for each batch of readings made, as the color darkens slowly for about an hour after the addition of the alkali.

It will usually be found that twelve samples constitute the maximum number that can be satisfactorily manipulated at one time.

VANILLA EXTRACTS MADE IN THE LABORATORY ACCORDING TO THE SPECIFICATIONS OF THE U. S. PHARMACOPOEIA.

Laboratory number.	Kind and quality of beans from which prepared.	Per cent. vanillin by	
		Official method.	Colorimetric method.
1	Mexican first	0.17	0.17
3	Mexican second	0.17	0.16
6	Mexican third	0.19	0.19
10	Mexican fourth	0.19	0.19
11	Mexican fifth	0.15	0.15
14	Bourbon first	0.20	0.20
17	Bourbon second	0.15	0.16
21	Bourbon third	0.20	0.21
24	Bourbon fourth	0.15	0.16
29	Bourbon fifth	0.16	0.16
30	Seychelles first	0.19	0.20
33	Seychelles third	0.21	0.21
37	Seychelles fourth	0.18	0.18
39	Madagascar second	0.23	0.21
42	Madagascar third	0.21	0.20
47	Madagascar fourth	0.24	0.24
48	Comores first	0.19	0.19
51	Comores third	0.19	0.19
54	Comores fourth	0.12	0.13
59	Comores second	0.25	0.24
64	South American first	0.23	0.25
65	South American second	0.19	0.19
66	South American splits	0.22	0.22
	Java fourth	0.23	0.22
	Tahiti	0.11	0.10
	Vanillons	0.06	0.07

Through the kindness of Dr. A. L. Winton we have been able to secure a large number of authentic vanilla extracts which were prepared from various grades of beans in the U. S. Food and Drug Inspection Laboratory at Chicago. Dr. Winton has also allowed us to use as a control on our new method the vanillin figures obtained in his laboratory on these extracts by means of the official method.¹

Through the kindness of Mr. B. H. Smith, of the Boston Laboratory, and of Mr. R. S. Hiltner, of the Denver Laboratory of the U. S. Food and Drug Inspection Service, we have also been able to secure samples of the vanilla extracts sent out for coöperative work in 1911 by the referee on flavoring extracts of the association of official agricultural chemists. Mr. Hiltner has also sent us the average vanillin figures obtained by the official method on these extracts by the chemists coöperating with him. In all somewhat more than a hundred samples of vanilla extract have been assayed for vanillin by our colorimetric method and in no case has there been any marked deviation from the values obtained by the official method.

Above are given a number of examples of the values obtained by the colorimetric method. These represent but a fraction of the number of results obtained, but the figures agree so uniformly with those given by the official method that it seemed useless to take up more space in this connection.

Below are given results obtained with a few miscellaneous extracts; again the vanillin figures reported as obtained by the official method were furnished us in part by Dr. Winton and in part by Mr. Hiltner.

No.	Prepared from:	Percentage vanillin by	
		Official method.	Colorimetric method.
I	Mexican beans, 60% alcohol and glycerine...	0.20	0.20
II	Bourbon beans, 60% alcohol and sugar (U. S. P.).....	0.19	0.19
III ¹	Mexican and Tahiti beans and maple syrup, prune juice, synthetic vanillin and caramel	0.18	0.17
IV ²	25% tonka extract, 75% prune juice, 0.15% vanillin and caramel coloring.....	0.15	0.16
	¹ A. U. S. P. extract.		
	² An entirely artificial extract.		

It is a well known fact that vanillin even in fairly dilute solution may be precipitated by basic lead acetate. We have satisfied ourselves, however, that in the very high dilutions employed in our method no vanillin is precipitated by the lead.

Coumarin, extract of tonka bean and acetanilid give no color with the phosphotungstic-phosphomolybdic acid reagent; the presence of sugar, caramel, or glycerine does not in any way interfere with or alter the color formation.

BIOCHEMICAL LABORATORY,
HARVARD MEDICAL SCHOOL,
BOSTON.

METHOD FOR DETERMINING FAT IN SUGARED EVAPORATED MILK.

By F. C. BROEMAN.

