taking a general view of the results the outstanding features to remember are, first, the enormous effect of air in increasing the corrosion of nickel, copper and tin and their alloys and, second, the fact that air tends to be beneficial with the other group of metals, chromium, aluminium, etc. where the protection is due to a film of oxide. This particular research, however, only covers the effect of $\frac{1}{2}$ or 1% solutions of citric acid at one temperature.

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In laboratory corrosion experiments consideration must be given to the contamination of the food by the dissolved metal and the destruction of the plant itself by corrosive action of the food.

Among the factors which can affect the progress of corrosion the following may be mentioned: (*a*) Temperature. (*b*) Presence or absence of oxygen, or gases evolved by the food. (*c*) Relative motion between the metal and the food. (*d*) Formation of films on the metal surface—either films which protect the metal from

further corrosion or those which prevent undue contamination of the food.

It is obviously necessary, therefore, that the actual practical conditions under which the metal is to be used must be simulated, as far as is possible in all laboratory corrosion tests, and the exactitude with which factory conditions can be reproduced in laboratory experiments largely determines their sphere of usefulness.

The many metals which may be used in the food industry and the numerous foods with which they may be brought into contact make this question a very extensive one. As would be supposed, the measurement of the corrosion of metals by foods has received a considerable amount of attention, and there is a fairly extensive literature on the subject. Nevertheless, each separate investigation must be based on a consideration of the actual working conditions, and the importance of this is well illustrated by the use of nickel for certain dairy equipment.

An ordinary laboratory test, in which nickel is partially immersed in hot milk, would show the dissolution of a relatively large amount of metal, and nickel behaves similarly in practice under conditions involving aëration at high temperatures. It has been found however, that nickel is a suitable metal for the construction of surface preheaters in the continuous pasteurization of milk, and that only a minute amount of metallic contamination occurs. On the other hand, much more nickel is dissolved if this metal is used for the surface coolers. The explanation is that in the first case cold milk comes into contact with hot metal and a protective film of proteiu substances is formed on the metal surface, protecting it from the action of the milk. In the second case, the hot milk comes into contact with cold metal and no protective film is formed.

As an example of the complete investigation of a practical corrosion problem, a paper by McKay, Fraser, and Searle (*Amer. Inst. Min. and Met. Engineers, Tech. Pub. No.* 192) may be mentioned. The work was carried out for the International Nickel Co., on the resistance of nickel and monel metal to corrosion by milk. The paper is divided into three sections: (1) Laboratory tests. (2) Plant experiments. (3) Discussion and conclusions. In the laboratory, metal specimens were exposed to the action of milk in glass bottles, under varying conditions of agitation, aëration, and temperature. Tests were run at low temperatures, at room temperatures, and at pasteurizing temperatures, and the influence of aëration was studied at these different temperatures. Variations in the milk itself were considered, and differences were observed between summer and winter milks. The influence of acid concentration and the effects of the various milk constituents were also investigated.

As the consequence of the information which these laboratory tests provided, plant experiments were undertaken, as the result of which data were obtained which were more accurate than those furnished by the laboratory corrosion tests, and the relative corrodibility of nickel and monel metal at all parts of the dairy equipment was determined. The protective film of protein on surface preheaters (which has already been mentioned) was discovered in these plant tests, and had not been predicted by the laboratory tests.

It was found in practice that the actual contamination of the milk by the entire use of nickel equipment was very much less than would have been predicted by a consideration of the results of the plant tests. The latter tests measured the corrosion of the metal, and not the contamination of the milk. The discrepancy is due to the formation of films on the metal surfaces of the equipment, which contain a large percentage (in one instance 97%) of the products of corrosion. These films are, of course, removed when the plant is cleaned.

The interpretation of the results of laboratory experiments calls for consideration of the following factors:—(1) Loss in weight of the test specimen; (2) Visual examination of the test specimen; (3) Determination of the metallic contamination of the food; (4) Toxicity of the dissolved metals; (5) Effect on the appearance, flavour, etc. of the food. The last three are obviously of particular interest in food corrosion experiments.

The loss in weight of the specimen is a useful determination in so far that it may give a direct comparison between two metals examined under identical conditions—provided that the nature of the corrosion is the same for both metals. Visual examination of the specimens is, therefore, necessary to enable us to decide the significance of the loss-in-weight figures. If pitting has occurred in one specimen but not in the other, it is obvious that weight comparisons are practically useless. In some corrosion tests an increase in weight is observed, and this is often the case with aluminium and its alloys. The products of corrosion are tenacious and cannot be removed by scrubbing: they are sometimes embedded in pits. In such cases the corrosion products may be removed by chemical means, such as immersion for a short time in cold 5% nitric acid. When this is necessary it is obvious that the contamination of the food is not measured by the total amount of the corrosion. The determination of the amounts of dissolved metals in the food is therefore an important factor in corrosion experiments, and the methods which have been suggested for these determinations are so numerous that selection becomes a difficult matter for those who have had no previous experience.

In our laboratories we use the following methods: Lead is determined colorimetrically as the sulphide after reduction of iron with sodium metabisulphite and conversion to ferrocyanide. Tin is determined by the usual method in which the metal is separated as sulphide, and finally titrated with standard iodine. Copper is determined colorimetrically with potassium ferrocyanide, after removal of iron etc. by precipitation with ammonia. Nickel is determined colorimetrically with α-benzil dioxime. Iron is determined colorimetrically with potassium ferrocyanide. Aluminium is determined by measuring the colour intensity of the lake formed with aurintricarboxylic acid. Zinc is determined by direct titration with standard potassium ferrocyanide solution after it has been separated from interfering metals. The question of the toxicity of the dissolved metals must of course be taken into account, and for equal amounts of contamination, the less toxic metal must be preferred. Apart from the question of

toxicity, the effect of small amounts of dissolved metal on the appearance, flavour and keeping qualities of the food must also be given due consideration.

