REPORT ON SEVENTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.

By Major W. W. O. Beveridge, D.S.O.
Royal Army Medical Corps.

(Continued from p. 208.)

SEWAGE DISPOSAL AND TREATMENT.

Dr. J. Grossman, of Manchester, read a highly interesting and very important paper on the disposal of sewage sludge, in which he said that the present mode of sewage sludge disposal is not only objectionable from a hygienic point of view, but is absolutely against all economic principles. In most places it is dumped on land, after concentration which is carried out by filter pressings, producing a cake containing about 50 per cent. of water and 50 per cent. of solid matter. A town of 100,000 inhabitants will produce some 30 tons of pressed sludge per day, so that the cost of its disposal is very considerable.

Its value as a manure is considerably reduced, and in many cases nullified by the fact that it clogs up the soil, owing to the large amount of fatty matter, grease, and soap contained in it, which comes from domestic sources. It is computed that 400,000 tons of soap are used every year in this country, practically all of which finds its way into the sewage. The sludge cake should, therefore, contain at least 5 per cent. of fatty acids, a quantity which would amply repay recovering, if a practicable process could be found, and would leave a manurial residue which would neither clog the soil nor create a nuisance.

The difficulties have been partly chemical and partly mechanical. Broadly speaking, the problem has been approached from three different directions:

1. The extraction of grease by means of solvents.
2. The treatment of the sludge by destructive distillation.
3. The treatment of the sludge by non-destructive distillation.

The first two processes cannot be made to pay. It was the third process to which the author had given special attention for the past five years, having tried it on a large scale at Bradford, where the sludge is very rich in grease. Owing to mechanical defects it was not satisfactory, although the grease distilled over found a ready market at from £7 to £8 per ton. He now has remedied these defects and is using a process which enables him to completely distil off the grease, and to obtain a residue free from grease in the form of a dry powder, which is eminently suitable for manuring. It is now working at Oldham. His process is as follows: The sewage is settled in large tanks from which the sludge, containing about 90 per cent. of water, is obtained in the usual way. The sludge cake is dried and then mixed with a suitable quantity of sulphuric acid. The mixture is then passed through a special retort,
consisting of a cylinder in which revolves a hollow shaft bearing perforated hollow paddles, and the sludge is thus thoroughly agitated whilst steam is made to permeate the mass. The steam carries with it the fatty acids, and is condensed in a tower into which water is injected. The condensed fat collects on the surface of a tank, and after drying has the following average composition:

| Fatty matter (saponifiable) | ... | ... | ... | 60.0 per cent. |
| Unsaponifiable matter | ... | ... | ... | 22.0 " |
| Mineral and organic impurities | ... | ... | ... | 18.0 " |
| **Total** | **100.0** |

The crude grease contains 70 per cent. of stearic acid, a valuable article of commerce used in large quantities. The residue varies, owing to the constant variations in the composition of the sewage sludge. It is of a brownish colour, fine as flour, quite odourless and is sterilised. It contains 40 per cent. of partly decomposed organic matter, and thus resembles humus, besides containing nitrogen, potash and phosphates, constituting the basis of a good manure. The intrinsic value of the manure obtained on the basis of the above would be 25s. per ton, but the author takes it as 10s. a ton in basing his calculations. After explaining the working charges and values of the products he estimates the average profit for a town of 100,000 inhabitants at about £2,500 per annum. The cost of working by his process would amount to £2,616 per annum, whilst the amount realised by the sale of the products obtained should come to £5,078. He concluded by pointing out that his method not only solves the problem of the disposal of sewage sludge in accordance with hygienic principles, but does so on a remunerative basis, and exhibited samples of the products obtained at Oldham.

The aerobic method of sewage treatment was dealt with by Mr. W. J. Dibdin, F.I.C. He said the organisms available for sewage treatment included bacteria, fungi, infusoria, and most other protozoa (according to climate and temperature), larvae, and worms. The essential requirements for aerobic decomposition were:

1. The solids should be exposed to the air and action of organisms as completely as possible. Consequently, the solids should be spread in thin layers.

2. The liquid containing dissolved or partially soluble substances should at all times have sufficient oxygen in solution to prevent an aerobic action. The term "maintained aeration" referred to the degree or percentage of the total possible oxygen dissolved in a liquid; 100 per cent. maintained aeration indicates that the water contains as much free oxygen as an equal quantity of pure water can dissolve from the atmosphere in twenty-four hours when exposed in a quiescent state in an open vessel.