Received June 8, 1912.

Ten grams of the milk are mixed with 100 cc. of hot water and 5 cc. CuSO_4 solution (Feh. St.) added and stirred. The ppt. contains the fat and it is filtered at once and washed with hot water. It is then transferred to a 150 cc. beaker (after a little experience it can be thrown out without a particle sticking to the paper) and 10 cc. conc. HCl added. Heat on hot plate until solution turns to chocolate brown, cool and then add 2-3 times volume of alcohol and extract 4 times with petroleum ether in separatory funnel. The results obtained agree with those obtained by the extraction methods when carried out under the most exacting conditions. The determination can be completed entirely in one hour.

LABORATORIES OF F. C. BROEMAN & Co.,
CINCINNATI, OHIO.

LABORATORY AND PLANT

A NEW TYPE OF INORGANIC FILTER FOR LABORATORY PURPOSES.

By M. A. WILLIAMSON AND P. A. BOECK.

Received July 15, 1912.

The use of porous inorganic materials for filtration

¹ *Bull.* 107, 156 (Revised), Bur. of Chem.

and separation of liquids and solids in quantitative work has been known for some time. A variety of materials and shapes have been employed for this purpose with more or less success.¹

¹ See Faraday's "Chemical Manipulation," new edition, 1830, Section 9, page 230, and *J. Am. Chem. Soc.*, 9, 22, article by Lucius Pitkins on the "Efficiency of Porcelain Filters."

The work encountered in analytical operations is so varied in character and is subject to such extremely severe conditions, that most of the materials tried have been found lacking in some one or more desirable characteristics, such as resistance to the influence of the re-agents employed, with the results that their successful application to quantitative work has been seriously curtailed.¹

There are two general methods of using porous inorganic filters.

1. A finely divided material which is placed loosely on a perforated or porous body, permitting the passage of the liquids, the solid matter being retained by the finer voids in the filtering medium.² Well known examples of this class of filter which are used for quantitative analytical work are sand, glass, wool, kaolin, clay, precipitated alumina, natural porous stones and infusorial earths, which may be used either with or without an organic material.

2. Bonding together these finely divided materials by means of some agglutinant which is insoluble in the solutions filtered and which does not occupy all the space between the grains or voids in the body. A massive but porous filtering bed is obtained which may be made into a variety of shapes whose filtering capacity can be varied by altering the size and number of the voids. This can be accomplished in several ways; by varying

- 1st, the relative sizes of the particles bonded;
- 2nd, the proportion of the various sizes of grain used;
- 3rd, the percentage of bonding material used;
- 4th, the shrinkage of the bonding material;
- 5th, the addition of some material which can be subsequently removed by ignition or solution, leaving the volume occupied by it as a void.³

For analytical work the use of a porous diaphragm or shape offers so many advantages that it has been the subject of much speculation and a variety of materials have been tried out. The advantage is strongly in favor of the bonded articles, as they are immediately available without previous preparation. The asbestos fiber Gooch crucible and Witte plate are good examples of the first class of these materials, but with the exception of soluble precipitates it has the disadvantage of requiring frequent renewal and preparation.

In carrying out the investigation on refractory aluminous bodies for high temperature work it was found that bodies made up of fused alumina, bonded with a highly resistant bonding material of porcelain nature, were very advantageous.

Tests conducted on the fused alumina alone showed it to withstand the action of both acids and alkalis in solution, quantitatively. Similar tests on the bonding material alone indicated that it was affected by only the strongest acids and alkalis and even then to

so small an extent that with the proper precautions it could be used for quantitative chemical operations in practically any solution.

MANUFACTURE OF CRUDE MATERIAL AND PROPERTIES OF FINISHED PRODUCT.