The effect of copper on the keeping qualities of milk, and its tendency to develop a tallowy flavour, is well known. Iron shows a similar but less marked influence, while nickel is stated to be without effect. Copper in minute amounts exercises a marked influence on the keeping qualities of fats and fatty materials.

In the case of coffee, the presence of a few parts per million of dissolved metal can readily be detected in the flavour, and we have found that an expert taster can differentiate coffee which has been made in contact with stainless steel, and which showed no chemically detectable metallic contamination. The presence of small amounts of aluminium has a definite effect on the colour of tea and coffee, presumably because it forms coloured lakes with the tannins present. The presence of small amounts of iron will affect adversely the colour of boiled sugar.

Laboratory corrosion tests have at times been very unkindly criticised, but they can provide much useful information if due consideration is given to all the factors involved, and provided too much is not expected from simple tests.

Mr. Sylvester's paper concluded with a description of apparatus used in the laboratory to determine corrosion, and a number of interesting slides and graphs were shown to illustrate the apparatus and the results obtained.

Prof. C. H. Desch then said that although the metals in general use did not have any toxic effect, it would be interesting to know, in view of the known bactericidal effect of metallic copper in contact with solutions, even when no dissolution could be detected by chemical tests, whether any destructive effect on the important constituents of food present only in infinitesimal quantities could be observed. The result obtained by Mr. Bryan, according to which the chemical attack on copper and monel metal was actually reduced by fine abrasion, was very difficult to understand, and it would be interesting to know whether such results could be repeated, or whether the effect was merely due to the removal of some surface accelerator of corrosion. How far adulteration was of importance at the present day he did not know, but in connexion with the usual test for the chemical resistance of stainless steel cutlery, which consists in allowing a drop of vinegar to evaporate to dryness on a blade, he had found a cheap vinegar on sale which was quite capable of perforating a steel blade. The protective action of colloids was highly important.

A paper was then read on behalf of Mr. Donald McDonald, in which he outlined the use of silver in the food and allied industries. This application of silver was comparatively recent, dating from the fall in price which had taken place between 1920 and 1930. Its principal use was in the vinegar and pickle-boiling industry, and there was an increasing application in the jam and confectionery trades. Quite large vessels had been lined with silver sheet and mixing gear could be covered in the same way. It was also employed for the distillation of hydrochloric acid and of essences and essential oils. The paper was illustrated with several interesting slides showing various plant constructed of silver.

In the discussion which followed, Mr. A. E. Hamblin said that the tallowy flavour of milk had also been shown to be produced by direct sunlight. It would be interesting to know if sunlight or artificial light had any effect in corrosion tests, and also the effects of lacquers on tin plates. Mr. Mark Bogod pointed out that the problems of the ice-cream industry were similar to those for milk plant. The effect of washing compounds was important in an industry where cleanliness was a prime necessity, and in this connexion aluminium presented many difficulties. Nickel-chromium steel alloys showed the greatest resistance to washing compounds containing active chlorine, and these appeared to be the most suitable metals available at present. Mr. J. W. Black, in referring to Mr. Morris's remarks on the suitability of aluminium for many foodstuffs in the presence of fat, stated that he had used an aluminium pan for many years for the preparation of gelatin, and the pan was in as good condition as ever. It was necessary to pay continuous attention to scouring and polishing the pan. Mr. D. M. Freeland remarked that a point not touched upon was the corrosion in plant due to the use of gas for heating. Both plant and flues conveying the products of combustion were affected, and the problem was one deserving the serious attention of metallurgists. Dr. R. Seligman said that aluminium, if suitably cared for, could be used successfully for boiling solutions containing gelatin, but had given trouble where used for the pans in which gelatin was allowed to set and in which no circulation could occur, so that what was assumed to be oxygen pitting took place. The reduction of corrosion by surface abrasion of aluminium he thought to be due entirely to the removal of corrosion products which, by harbouring dirt and in other ways, tended to promote corrosion. With regard to the greater resistance found by Messrs. Morris and Bryan in copper surfaces which had been abraded, he must warn them against generalizing from their observations. In some cases, at any rate, the reverse held true. It had been shown for instance, by the late Mr. Chaston Chapman, that bright copper surfaces exerted a more serious effect on the vitality of yeast than surfaces which had been allowed to become dull, and this fact was not recognized in brewing. Prof. Desch had referred to the bactericidal effect of minute traces of copper; another metal with the same property was silver, which was said to be oligodynamically active, and was actually being used for destroying bacteria in beer, under the combined influence of metal and heat. Personally he felt that the same result could be obtained by heat alone. He thought a general warning should be given against the general use of stainless steels in contact with brine. Under certain conditions their corrosion was rapid and serious. Whilst the discussion had been proceeding he had been wondering if food chemists and metallurgists could help one another in the solution of many difficult problems, only a small proportion of which had been raised that evening.

At the conclusion of the meeting, Messrs. Morris and Bryan commented briefly on the discussion, and a vote of thanks to the chairman, Dr. Lampitt, and all the speakers, was moved by Mr. S. L. Archbutt, chairman of the London Local Section of the Institute of Metals.

BRITISH ASSOCIATION OF CHEMISTS

A hot-pot supper and smoker was held at the Stork Hotel, Queen's Square, Liverpool, on Wednesday, February 1, 1933, at 6.45 p.m. There was an excellent attendance of members and friends who were afterwards entertained by Mr. Woodward and "Bill." Mr. H. P. Minton, Mr. L. Wild, Mr. Casson, and others contributed musical and other items to the programme.

Mr. C. B. Woodley, general secretary, spoke upon the activities and continued progress of the Association, emphasizing the value of membership and the benefits to be obtained through the Appointments Bureau and the Legal Aid and Insurance Departments. Mention was also made of the improved industrial outlook and the increasing number of appointments which are becoming available at reasonable salaries. Mr. Woodley complimented the Liverpool Section on the excellent work it was doing, and the success with which its propaganda campaign was meeting.