He found in practice that a sewage should not remain quiescent for
more than two hours; during this period the suspended solids will settle. In order that these solids should be spread in thin layers it was necessary that they should be deposited from shallow layers of water. He effected this by using large pieces of coke, clinker, or ballast in the tank, thus forming the coarse contact bed. With the admission of air on emptying the bed the layers of putrescible matter were well aerated and rapidly decomposed by the organisms which were thus cultivated. The whole process was inoffensive and the beds continued to work for from five to eight years.

In order to obviate both the silting up of the coarse beds and also the formation of sludge, he introduced the slate bed and obtained the following results after six years experience with it:

1. The suspended solids in the sewage are removed during quiescence.
2. The albumenoid ammonia is reduced 20 to 50 per cent., according to the sewage treated.
3. The amount of residue from the solids escaping in the effluent is less than 3.0 grains per gallon, i.e., a trace.
4. The decomposition of the solids is effected without nuisance.
5. The effluent is charged with forms of aerobic life, and consequently can easily be purified by further treatment.

The author was of opinion that, provided on exposure the final effluent maintained 50 per cent. of maximum oxygen, it will support fish life and purify itself further by the continued action of the organisms contained in it. To obtain such an effluent, either contact beds or continuous filters may be used. He did not see any real advantage in continuous filtration, as periodically such filters must be rested. When effluents were to be discharged where they would affect water supplies or shell fisheries, the desideratum was that they should be non-pathogenic; a little more or less organic matter was nothing. In these cases sterilisation by ozone or otherwise was to be recommended.

Mr. F. Wallace Stoddard, F.I.O., described a "continuous nitrifier," and gave tables of analyses, illustrating the effects obtained and considered to justify the conclusions.

1. That free exposure of the surface and base of the biological filter to air is essential for efficient oxidation, but that lateral aeration is comparatively unimportant.
2. That whilst it is essential that the liquid should be so distributed that each particle of medium shall receive only so much as will flow in a thin film over its surface, there is no advantage in the actual subdivision into drops or in causing drops to fall through the air on to the medium.
3. That the best results are obtained by a literally continuous flow of liquid throughout the system, and that any intermission or interruption, even for so short a period as ten minutes, entails a loss of efficiency.
4. That the optimum temperature is about 30° C., but that putrescible suspended solids may interfere.
(5) That the weight of nitrogen oxidisable is practically constant for a given internal filter surface and temperature, whatever the degree of dilution may be, and that this weight for a cubic yard of medium of $\frac{3}{4}$ inch (3 mm.) grade at summer temperature is approximately $\frac{4}{5}$ lb.

(6) That the presence of "humus" is not essential to nitrification.

(7) That the conditions of the experiments described are inconsistent with the "absorption theory" of sewage disposal. It is shown that not only ammonia and urea, but such substances as gelatine and albumen are directly and immediately oxidised as they pass in solution over the medium of a mature filter.

Professor Kenwood and Dr. Kay-Menzies read a paper on the chemical evidence of slight sewage pollution of sea-water. They pointed out that the chlorine figure, often useful in indicating animal contamination in fresh water, was useless when dealing with sea-water. The oxidised nitrogen figure in polluted sea-water may also not be available, and its absence is no guarantee of freedom from such contamination in a dangerous form, and may indeed be even more significant of danger than its presence in sea-water exposed to recent contamination.

The free ammonia figure on the contrary was a very valuable clue to contamination of sea-water, forming invariably an item of evidence which, starting at the actual time of contamination, persists for several weeks. From the results of their investigations they concluded that the free and saline ammonia figure furnished the only reliable chemical guide to the lesser degrees of animal contamination of sea-water, and suggested that an ammonia figure much exceeding 0.002 is certain evidence of the sewage contamination of sea-water.

Messrs. J. E. Purvis, Macalister, and Minnett gave an account of chemical and bacteriological experiments they had conducted in order to ascertain the action of sea-water in the decomposition of sewage with 1 per cent., 5 per cent., and 10 per cent. mixtures of weak and strong sewages in sea-water. They found that (1) in all the mixtures of sewage and sea-water, either with strong or weak sewage, and with variations in the amounts, from 1 per cent., 5 per cent., and 10 per cent. of sewage there remained 70 per cent. of undecomposed and unacted upon nitrogenous compounds after eighteen days incubation; that (2) 1 per cent. mixtures of weak sewage and sea-water showed neither nitrates nor nitrites after eighteen days incubation; that (3) 5 per cent. mixtures of weak sewage and sea-water showed neither nitrates nor nitrites after eighteen days; that (4) 10 per cent. mixtures of strong sewage and sea-water gave nitrites for four days, and then they disappeared, but that no nitrates appeared; that (5) 5 per cent. mixtures of strong sewage and sea-water showed nitrites for three days, and then they disappeared, but that no nitrates were produced at any period; and that (6) 1 per cent. mixtures of strong sewage and sea-water showed nitrites at the end of
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the first day's incubation, and then they disappeared, but that no nitrates were produced at any period.