The fused alumina, the material used in the manufacture of the filters to be described, has been used for the past ten years in the manufacture of abrasive wheels and stones under the trade name of "Alundum." It is obtained by fusing calcined hydrated oxide of alumina or bauxite in a water cooled electric arc furnace, from which it comes in the form of an ingot weighing some three tons. The impurities contained in the bauxite as iron oxide, silica, and titanium oxide are reduced to a certain extent and segregated at the bottom of the pig as a low grade ferro-silicon containing some titanium. The resulting pig or ingot consists essentially of pure crystalline alumina. The physical properties of this material adapt it peculiarly well to the manufacture of refractory laboratory articles. On being crushed, it is graded to a uniform mesh and mixed with the required amount of bonding material, the character of which is determined by the uses to which the resulting article is to be put. When made into the form of bonded shapes these materials have been found to possess a high thermal coefficient. The following curves illustrate graphically the relative thermal conductivity of ordinary fire-brick, Seger porcelain, bonded Alundum and bonded Crystolon at comparatively low temperatures. The finished articles also possess an extremely

FIG. 1.

high melting point, approximately 1900° Centigrade, or 3500° Fahrenheit, a comparatively low coefficient of expansion 0.0000071 per degree C., and are non-conductors of electricity. This dielectric property was determined by Dr. Thompson, of the Massachusetts Institute of Technology, and is found to be greater than that of porcelain, even at high temperatures. The specific resistance of centimeter cubes at various temperatures are as follows:

Degrees C.	Megohms.
528	130
720	16
892	5.3
1020	1.8

The maximum crushing strength of bonded Alundum is 15,410 lbs. or 7½ tons per square inch while its tensile strength is 1,700 lbs. per square inch. This factor is dependent on the thermal conductivity, coefficient of expansion and other properties desired.

These articles have furthermore been found remarkably resistant to the action of fluxes, especially those of a basic nature even at high temperatures.

¹ See *J. Am. Chem. Soc.*, 3-4, 248, article by P. Casamajor. Also *Chem. News*, 32, 45, article P. Casamajor, on "Implements of Filtration."

² See *J. Am. Chem. Soc.*, 8, 192, article by J. H. Stebbins, Jr. "The Micromembrane Filter." Also *J. Am. Chem. Soc.*, 27, by Mr. Porter W. Shimer on a "New Filter."

³ Article appearing in the German Chemical Society, sixth year, No. 8, page 227, by W. Pukall. "Treatise on Clay Filters, their Properties and Application in Chemical and Bacteriological Laboratories."

GENERAL REQUIREMENTS OF LABORATORY FILTERS.

The general requirements of a filter for laboratory work are, sufficient porosity permitting them to be used for a variety of purposes, rapid cleansing and preparation for subsequent operations. They should possess sufficient strength to resist a high degree of suction and withstand the moderately high temperatures encountered in the ordinary laboratory for igniting the filter; inactivity towards reagents and materials which are ignited in them; constancy in weight within the practical limits of error through ordinary quantitative treatment.

In the platinum Gooch all of these desirable properties are found. It, however, possesses the disadvantage of requiring careful preliminary preparation of the asbestos mat. The cost of platinum, unfortunately, places it beyond the reach of the every-day analyst, also the precautions to be exercised in the use of this ware handicap the operation.

With porcelain, several difficulties are encountered: (1) the time and trouble necessary in preparing the

in that they were not placed in the carbon tube far enough to bring the entire filtering area into the zone of suction. The portion which projected beyond the zone of suction became impregnated with the soluble salts in the solution being filtered which could only be removed after prolonged washing, consuming so much time that in many operations this crucible did not offer any particular advantages over the Gooch. Several methods were developed, employed and found excellent, only they required more time and apparatus than the ordinary porcelain Gooch.

To overcome the foregoing objection, glazing the upper portion of the crucible was attempted. The idea was to obtain a crucible of fused alumina with impervious walls and a porous bottom. This promised a solution of the difficulty in analytical work, but owing to the fact that the walls were impervious to all glazes, it was found that the glaze simply spread over the surface, leaving a porous strata of Alundum between the walls of glaze. This is an extremely unsatisfactory condition in filtering off any precipitate.

TABLE I.—ABSORPTION PROPERTIES OF ALUNDUM AS COMPARED WITH PORCELAIN AND PLATINUM.
Alundum crucibles.