Prof. E. C. C. Baly, C.B.E., F.R.S., president, in addressing the members stated that he was very proud of the high honour of having been elected president of the Association for this year, and that since he was a member of the Liverpool Section this was also an honour to the Section. Continuing, Prof. Baly stated that there was a splendid opportunity before the Association since its activities were so necessary to the welfare of the professional chemist, as all must ultimately take up membership.

After an appeal by the chairman of the Section, Mr. H. P. Minton, a collection on behalf of the Special Aid fund was made. The sum collected was over £3. On behalf of the treasurer the general secretary thanked members for this generous support.

MINERALOGICAL SOCIETY

A meeting of the Mineralogical Society was held on January 26, with Sir John S. Flett, president, in the chair.

The following papers were read: "Meteoric irons and silica-glass from the meteorite craters of Henbury (Central Australia) and Wabar (Arabia)," by Dr. L. J. Spencer. The materials from these two recently discovered occurrences throw much light on the formation of meteorite craters. Such craters are not merely dents made on the earth's surface by the percussion of large meteorites; they are explosion craters due to the sudden vaporization of part of the material, both of the meteorite and of the earth, in the intense heat developed by the impact. The meteoric iron from these two localities is of exactly the same type, namely a medium octahedrite containing 7·3% of nickel. At Wabar a 25 lb. mass and a few small fragments of iron were collected; but at Henbury thousands of masses of iron are scattered around the craters.

Silica-glass, which is of rare occurrence in nature, shows a remarkable development at Wabar. A snow-white, highly vesicular glass was formed by the fusion of the clean desert sand; and bombs of this material shot out from the craters were coated with a thin skin of black glass free from bubbles and containing iron and nickel in the same ratio as in the meteoric iron.

"Garnet in the Dartmoor granite: its petroge significance," by Dr. A. Brammall and Mr. S. Brace Seventeen occurrences prove to be manganife almandines containing 3% to 22% of MnO. Two or r varieties may occur in a single hand-specimen of granite. The more manganiferous varieties (7% M are restricted to the tor-horizons; the less manganife varieties occur (*a*) below these horizons, (*b*) in sl contaminated facies of the granite, and (*c*) in xenol hornfelsed shale.

"The identity of mottramite and psittacinite cupriferous descloizite (cuprodescloizite)," by Mr. E Bannister (with chemical analyses by Mr. M. H. H Oscillation, Laue, and rotation photographs show descloizite has an orthorhombic unit-cell with e $a = 6{\cdot}05$, $b = 9{\cdot}39$, $c = 7{\cdot}56$A, and space-group (The unit-cell contains 4 $PbZn(VO_4)(OH)$. Pov photographs of descloizite, cuprodescloizite, mottran and psittacinite from the type localities are ident with each other.

SOCIETY OF PUBLIC ANALYSTS AND T FOOD GROUP: JOINT MEETING

A joint meeting of the Society of Public Anal with the Food Group of the Society of Chemical Indu was held on Wednesday, February 1, at the Bar Hall, Wimpole Street, W., by kind permission of Royal Society of Medicine. The president of the Soc of Public Analysts, Mr. F. W. Arnaud, was in the ch

Certificates were read for the first time in favou A. T. S. Babb, S. H. Cakebread, H. Phillips, and D. Raymond. The following were elected meml of the Society of Public Analysts: C. K. Boundy, R. Callow, M. E. Catt-Camfield, J. Dewar, C. W. He H. H. Jones, F. L. Okell.

The president extended a welcome to the meml of the Food Group of the Society of Chemical Indu and opened the discussion on "Changes taking pl during the Storage of Fruits," first outlining the effo of the British farmer to produce sound fruit.

Dr. L. H. Lampitt (chairman of the Food Gro referring to the methods of preserving soft fru pointed out that the jelling power of soft fruits reduced or destroyed by freezing. Preservation lemon juice by the action of cold was effected provi that not too much essential oil was present, but process was ineffective for orange juice.

Dr. Ezer Griffiths, discussing the technique of pre-cooling and transport of fruit, gave a descript of the plant and refrigerating trucks used in South Afr He also gave an account of the apparatus used measuring the moisture at the optimum storage tempe ture and the relationship between the temperature a atmospheric moisture, and discussed the laws govern evaporation from surfaces.

Mr. H. Williams called attention to the effect of carbon dioxide produced by apples on the developm of "brown heart." For apples in cold storage the b results were obtained by causing the air to circul so as to remove carbon dioxide and prevent moist settling on the surface. Pre-cooling was not essent

in temperate climates. Mr. T. Rendle said that fruit kept in cold storage had not the flavour of the original fruit. A method that would enable soft fruits to be kept until they were out of season had yet to be devised. Mr. A. Samson said that storage of soft fruit in carbon dioxide was useless. Freezing in 30% syrup was the most effective method of preservation, but exposure of the frozen fruit to the air caused oxidative changes which destroyed the flavour. Oranges could not be preserved under conditions suitable for apples. Storage in an inert gas, such as carbon dioxide, hydrogen or nitrogen, or in a vacuum, was ineffectual. Messrs. A. More, T. McLachlan, Barrs, Coyne and F. R. Stephens also contributed to an interesting discussion.

OBITUARY

PROF. C. M. THOMPSON

By the death of Claude Metford Thompson on January 4 the Society has lost a distinguished member of nearly 50 years' standing.

Thompson was born of Quaker parentage in Bridgwater in 1855 and in due course studied at University College, London, then Trinity College, Cambridge, where he graduated M.A., and later with Claisen at Bonn. In 1881 he was awarded a D.Sc. by London University and in 1883 was appointed first Professor of Chemistry in the then newly-formed University College of South Wales and Monmouthshire at Cardiff under Principal Viriamu Jones. This post he held until 1921, when he retired and was elected Emeritus Professor. He also represented the University of Cambridge on the Court of Governors of the University of Wales. The College which developed so well and the University both owed much to his administrative ability, sound judgment, and wise counsel as a member of its Senate, also to his teaching skill.