The general conclusions of the bacterial investigations were (1) that there was a rapid diminution in the total number of organisms, both in the sewage and the mixture of sewage and sea-water, but the diminution was far greater in the mixture; that (2) the denitrifying organisms could live a longer time in a mixture of sewage and sea-water when potassium nitrate was also present in the mixture; and that (3) the nitrifying organisms did not appear to be present in the sewage or in the mixture of sewage and sea-water at any period. The bacterial investigations, therefore, confirmed the chemical ones. Decomposition of sewage in seawater cannot take place rapidly, so that simple compounds of CO₂, water and nitrates are produced.

The experiments proved that it was quite unsound to pour sewage directly into the sea, or even into a tidal estuary. It should first undergo some preliminary treatment, whereby the greater part of the complex compounds may be rapidly and completely destroyed.

Messrs. Fowler and Ardern read a paper on "Disposal and Puri-
fication of Trade-effluents," in which they said the polluting effects may be due to:

(a) An excessive quantity of suspended solids.
(b) Substances capable of fermentation or putrefaction, and consequent production of nuisance.
(c) Colouring matters, such as vegetable or artificial dye-stuffs.
(d) Substances poisonous to aquatic vegetation or fish-life.
(e) Oily matters, fat and soap.

They went on to describe briefly the respective methods of treatment, and summarised the law as to trade-effluents, giving cases illustrating the difficulties noted.

Dr. Adeney explained his apparatus for determining the rate of absorption of atmospheric oxygen by polluted waters, and showed one form. An interesting discussion followed, in which several members gave their own personal experience of the working of this apparatus.

E. A. Letts communicated a paper on nuisances caused by certain green seaweeds, and indirectly by sewage, much of which appears in the Fifth Report of the Sewage Commissioners.

T. H. Castle and E. Elrove, Washington, U.S., described a new method they had devised for the determination of nitrites in sanitary water analysis by means of a permanent standard, namely, fuchsin—S., used in a simple form of colorimeter.

As is known, it is possible to determine nitrites by means of a standard iodine solution in chloroform, but it is very unstable, fading rapidly. The fuchsin—S. standard of Elrove has not this disadvantage, and preserved its colour unchanged for seven months. This method has an advantage that it probably would be of much value for Service use,
S as reasonably accurate nitrite determinations could be made in the field at the moment the sample was collected. The method will be tried at the Hygiene Research Laboratory, Royal Army Medical College, and a further report published later on.

BROMATOLOGY.

This was one of the subsections of hygiene, and signifies the science of food. Mr. F. W. Beck read a paper on the advantages and disadvantages of legally binding standards of composition of foods. He argued that a general fixing of standards for natural products was of doubtful utility, and that a standard in the case of mixtures such as coffee and chicory was futile, because quality was more important than quantity. He thought, however, there was great necessity for standards as to preservatives and colouring matters. All standards should be subject to variation on adequate disclosure. In English legislation the only standards fixed were for the composition of milk, water in butter and margarine, and the strength of spirits.

Messrs. Moor and Partridge submitted a paper on standards of purity for foods and drugs, and gave a collection of various standards, or figures accepted as standards, which have been adopted or proposed, together with suggestions as to the advisability of a variable standard for articles which are affected by seasonal conditions. Various foods and drinks were considered specifically. They considered 16 per cent. of water allowed in butter to be too high, and suggested the amount of salt should be fixed at 2 per cent. The amount of fat in milk, 2½ to 3 per cent., was far behind the percentage required in other countries, namely, 3½ per cent. They suggested that public analysts in every district should publish the percentage of fat contained in the milk supplied by different dealers and should also mention their names.

Mr. Moor suggested grouping the butter producers of the country into associations, each of which should have its own stamp, also that the standard for bread should be that the moisture must not be more than 40 per cent., and that cheese containing less than 30 per cent. of fat should be registered as prepared from skimmed milk.