	1		2		3		4		Gooch porcelain crucible.		Platinum crucible.	
	Wt. Grams.	Differ- ence. Mg.	Wt. Grams.	Differ- ence. Mg.	Wt. Grams.	Differ- ence. Mg.	Wt. Grams.	Differ- ence. Mg.	Wt. Grams.	Differ- ence. Mg.	Wt. Grams.	Differ- ence. Mg.
A.....	16.2072		12.1658		22.1256		15.4388		19.0030		24.4059	
B.....	16.2039	-3.3	12.1617	-4.1	22.1194	-6.2	15.4294	-9.4	19.0008	-2.2	24.4055	-0.4
C.....	16.2018	-2.1	12.1605	-1.2	22.1174	-2.0	15.4290	-0.4	19.0028	+2.0	24.4055	0.0
D.....	16.2028	+1.0	12.1628	+2.3	22.1193	+1.9	15.4315	+2.5	19.0035	+0.7	24.4056	+0.1
E.....	16.2032	+0.4	12.1628	0.0	22.1194	+0.1	15.4316	+0.1	19.0035	0.0	24.4056	0.0
F.....	16.2008	-2.4	12.1600	-2.8	22.1162	-3.2	15.4270	-4.6	19.0007	-2.8	24.4049	-0.7
G.....	16.2031	+2.3	12.1623	+2.3	22.1182	+2.0	15.4325	+5.5	19.0039	+3.2	24.4059	+1.0
H.....	16.2031	0.0	12.1623	0.0	22.1188	+0.6	15.4325	0.0	19.0039	0.0	24.4059	0.0
I.....	16.2007	-2.4	12.1596	-2.7	22.1160	-2.8	15.4286	-3.9	19.0019	-2.0	24.4054	-0.5

asbestos mat and in varying the thickness in order that any desired degree of porosity may be obtained; (2) the comparatively low thermal conductivity of porcelain is a militating factor in several ways, as in the ashing of organic compounds, burning off precipitates, etc., increasing the time appreciably. Porcelain can be used at only relatively low temperatures in comparison with this new material.

The articles made from fused alumina or Alundum will be found to possess most of the desired advantages. They are rapid, always ready, easily cleansed, withstand any temperatures available in the average laboratory; the porosity can be varied to meet any requirement; they will withstand the action of practically all reagents and materials ignited in them. They are not adapted to making fusions with alkaline carbonates or similar material, because of the siliceous nature of the bond. Like porcelain they are fragile, and will withstand but moderately sudden temperature changes. On the other hand, however, they possess a high thermal conductivity which together with the porosity makes them better adapted than porcelain to the burning off of organic materials.

OBJECTIONS TO ALUNDUM.

One disadvantage in making filtrations with the ordinary shaped crucibles of fused alumina was found

The porous strata would become impregnated with a solution containing salts impossible of removal, causing an increased weight in the crucible and the possibility of contaminating any solution which would be passed through it afterwards.

The idea of building up crucibles of two parts, that is, glazing the upper portion and cementing it to a porous bottom, was tried out, but found subject to the same objections. Accordingly this scheme had to be abandoned.

Another difficulty experienced by some is the property of Alundum to absorb moisture from the air. This is by no means a chemical action for there is nothing in the bond or the fused alumina which will combine with water at ordinary temperatures. The moisture of the air is simply condensed on the walls of the voids or pores, which action can continue only up to the point of saturation; that is, when a crucible of this material is ignited and immediately weighed it will be found to gain in weight when exposed to the air. Upon again igniting, it will return to the former weight. This variation, however, is so limited that in ordinary determinations it becomes a negligible quantity. The action can be observed more plainly by reference to Table I. Four Alundum crucibles (marked 1, 2, 3 and 4), one 30 cc. porcelain Gooch

crucible and one 30 cc. platinum crucible were used for these tests.

All crucibles were carefully weighed before making this test. They were then ignited in the electric furnace at 1000°C ., cooled in a desiccator, and weighed. They were then washed with 250 cc. each of hot and cold water, dried in the electric oven at 100°C ., ignited in the electric furnace, and cooled in a desiccator, before weighing. The crucibles were then allowed to stand on the scale pan in the balance case for one, two and three hours respectively. Weighings were made at the end of each period of time. The crucibles were then ignited in the electric furnace, permitted to stand in the atmosphere as before and again ignited for the fourth time. Every conceivable precautionary measure was observed in this test in order that the results might be as accurate as possible. The weights taken of these crucibles at the various stages of the operation are marked by letters, as follows:

A, the original weight of the crucible when received.