If, as Plato says, "Science is true judgment in conjunction with reason" Thompson was well awarded a doctorate therein; his wise counsel was constantly in request and always freely at the disposal of others. He was a man of simplicity of character and wide culture, full of ripe experience and erudition; well read, well travelled, kindly and courteous, an example of a scholarly gentleman of the more spacious days which have passed. Few can now have the leisure to acquire so wide a store of learning, both ancient and modern. The writer well remembers the charm of evenings spent at his house and the wide sympathies and interests shown in his conversation. He was the author of several papers on organic subjects in the early eighties, but his later scientific investigations centred chiefly round geological problems, the chemistry of the rare earths and their industrial application. He was an ardent climber and long a member of the Alpine Club, also one of the British members of the Swiss Alpine Club, an enthusiastic gardener and an active member of the Cardiff Naturalists' Society.

Thompson joined the Society of Chemical Industry in 1885, but an early attempt to start a section in South Wales did not mature, mainly owing to geographical difficulties. In 1917, however, the Bristol and South Wales section was formed, Thompson being on its committee, which met in Bristol; meetings were also held in Cardiff and in 1919 it was possible to form a separate South Wales Section of which Thompson was first chairman, and on the committee of which he served for many years. He was always greatly interested in the local chemical industry and frequently helped it much by sound knowledge and judgment. By his passing at the ripe age of 77 years the Section has suffered a great loss, for Thompson was a man not easily replaced and one who will be much missed by his friends.

H. E. Cox

CORRESPONDENCE

THE HYPOCHLORITES AS DISINFECTANTS

SIR,—An article in CHEMISTRY AND INDUSTRY of January 27 gave an excellent description of the manufacture and properties of hypochlorites and their use as disinfectants, particularly in connexion with foodstuffs.

It is not our intention to question the facts stated with regard to the application of hypochlorites, but the table of germicidal values, reproduced from Thorpe's Dictionary of Applied Chemistry, is calculated, in our opinion, to give a wrong impression of the types of disinfectants available to-day for general disinfectant purposes.

With your permission we should like to reproduce part of this table, and to comment on the Rideal-Walker coefficients claimed:

Agent	Germicidal value
Cresylic acid (commercial)	3·7
Hypochlorites (calculated on available chlorine)	146—220
Mercuric chloride	400—3540
Potassium permanganate	42

Mercuric chloride.—The germicidal values quoted are entirely misleading, and were probably determined in the days before it was realized that the small quantity of $HgCl_2$ carried over to the subculture tubes had an inhibitory effect on the test organism (*B. typhosus*). When this is corrected by the addition of $(NH_4)_2S$ to the subculture tubes, the Rideal-Walker coefficient becomes about 23. The extremely poisonous nature of mercuric chloride is the strongest argument against its use.

Hypochlorites.—It will be noticed that the values quoted are "calculated on available chlorine," and as the latter rarely exceeds 12½% in commercial solutions the values given should be divided by eight, thus giving coefficients of 18—27.

Coal Tar Disinfectants.—Cresylic acid is the only disinfectant agent mentioned that bears any relation to the modern coal-tar disinfectants. These are now made with coefficients quite as high as the corrected value for hypochlorites quoted above, and for general disinfectant purposes possess decided advantages over other types of disinfectants. Organic matter is almost invariably present during disinfection, and under these conditions hypochlorites, permanganates, and mercuric chloride suffer a serious reduction in their germicidal values.

The following table gives the Rideal-Walker coefficients obtained in the presence of organic matter:

Diluent	Hypochlorite solution	$KMnO_4$	Coal-tar fluid
Water	*21·0*	*50·0*	*14·0*
Urine	0·9	0·8	12·5
1% Serum	1·6	17·0	13·5
1% Mucin	1·1	3·0	13·0
1% Peptone	0·2	1·3	13·5
1% Casein	0·3	1·7	13·0
1% Gelatin	0·4	7·5	14·5
1% Blood	0·6	6·2	13·5

Coal-tar fluids of much higher coefficient than that used in these tests can be obtained, but the table serves to show the superiority of this class of disinfectant in the presence of organic matter. For this reason it may fairly be claimed that coal-tar disinfectants are the most suitable for general disinfection purposes.

I am, Sir, etc.,

FOR JEYES' SANITARY COMPOUNDS CO., LTD.,

JAS. GIBSON,

Chief Chemist

London, E. 13
Feb. 10, 1933

PERSONAL AND OTHER ITEMS

We regret to announce the death on February 12 of Sir J. Arthur Thomson, LL.D., Emeritus Professor of *Natural History in the University of Aberdeen*, who was well known as a writer and lecturer on biological subjects and the relation of science and religion.

We deeply regret to learn of the death in December last of Mr. C. A. R. Macintyre, who was well-known to members of the Society in Canada, and some in England, as the son of Dr. A. E. Macintyre of the Ottawa Section. "Alex" Macintyre was not quite twenty-eight years old at the time of his death, but he had established a reputation as one of the most promising young men in Canada in the advertizing field. During the Imperial Economic Conference at Ottawa last year he gave very useful assistance to Dr. E. F. Armstrong, Mr. J. Davidson Pratt, and other delegates to the Conference. He was universally popular, and possessed something of the same energy that has made his father one of Canada's most noted scientists.

Sir Robert Hadfield has been elected an honorary member of the Academy of Science of the U.S.S.R. in recognition of his services to metallurgical research.

Sir David Milne-Watson, governing director of the Gas Light & Coke Co., has joined the board of the South-Eastern Gas Corporation, of which he will be chairman. New directors of the Corporation include Mr. Henry Woodall and Mr. W. R. Foot, whilst Mr. G. M. Gill is retiring from the board to become consulting engineer.

We regret to announce the death on February 7 of Mr. Arthur V. Hunt, a member of the Society since 1900. Mr. Hunt, who was a native of Manchester, was manager of the chemicals department of Lever Brothers, Port Sunlight, with whom he had been employed for the last twenty-nine years.