Mr. Edward Russell and F. Arnaud desired that legal standards should be fixed for milk and suggested new standards for fat based on the average monthly percentages obtained in the case of two large towns, submitting more than 500 samples of milk for analysis annually. The results compared with those obtained by Mr. Droop Richmond on samples from known herds show that the town supplies contain on an average about 0·2 per cent. less fat, this difference tending to decrease during March, April, May and June, the "poor" months of the year, and increase during October, November, December and January, the maximum period. The highest average monthly figure is about 3·7 per cent., the lowest 3·4 per cent., a difference of 0·3.
As the difference between morning and evening milk amounted to 0.5 per cent, a possible figure for genuine milk during the minimum period would certainly be a bare 3 per cent. The author suggested seasonal standards, which might be fixed in two ways, either a 3 per cent. standard for four minimal months, raising the standard to 3.3 per cent. for other periods of the year, or taking a very low figure, such as 2.85 per cent. of fat for the minimal period, raising this to 3.5 during the maximal period, and fixing the standard at 3.3 for the intermediate months. Dr. Thorpe opposed this suggestion on the ground that administrative difficulties would arise and that reform would mean a levelling down of the milk standards. Dr. Avory, of Australia, stated that at the present time in Australia the standard was 3.5 per cent.

G. Cornalba, Chemist to the Royal Experimental Cheese-making Station at Lodi, presented a comparative study of the new methods of detecting watering of milk. He found that a sure means of detecting dilution of milk with water was furnished by the sum of the soluble components of milk. Taken separately these soluble components give no reliable data, as their amounts vary somewhat widely; but their sum varies only between such narrow limits as to render possible detection of a dilution as small as 5 or even 4 per cent.

The mean value of this constant for mixed milk from a number of animals was about 6.25, the limiting values being 5.95 and 6.46. For the milk of single cows the limiting values were 5.80 and 6.60, and with the majority of the cows the value oscillated round the number 6.2. Taking the mean value 6.15, addition of 5 per cent. of water to the milk would lower the value to 5.84.

This constancy of the composition of the serum is always observed, no matter what the age or breed of cows, the period of lactation, the quantity of milk produced, or the diet may be. The establishment of this principle lends support to the view generally held at the present time, namely, that the production of milk comprises two distinct phases: (1) A secretion of a serum almost uniform in composition; and (2) a destruction of glandular tissue which supplies to the serum, in the forms of fat and casein, the products of demolition of the cell.

The refractometric, densimetric and cryoscopic methods of examining milk were discussed, the method devised by the author being in agreement with these physical methods. The refractometric method gave results which were accurate only with milks not very rich in fat and casein. Determination of the density of the serum, which should not be less than 1.030, was capable of revealing dilution of milk to the extent of 10 per cent. The cryoscopic point of normal milk is 0.555, and even with two specimens of colostrum containing: (1) albumin 16.38, lactose 2.19, and salts 1.12; and (2) albumin 3.13, lactose 3.37, and salts 0.90, the respective values were 0.55 and 0.56. The cryoscopic and refractometric methods are applicable only to fresh milk free from preservatives.
The author also communicated a paper on some new criteria for the natural production of milk most suited to the nourishment of infants. With regard to sterilisation of milk, he said, whilst it impaired the digestibility of milk, it afforded no certainty of absolute sterility, the spores of certain germs withstanding temperatures higher than those which can be employed in sterilising. It had also no influence on the toxins developed by bacteria.

The changes produced in the composition of milk by sterilisation were:

1. The albumenoid substances are profoundly modified and the albumen rendered insoluble.
2. The organic phosphorus compounds of calcium are altered so as to become difficultly assimilable.
3. The harmful germs are destroyed, as also are the enzymes taking part in the digestion of the milk.
4. The lactose is caramelised and the flavour of the milk injured.

He considered that by selection of cows in full lactation, on the basis of their individual characteristics, it is possible to obtain milk having a composition the same as that of prepared milks and approaching that of human milk for the nourishment of infants.

Mr. Norman Booth referred to the absence of any legal standard for chocolate in England, although in some of the European countries standards are in force, and pointed out that articles of which the sale would be prohibited in some other countries are permitted to come without restriction on to the English market.