B, weight of the crucible after igniting in an electric furnace at 1000°C . and cooling in a desiccator.

C, weight after 250 cc. of hot water had been run through by means of a reverse washer, and 250 cc. run through as in direct filtration, and the crucible dried and ignited in the electric furnace at 1000°C . and cooled in a desiccator.

D, weight after allowing the crucible to stand in the balance case one hour and weighing immediately.

E, weight after the crucible had been in the balance case two hours.

F, weight after the crucible had been ignited in the electric furnace at 1000°C .

G, weight after the crucible had been in the balance case one hour.

H, weight after the crucible had been in the balance case two hours.

I, weight after the crucible had been in the electric furnace and cooled in a desiccator.

The fused alumina is crushed to grains of suitable size, mixed with a ceramic bond, moulded, dried and then fired in an ordinary porcelain kiln. The bond becomes more or less vitrified, forming a hard resistant body. During the process of manufacture small particles of the grain adhere to the outside of the article and are retained in the pores. Upon washing, these small particles are dislodged and washed out. Unless this preliminary precaution is observed an appreciable variation in weight is noted, as shown by the following tables.

TABLE II.—EFFECT OF WASHING ON WEIGHT OF ALUMINUM.

Crucible No.	Wt. before washing. Grams.	Wt. after cleaning. Grams.	Loss. Mg.
1.....	11.6725	11.6708	1.7
2.....	9.7492	9.7468	2.4
3.....	11.2629	11.2602	1.7
4.....	10.0136	10.0094	4.2

Four crucibles were employed. They were weighed, washed with 500 cc. each of hot and cold water, dried in an electric oven at 105°C ., ignited in an electric furnace for fifteen minutes at 1000°C ., and cooled in a desiccator before weighing. The results are shown in Table II.

After treating these crucibles as above, each was washed with 250 cc. of both hot and cold sulphuric acid, this operation being repeated with hydrochloric acid, 10 per cent. solution. They were then thoroughly washed with distilled water, ignited and weighed. The results of this investigation are summarized in Table III.

TABLE III.—EFFECT OF WASHING WITH ACIDS AFTER TREATMENT WITH WATER.

	Wt. of crucible.	H ₂ SO ₄ , cold.	H ₂ SO ₄ , hot.	HCl, cold.	HCl, hot.	Total loss.
Crucible No. 1...	11.6708	11.6702	11.6693	11.6682	11.6668	
Loss		0.6 Mg.	0.9 Mg.	1.1 Mg.	1.4 Mg.	4 Mg.
Crucible No. 2...	9.7468	9.7464	9.7459	9.7458	9.7448	
Loss		0.4 Mg.	0.5 Mg.	0.8 Mg.	0.3 Mg.	2 Mg.
Crucible No. 3...	11.2602	11.2598	11.2592	11.2587	11.2582	
Loss		0.4 Mg.	0.6 Mg.	0.5 Mg.	0.5 Mg.	2 Mg.
Crucible No. 4...	10.1058	10.1058	10.1048	Crucible broken.		
Loss		0.0 Mg.	1.0 Mg.			

Comparing Table III with II, the necessity of preliminary preparation is demonstrated by the difference in losses suffered due to the several treatments.

IMPROVED TYPE OF FILTER.

A new type of filter, which differs from the crucible, principally in shape and bond, has been recently developed, giving promise of better adaption to analytical work than any other. It differs from the other types of filters mentioned in that it is compact, filters rapidly, and is always ready. It is made from the same materials as the crucibles but is somewhat more resistant to action of the reagents used in ordinary analysis. This new filter is in the form of a cone and is designed to fit into the 60° funnel. One size found satisfactory measures $1\frac{3}{4}$ " in diameter by $1\frac{1}{4}$ " high and weighs about ten grams; while this is the most convenient size, the cones can be made up into any desirable shape or size, depending on the specific requirements.