We regret to learn of the death recently of Mr. G. H. Buchanan, *chemical engineer and chief technologist* of the American Cyanamid Co. Mr. Buchanan did considerable work on the chemistry of cyanamide and cyamides, plastics and resins, and flotation reagents, and held a large number of American and foreign patents.

Mr. J. W. Cuthbertson, M.Sc. has been appointed assistant lecturer in metallurgy in the University of Manchester, the appointment to date from September 29, 1933.

We regret to learn of the death on February 9 of Dr. John Watts, of Merton College, Oxford. Dr. Watts was associated with the University for 55 years, and was a very successful tutor of many generations of chemistry students. In his early years he was personally acquainted with Faraday and was for several years assistant to Prof. Odling. He died at the age of 89 in the rooms he had occupied in Merton for more than 50 years.

Mr. A. Chaston Chapman, F.R.S., left estate of gross value £16,571, with net personalty £15,075.

Sir Dugald Clerk, K.B.E., F.R.S., D.Sc., the consulting engineer, who died in November last, left estate of the gross value £54,412, with net personalty £41,005. He bequeathed substantial amounts to the Institution of Civil Engineers, the Royal Society, the Royal Institution, the Institute of Mechanical Engineers, and the Universities of Glasgow, Leeds, St. Andrews, Manchester, and *Liverpool*.

Trade Marks Law

The President of the Board of Trade has appointed a Committee to report upon the desirability or otherwise of changes in the existing law and practice relating to trade marks. The chairman is Viscount Goschen, and other members of the committee include Mr. J. E. *James, secretary to Imperial Chemical Industries, Ltd.*, and Mr. C. B. L. Tennyson, secretary of the Dunlop Rubber Company and a member of the Council of the *Federation of British Industries*.

Fuel Oil from Coal

According to the *Financial Times*, a contract for a year's bulk supply of oil has been placed by the Admiralty with Low Temperature Carbonisation, Ltd. The order follows exhaustive trials of the fuel by H.M.S. "Westminster," which indicate that it extends the cruising range as compared with ordinary petroleum oil. It is stated that the oil is to be supplied at a price which compares favourably with the standard price for first-class bunker petroleum oil.

Vitamin-*A* Concentration

A further step towards the isolation of pure vitamin-*A* is indicated in a recent communication to *Nature* from Dr. F. H. Carr and William Newell. Several workers have believed that the highest concentrations of vitamin-*A* they were able to obtain were almost pure, but the latest work in the B.D.H. laboratory shows a very marked increase in concentration. Thus the antimony trichloride blue value for the purest vitamin-*A* obtained by Heilbron and his colleagues was 65,000, but Carr and Newell have obtained a fraction boiling between 136° C. and 137° C., which has a figure of 78,000, and the belief that the substance is a purer vitamin than any hitherto described is confirmed by spectroscopic figures.

This substance shows no optical activity in alcoholic solution, whilst analysis shows C = 83·5% and H = 10·6%, which are in excellent agreement with the formula $C_{22}H_{30}O$ suggested by Karrer. An idea of the concentration of this product can be gauged from the fact that the Carr-Price value is 13,000 times that of the cod-liver oil of the B.P. 1932.

Bakelite Impregnation of Fossil Bones

In a recent issue of *Nature* attention is drawn to a very interesting use for Bakelite suggested in a paper (*Museums Journal*, May, 1932) by Nichols and Orr of the Field Museum of Natural History in Chicago. The preservation of fossil bones found in the more recent geological strata has always been something of a problem for collectors and curators, exposure to air causing the bones quickly to crumble. A number of materials, including paraffin wax and shellac, have been used for impregnating such bones, but a more satisfactory method has now been developed with Bakelite. Broken bones are cemented with a mixture of plaster of Paris and dextrin, and then lowered into a tank of Bakelite made sufficiently fluid by the addition of a thinner. The bones are then allowed to dry and the surface cleaned. If a specially strong surface is required the bones are baked at a temperature of about 208° F.

World Power Conference

A sectional meeting of the World Power Conference is being held this year in Scandinavia, and technical sessions will be held in Stockholm from June 28 to July 4. Forms of application for membership will be available shortly, and may be obtained from the British National Committee of the Conference, 63, Lincoln's Inn Fields, London, W.C.2. The following British papers have been announced: "A Survey of Industrial Electrical Power Supply in Great Britain," by H. Hobson, F. Forrest, and C. D. Taite; "Long Distance Gas Transmission in England," by Dr. E. W. Smith, C.B.E.; "The British Coal Survey," by Dr. F. S. Sinnatt, M.B.E., and H. E. Witton; "Some Notes on English Diesel-Electric Practice," by A. E. L. Chorlton, M.P.; "British Marine Oil Engines," by I. V. Robinson; "Electric Resistance Furnaces," "High Frequency Induction Furnaces," and "The Handling of Urban and Suburban Passenger Traffic by Railway, Electric Traction, Tramways and Motor Omnibuses" (authors not yet announced).

Rayon Test Case

In the action brought by British Celanese, Ltd. against Courtaulds, Ltd. for infringement of its patents in the manufacture of rayon, judgment has been given by Mr. Justice Clauson for the defendants. In the action, which was brought in November, 1932, and lasted for 35 days, British Celanese claimed an injunction restraining Courtaulds, Ltd. from infringing patents relating to the form and solidification of films composed of a cellulose derivative, the twisting and simultaneous winding into a thread of a number of filaments, and the production of silk of a desired quality and uniformity of the desired denier. The counter-claim by Courtaulds that the patents were invalid and should be revoked was allowed.