He suggested the following definitions for chocolate foods as reasonable:

1. Unsweetened Chocolate must be prepared exclusively from roasted, shelled, finely-ground cocoa beans, with or without the addition of a small quantity of flavouring matter, and should not contain less than 45 per cent. of cocoa butter. (Note.—There is an average of 50 to 55 per cent. of butter in cocoa.)
2. Sweetened Chocolate.—A preparation consisting exclusively of the products of roasted, shelled, finely-ground cocoa beans, and not more than 65 per cent. of sugar, with or without a small quantity of harmless flavouring matter.
3. Granulated or Ground Chocolate for Drinking Purposes.—The same definition as for sweetened chocolate should apply here, except that the proportion of sugar may be raised to not more than 75 per cent.
4. Chocolate-covered Goods.—Various forms of confectionery covered with chocolate, the composition of the latter agreeing with the definition of sweetened chocolate.
5. Milk Chocolate.—A preparation composed exclusively of roasted, shelled cocoa beans, sugar, and not less than 15 per cent. of the dry solids.
of full-cream milk, with or without a small quantity of harmless flavouring matter.

The addition of starch other than that naturally present in the cocoa bean, of fats other than that naturally present in the cocoa bean, and of cocoa shell in powder form, should be absolutely excluded from any article which is to be sold under the name of "chocolate."

At the present time a mixture of cocoa with sugar and starch cannot be sold as pure cocoa, but only as "chocolate powder," and with a definite declaration that the article is a mixture of cocoa with other ingredients. Prosecutions are constantly occurring where mixtures of foreign starch and sugar with cocoa have been sold as "cocoa," and it seems, therefore, a proper step to require that a similar declaration shall be made in the case of "chocolate" which contains other constituents than the products of cocoa nib and sugar.

Mr. Beamont Hart has traced a hitherto unrecorded source of metallic impurity in the presence of copper in some samples of gelatin. In his communication to the section he stated that some pressed beef, alleged to have caused symptoms of poisoning, when microscopically and bacteriologically examined was found to be quite sound, but a small quantity of copper was detected, the origin of which was eventually traced to the gelatin used as a garnish, the results being as follows:

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<th>Pressed beef (1)</th>
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The examination of a number of samples of gelatin sold for household use gave results varying from 0 to 56:3 milligrams of copper per kilo, and the figure varied directly with the ash.

Dr. J. M. Alvahary read a paper on the presence of oxalic acid in cocoa and chocolate and described in detail his method for estimating the amount present. He considered that both cocoa and chocolate are rich in oxalic acid.

In the Pharmaceutical Section, W. Harrison Martindale communicated a paper on the organic arsenic compounds. He reviewed the numerous relatively non-poisonous organic arsenic compounds which have been tried up to the present time. He suggested the use of allied substances which hitherto had not been tried in medicine, and discussed sodium methyl arsenate and the cacodylic bodies, which, owing to their being little attacked in the system, have been discarded in the treatment of disease. Phenyl cacodyl compounds in general were toxic. He drew attention to the fact that inorganic arsenic is slowly eliminated, whilst such substances as the arsenilates pass off rapidly, but nevertheless in
so doing they are not void of unpleasant after-effects. The introduction of sodium arsenilate has been a distinct advance, but not an ideal. The \( \text{NH}_2 \) grouping has been stated to be an essential adjunct to arsenic in combating trypanosomes.

R. R. Tatlock, in the Analytical Chemistry Section, read a paper on the expediency of appointing a general international permanent committee to secure uniformity in method of analysis, and in the interpretation of results. He said that hitherto the efforts made to arrive at unification have been confined to analytical methods as such, and have not dealt with the interpretation of results, in which, in numerous instances, the views and practice even of eminent chemists are "wide as the poles asunder," with the consequence that the profession of the analyst is discredited in the eyes of the public. As examples, he said there were not many subjects on which more labour has been bestowed, and more elaborate treatises written, than the analysis of water, but that the accuracy and refinement attained were frequently rendered valueless by their interpretation.

"Some analysts do not hesitate to give a report upon the suitability of a water for dietetic purposes, based entirely upon the results of the chemical analysis; others require, in addition, a bacteriological examination, and there are chemists who consider it absolutely necessary to make an examination with regard to the source and history of the water. There are analysts who assume that the nitric nitrogen, even when present in considerable proportion, is of little or no significance, but there are probably more who consider it a valuable indicator of possible danger. Then the question of the condition of water, such as that of a stream or tidal river, in relation to fish life, does not seem to be disclosed by any or all of these three forms of examination, and it has been found necessary to give these only a secondary place, and to resort to the determination of the amount of free oxygen, the rate of the absorption of oxygen by the organic matter present, and the facility with which the water absorbs oxygen from the atmosphere. There can be no doubt that in some cases the misinterpretation of the significance of nitric nitrogen in potable waters has given rise to serious consequences, and it would be of the greatest importance to have a decided and authoritative statement with regard to its import if present in appreciable proportion.