Association of British Chemical Manufacturers

The Association of British Chemical Manufacturers recently issued its official directory "British Chemicals and their Manufacturers" for the year 1933. It contains in English, French, Spanish, Italian, portuguese, and German a list of the members of the Association, a classified list of British chemicals, a list of proprietary and trade names, and the necessary indexes. It retains its familiar form and appearance. Two or three names have disappeared from the list of members and a few new firms have been added, Messrs. William Edge & Sons, Ltd., Keeling & Walker, Ltd., Refiners, Ltd., Scottish Chemical Co., Ltd., John & E. Sturge, Ltd., Synthite, Ltd., and Whey Products, Ltd. The book has 24 pages more than the previous volume, an indication that many more chemical products are now manufactured here.

Duddell Medal

The Duddell Medal of the Physical Society has been awarded to Wolfgang Gaede, director of the Physical Institute at Karlsruhe. This is the tenth award of the Duddell Medal, which is given for important contributions to the advancement of knowledge by the invention of scientific instruments, or the discovery of materials used in their construction. Prof. Gaede is well known as the inventor of a number of high vacuum pumps by means of which many important investigations have been carried out.

Canadian Mining

According to the Toronto correspondent of the *Financial Times* (Montreal) the laboratory at the radium refining plant of Eldorado Gold Mines, Ltd., established some months back at Port Hope, Ontario, is already in operation and the concentrating department is likely to be working almost immediately. Sulphate of radium is sold to the hospitals, being placed in platinum containers enclosed in lead. Bromide of radium (soluble in water) is the form in which the product is sold for ordinary commercial use. It was stated recently by Mr. L. L. Bolton, Assistant Deputy Minister of Mines at Ottawa that the chemists of the Dominion Department of Mines have succeeded in concentrating the radium from one part in ten million to one part in 100,000. The concentrate is virtually free from all other impurities except barium and represents 95% of the radium present in the original ore. Already over 4000 grammes of this radium-barium compound, all ready for the refinery, has been concentrated by chemists of the Dominion Department of Mines and it is confidently expected that early this year several grammes of radium from Canadian sources will be available for use in the radium emanation plant shortly to be installed at Toronto University.

Indian Notes

Paper pulp. A rod mill has been erected in the experimental factory of the Paper Pulp section at Dehra Dun Forest Research Institute for carrying out investigations on short fibred materials used in the manufacture of paper. Some of these materials have previously been the subject of experiment, but had not been found satisfactory for bleached papers. In the light of recent technical development, economical and profitable uses

may now be found for them. In addition to grasses certain pulp woods from the Himalayas are being tested, and if these tests are successful, the manufacture of mechanical pulp from conifers, with the assistance of the electric power supplied by the Mundi Hydro-Electric scheme, may become a commercial proposition in the near future. Eucalyptus wood from South India is also being used in the experiments.

Indian Road Tar.—Due to the depression several coke-oven plants in India have been closed down, with the result that work on the development of the by-products has been arrested. Experiments dealing with the recovery of road tar had so far advanced as to yield a really satisfactory tar comparable with English road tar, but unfortunately the lack of demand for hard coke has compelled the closing of the plants.

World Petroleum Congress

The World Petroleum Congress, which is organized by the Institution of Petroleum Technologists is to be held this year at the Imperial College, South Kensington, from Thursday, July 20 to Tuesday July 25. A preliminary outline of the subjects to be dealt with shows that in the engineering and chemical sections subjects will be discussed such as drilling, production, gas and oil collection and treatment, hydrogenization, solvent extraction, fuels for high speed Diesel engines, knock-rating of Diesel fuels, and safety in plant. A number of papers will also be presented on subjects connected with standardization. Membership of the Congress is open to all interested persons at a fee of 10s. Amongst arrangements which have been made for the conference are a private view of the International Oil Industries Exhibition, an exhibition of films illustrating the petroleum industry, and a dinner to foreign delegates.

German Chemical Plant Exhibition

In accordance with the wishes of plant and equipment manufacturers exhibiting at the chemical plant exhibition "Achema VII" to be held in Cologne this year it has been finally decided to hold the exhibition during the week May 18 to 27. The exhibition of the German Society for Rubber Industries, which was to have been held in conjunction with the Achema VII, will take place independently in Cologne.

Platinum in U.S.A.

A pamphlet recently issued by the United States Bureau of Mines states that America produced 885 oz. of platinum in 1931. The value of platinum metals imported was $3,531,071, as compared with $5,836,492 in the previous year. Of the total sales during the year, chemical industry absorbed 11% for catalysts and laboratory equipment, and 25% was taken up by the electrical industry, the remainder being mainly divided between dental preparations and jewellery.

Metallurgical Research at Pittsburgh

A new programme of research which is to be commenced shortly by the Bureau of Metallurgical Research at the Carnegie Institute of Technology, Pittsburgh, will include work on the segregation of ferrite and cementite, studies on precipitation from solid solutions and age hardening and the detection of internal stresses by *X*-rays.

REVIEWS

CHAPTERS IN MODERN INORGANIC AND THEORETICAL CHEMISTRY. By E. S. Hedges, D.Sc., M.Sc. Ph.D., *Pp. vii + 279.* London: Edward Arnold & Co., 1932. 12s. 6d.

It is hardly fair or encouraging to the author of a useful book to complain that he has not treated his subject as fully as might be wished, and the critic who, having acquired something good, complains only of its size merely exposes himself to the accusation of greed. Nevertheless one hopes that in a future edition it may be found possible to extend some of the chapters without largely increasing the price of the book. Nobody would suppose that modern inorganic and theoretical chemistry can be adequately outlined in a volume of less than three hundred pages; on the other haud, honours students of chemistry, for whom the book is primarily intended, can scarcely obtain a sufficient conception of the modern position of, for example, the chemistry of the rare earths, or of intermetallic compounds, from five pages of description, or of progress in radioactivity from little more. Not every subject is so summarily discussed; the impression left by the chapters on, say, corrosion and on colloids, brief as they are, is more satisfying. With this reservation, the book can be recommended unhesitatingly as a résumé and a guide to further reading. A short chapter on the periodicity of the elements is followed by a discussion, at rather greater length, of allotropy, including a summary of the present position of work on the influence of intensive drying on physical properties. There are three rather more descriptive chapters, devoted respectively to the properties and reactions of some of the less common elements, to the general properties and separation of the rare earths, and to the new elements rhenium and hafnium. Complex ions and co-ordination compounds and the phenomena of radioactivity are dealt with briefly: the structure of the atom, isotopes, atomic weights, and valency receive rather more detailed treatment. Chapter eleven discusses the structure of crystals, whilst the following chapter is devoted to a consideration of some inorganic catalytic reactions. In this section, as elsewhere, the emphasis which the author lays on the undesirability of differentiating between "inorganic" and "physical" chemistry is joined by a similar insistence on the inter-relationship between "pure" and "applied" science. A short chapter on intermetallic compounds is followed by valuable summaries of work on corrosion and on inorganic colloids. A. A. E.

DIE METALLSEIFEN. By Dr. H. J. Braun. Pp. viii + 83. Leipzig: O. Spamer, 1932. Paper, 7 rm.; bound, 8.50 rm.

This is the first time, so far as we know, that the metallic soaps have had a text-book to themselves: their growing importance in industry merits this distinction. The term is applied to the non-alkali salts of the higher fatty acids, wax and resin acids and the naphthenic acids, and includes the whole range of metals. In this book, after a few introductory pages, the soaps of each metal are described separately in alphabetical order, so that reference is facile.

The metallic soaps may be liquid, as zinc oleate, pasty like lead oleate, or hard and porous, as, for example, cadmium stearate, or may assume any intermediate state: in practice their successful use depends largely on their colloidal condition. Their waterproofing value, for example, is due to their capacity for absorbing water. Their uses in industry are too numerous to be enumerated here; they are set out in connexion with each of the metals. The description in each case is full where the soap has technical importance, and there are numerous references to the original literature collected together at the end of the book. The soaps which are only of theoretical interest, such as those of the rare earths and the platinum metals, are merely listed. In any case their price puts them out of consideration, though no one can say to-day when a particular substance, however rare, will become of technical importance. Most attention is naturally paid to the aluminium, lead, calcium, copper, magnesium, and manganese soaps. The book should be of considerable value to all those who use this class of material, particularly since the information it contains has hitherto been widely scattered. E. F. A.

ATOMIC REACTIONS. By M. Polanyi. Pp. 63. London: Williams & Norgate, Ltd., 1932. 6s.

Professor Polanyi's ingenious and spectacular researches have played such an important part in the development of modern chemical theory that a clear and concise account of his work, such as he has given us in this little book, constitutes a very desirable addition to the chemist's library. A brief account of the application of the theory of Heitler and London to the calculation of energies of activation is followed by two sections in which experiments with atomic sodium are described, and the most important results are conveniently tabulated. An interesting parallel is drawn between these processes and certain comparable ionic reactions and it seems reasonable to expect that this may lead to further progress in the theory of chemical reaction in solution. The matter suffers slightly from being too highly compressed, but on the whole it is a very readable book, although rather dear at 6s.

COMPANY NEWS

BOOTS PURE DRUG CO.

It is reported that the Tobacco Securities Trust has purchased 200,000 of the 1,125,000 ordinary shares of Boots Pure Drug Co. held by the United Drug Co. of America. The price paid is stated to have been in the neighbourhood of £6 12s. as against the London quotation of £7 10s.

SOUTH METROPOLITAN GAS CO., LTD.

The ordinary general meeting of the company was held on Wednesday, February 8, with the President, Dr. Charles Carpenter, in the chair. The financial results of the year's working were given in CHEM. & IND. of February 10. In his address, Dr. Carpenter criticized the present position regarding price control of coal, exercised with the authority of the Coal Mines Act, 1930, by which coal could not be bought by gasworks on the open market; thus other industrial users, such as iron and steel makers, were charged at a much lower price. Dr. Carpenter said that a big demand had developed for "Coalite," but a surprising feature was that the demand was from the less affluent users of domestic fuels. At present it did not pay, but the engineering staff was directing its efforts to see how far the defects could be overcome. The company was also pushing on with the improvement of domestic coke. Tar for road making was a developing business, the qualities needed being much better understood than some years ago. Ammonia was a definite loss.

BORAX CONSOLIDATED

The directors of the company are again unable to recommend payment of dividends for the year ended September 30, 1932, on the preferred ordinary and deferred ordinary shares.

SOUTH SUBURBAN GAS CO.

The net profit of the company for 1932 was £113,674, as compared with £109,510 in 1931. A final dividend of 3% is recommended on the ordinary shares, bringing the total for the year to 6%, as against a dividend of 6¼% in 1931. Sales of gas during the year showed only a very slight reduction from the previous year.

The company is promoting a Bill in the present session of Parliament to remedy certain inequalities of cost of supply that have arisen as a result of the growth of the company's limits of operation. The company is at present required to supply gas throughout its area at a uniform cost, and it is now stated that the differences in the cost of supplying consumers in different parts of the area are so pronounced that it is no longer expedient or equitable for the price to remain at a uniform figure. It is proposed to make a slight reduction in the basic price for supply within the metropolitan area and to increase the price outside the area from ½d. to 2½d. per therm. Discussions between the company's representatives and the London County Council with regard to certain details are still continuing.

I.G. FARBENINDUSTRIE

According to the report of the company for the final quarter of 1932 the signs of an economic revival which were anticipated at the end of the previous quarter have on the whole continued, notwithstanding complications in foreign trade relations. Business in dyestuffs and auxiliary products continue to improve in Europe, and the improvement in the market for artificial fertilizers was maintained, especially in the home market. The quarter showed further progress in chemicals, although at a slow rate, and the rayon turnover was at the same level as the previous quarter, being a little higher than in the same period in 1931. The favourable points in the report indicate further improvements in the dyeing industry and fertilizer trade, and it is significant that during this quarter, and in the time which has since elapsed, the trust has been able to increase its staff by about 5000 men.