"Another subject on which there is much divergence of opinion as regards the inference from the results is vinegar. It has been the practice of some chemists to demand that the residual products of the acetous fermentation must be present before the article can be accepted as malt vinegar, which of course disqualifies distilled malt vinegar. There are not a few also who affirm that the source of the acetic acid in certain samples is wood, although this is merely an inference from their figures, and not the result of a direct chemical test."
There are few questions with regard to interpretation of results that have given rise to more controversy than those relating to brandy, whisky, rum and gin, many analysts of eminence holding that a standard or limit based upon analytical figures is absolutely unsuitable, while others have no hesitation in adopting arbitrary standards for any or all of these. Even if such standards were suitable, and were adopted, they must necessarily be exceedingly low ones, and must give rise to the grossest sophistication of the genuine article by more or less characterless alcohol. These remarks apply to all the four subjects referred to.

Even at the present time there seems to be little unanimity on the part of analysts of butter, as to how the results in certain cases should be interrupted. Some have taken the position that although no single figure may prove admixture or adulteration, the relation or balance between two or more of the constituents may disclose it, and no doubt this would be a reasonable enough view if the ratios found were outside experience with genuine butters, but this condition has not always been observed.

A further instance of want of uniformity in the interpretation of results is that of the so-called fruit wines. There are chemists who demand that these non-alcoholic beverages shall have no other source, either wholly or partly, than the juice of the particular fruit whose name they bear. Others again are satisfied with what they call a substantial proportion of the particular fruit juice.

It is scarcely surprising that there should be such divergency of opinion with regard to what ought to be legitimately inferred from the figures of analysis, because in many instances no inference at all can be made. For example, we may have the very best brands of genuine cognac brandy showing exactly the same composition, by analysis, as genuine high-class pot still malt whisky, or even genuine pot still Jamaica rum, and in such cases it would be impossible to state which was the one or the other, without tasting and smelling them, and only by these means can we determine to which the arbitrary standards for brandy, whisky, and rum respectively are to be applied. Seeing that chemical analysis may not be able to distinguish between the one or the other, it must be hopelessly impossible to determine the quality by its means.

Another example of this is butter, the best quality of which will often show less volatile acids than a very poor quality.

What he pleaded for was the appointment of a General International Permanent Committee or Commission, to secure not only uniformity in methods of analyses, with which already great progress has been made, but also in the interpretation of results. The present Commissions would naturally be incorporated in this wider scheme.

The following contributions from the laboratories of the General Chemical Company of New York are useful:
I.—The Determination of Small Amounts of Arsenic by the Gutzeit Method.

A detailed description, with diagram, of an improved apparatus and method for use in the determination of small amounts of arsenic by the Gutzeit method. The test paper used is sensitised with a $\frac{1}{4}$ per cent. HgCl$_2$ solution. The standard stains are made from a standard arsenate solution, coated with paraffin and sealed in a glass vessel over P$_2$O$_5$ to prevent deterioration. Development of the stains with NH$_4$OH or HCl is unnecessary.

II.—The Determination of Minute Quantities of Arsenic in Brimstone.

Brimstone is oxidised by a mixture of three volumes of carbon tetrachloride to two volumes of pure bromine, followed by nitric acid. A little water is added and the nitric acid and carbon tetrachloride removed by evaporation. Arsenic is then determined in residue by the Marsh or Gutzeit methods.

III.—The Determination of Arsenic in Sulphuric Acid.

Arsenic, when more than 0.002 per cent. is present in concentrated sulphuric acid, is reduced by tartaric acid. The excess of the latter is removed by heating, and the As$_2$O$_3$ titrated with standard iodine solution, after neutralisation with ammonia and bicarbonate of sodium.

IV.—The Determination of SO$_2$ in Dry Gases.

Orsat apparatus made available for the purpose by use of chromic acid in concentrated phosphoric or sulphuric acid solution.

V.—Note upon Marsh or Gutzeit Tests.

Presence of impurities such as lead in the zinc used in the Marsh or Gutzeit tests sometimes causes suspension of hydrogen evolution. Addition of a colloid to the acid solution counteracts this and facilitates even evolution of hydrogen.