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., Feb. 3, 1933, p. 109).

TAR PRODUCTS

Naphtha.—Solvent 90/160, 1s. 5d.—1s. 6d. per gal. Solvent 95/160, 1s. 7d.—1s. 8d. per gal. Solvent 90/190, 11d.—1s. 2d. per gal.

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. *Belgium:* Articles of synthetic resin, bakelite, *etc.* (221). *Jamaica:* Paint, varnish, white lead, lubricating oils (214).

A Laboratory Emulsifier

Chemists who require to make in the laboratory small quantities of emulsions will be interested to hear that an inexpensive emulsifier is manufactured by Messrs. Quality Products, Ltd. of Hyde, Cheshire. Recently, by the courtesy of Dr. Karl Edwards of the Ormond Laboratories, we had an opportunity of seeing one of these machines in use. The two phases of an emulsion of water and white oil were first mixed and then poured into the hopper of the machine, and were then converted into an emulsion by the simple process of raising and lowering successively a handle, similar to an ordinary pump handle. This handle actuates a reciprocating plunger, which forces the two phases past a non-return valve and through a very fine orifice, the resulting emulsion exuding into a beaker placed below. The emulsifier occupies very little space and can be screwed down to a laboratory bench.

Nicrosilal

An interesting publication recently issued by the Mond Nickel Co., Ltd., Thames House, Millbank, S.W.1, deals with the heat-resisting nickel–chromium–silicon cast iron which is manufactured under the name "Nicrosilal." The particular feature of this material is the presence in the austenitic cast iron of a much higher content than usual of silicon. The chromium which is present has a stabilizing effect on the high-silicon austenite and improves materially the heat-resisting properties of the matrix, with a refining influence on the graphite structure. Useful information is given in this brochure regarding the properties of "Nicrosilal" of varying composition and a number of applications of the alloy in engineering practice are illustrated.

Tangyes, Ltd.

A new series of attractive leaflets has recently been issued by the engineering firm Tangyes, Ltd. One of the most interesting of them deals with the Tangye VM Type Diesel transport engine, which claims complete absence of exhaust smoke or smell at all speeds and loads. The use of various metals in this engine is of interest; the cylinder head is of nickel iron, the cylinder block and crankcase is cast in one unit of an aluminium alloy, and connecting rods are drop-forgings of nickel-steel, bushed with bronze at the small ends and white metal at the big ends. Other leaflets deal with the well-known "Tan-Gyro" centrifugal pumps, such as are used for docks, drainage and sewage schemes, bucket and plunger well pumps, Tangye power presses, and the Tangye garage equipment—of which a very extensive range now exists.

PUBLICATIONS RECEIVED

REPORT ON ECONOMIC CONDITIONS IN ECUADOR. SEPTEMBER, 1932. By R. M. Kohan. Department of Overseas Trade. No. 535. Pp. 44. London: H.M. Stationery Office, 1933. 1s. 6d.

WATER POLLUTION RESEARCH. SUMMARY OF CURRENT LITERATURE. VOL. VI, No. 1. JANUARY, 1933. ABSTRACTS NOS. 1—120. Department of Scientific and Industrial Research. Pp. 36. London: H.M. Stationery Office, 1933. 2s.

ON THE MECHANISM OF OXIDATION. By H. Wieland. Pp. x + 124. New Haven: Yale University Press; London: H. Milford, Oxford University Press, 1932. $2.50. 15s. 6d.

DER CHEMIE-INGENIEUR. Edited by A. Eucken and M. Jacob. VOL. I, PART I. HYDRODYNAMISCHE MATERIALBEWEGUNG: WÄRMESCHUTZ UND WÄRMEAUSTAUSCH. By M. Jakob and S. Erk. Pp. xix + 539. Leipzig: Akademische Verlagsges., 1933. Paper, 52 m.; bound, 54 m.

MINERAL INDUSTRY OF THE BRITISH EMPIRE AND FOREIGN COUNTRIES. BORATES. 2nd ed. 1920—1932. Imperial Institute. Pp. 44. London: H.M. Stationery Office. 1933. 9d.

SÄURE-BASEN-INDICATOREN. By Dr. I. M. Kolthoff and Dr. H. Fischgold. Pp. xi + 416. Berlin: J. Springer, 1932. Paper, 18.60 rm.; bound, 19.80 rm.

ZOOLOGIE BIOLOGIQUE. By E. Rabaud. PART II. LES PHÉNOMÈNES DE NUTRITION. Pp. 224—476. Paris: Gauthier-Villars et Cie, 1933. 50 fr.

STEREOCHEMIE: EINE ZUSAMMENFASSUNG DER ERGEBNISSE, GRUNDLAGEN UND PROBLEME. Edited by K. Freudenberg and others. No. 6. Pp. 799—958. Leipzig and Vienna: Franz Deuticke, 1933. 18 m.

COLLOID ASPECTS OF TEXTILE MATERIALS AND RELATED TOPICS. Faraday Society Discussion, September, 1932. Pp. 368. London: Faraday Society, 1932. 15s. 6d.

REPORT OF THE DEPARTMENT OF INDUSTRIES, MADRAS, FOR THE YEAR ENDING MARCH, 1932. Pp. 71. Madras: Government Press, 1932. 8 annas.

REPORT OF THE FOREST PRODUCTS RESEARCH BOARD FOR 1931. Department of Scientific and Industrial Research. Pp. vii + 51. London: H.M. Stationery Office, 1932. 3s. 6d.

HANDBUCH DER BIOLOGISCHEN ARBEITSMETHODEN. Edited by Prof. E. Abderhalden. DIE METHODEN DER DIENSYNTHESE. By K. Alder. ABT. I, CHEMISCHE METHODEN, TEIL 2, 2. HÄLFTE, HEFT 9 (SCHLUSS). LIEFERUNG 400. Pp. 3079—3291. Berlin: Urban & Schwarzenberg, 1933. 13.50 rm.