FIG. 2. FILTER CONE ON SCALE PAN.

This type of filter is placed in operation by first stretching over a large end of the funnel a piece of soft rubber tubing about $1\frac{1}{2}$ " in diameter and $1\frac{1}{2}$ " long, allowing half of the tube to project over the top. The funnel is then connected with the filter bottle and the conical filter placed in the aperture formed by the rubber ring. When suction is applied and the filter moistened, the cone is drawn down against

the gasket with a force sufficient to make a gas-tight joint. The efficiency of this joint varies directly with the suction applied. This type of apparatus possesses all the advantages outlined for the best

FIG. 3. METHOD OF ADJUSTING CONE.

laboratory filters. It can be used with or without filter paper, depending on the manipulator and the degree of accuracy required.

When using an ordinary filter paper it may be folded in the usual manner and the point turned back about $\frac{1}{8}$ " so that the paper may fit snugly into the cone, proceeding then as in the ordinary operation. Several advantages are gained by this method, among

CONSTANCY IN WEIGHT.

The constancy in weight of the cone has been the subject of considerable speculation and discussion. With the idea of determining this under characteristic conditions, the following test was made.

Four cones, of different mixtures, were chosen for this test, namely, RA-320, 321, 322, 327, and were compared with a porcelain Gooch with asbestos mat and an ordinary platinum laboratory crucible.

All of these were soaked in a 10 per cent. solution of sulphuric acid at ordinary temperatures, washed with distilled water and ignited. They were then allowed to stand on the scale pan for one, two and three hours, weighing at the end of each period of time. They were then ignited and weighed, the results being recorded in Table IV.

This type of filter is subject to the same criticism as the other form, namely, the apparent inconstancy of weight, due to the absorption of moisture from the air. As before stated, this characteristic is in no manner detrimental, since the various articles will remain

FIG. 4.

constant when used under the same conditions each time. This fact is illustrated in Table IV.

The question to be determined is whether they are adapted to quantitative analysis. The favorable results obtained in further tests and recorded in Table V constitute the necessary evidence.

For this final test five conical filters were used and an ordinary porcelain Gooch with asbestos mat. Cones Nos. 1, 2 and 3 were tested without, while cones Nos. 4 and 5 were provided with a lining of filter paper in addition to these a test was made with a filter paper

TABLE IV.

Treatment.	Cones.								Porcelain Gooch crucible.		Platinum crucible.	
	320		321		322		327		Weight. Grams.	Difference. Mg.	Weight. Grams.	Difference. Mg.
	Weight. Grams.	Difference. Mg.	Weight. Grams.	Difference. Mg.	Weight. Grams.	Difference. Mg.	Weight. Grams.	Difference. Mg.				
Soaked in 10% H_2SO_4 and water, then ignited.....	9.4880		8.0398		5.2539		9.7204		15.6473		11.3184	
Stood 1 hr. in case....	9.4893	+1.3	8.0404	+0.6	5.2552	+1.3	9.7216	+1.2	15.6472	-0.1	11.3184	0.0
Stood 2 hrs. in case....	9.4893	0.0	8.0408	+0.4	5.2552	0.0	9.7216	0.0	15.6475	+0.3	11.3184	0.0
Stood 3 hrs. in case....	9.4893	0.0	8.0408	0.0	5.2552	0.0	9.7215	-0.1	15.6475	0.0	11.3184	0.0
Ignited again.....	9.4881	-1.2	8.0398	-1.0	5.2542	-1.0	9.7205	-1.0	15.6468	-0.7	11.3183	-0.1

them being extremely rapid filtration, depending on the fineness and nature of the precipitate to be filtered. In very accurate work the weight of the cone is independent of the weight of the paper and the cone acts only as a support. It permits the use of a paper whose porosity is suitable for the work in hand.

The entire filtering area of the cone is subjected to the suction so that any and all soluble salts which might be retained by the porous material can be readily removed by proper washing. The advantages resulting from the use of this filter are obvious.

in the usual manner. The 3 precipitates chosen for the test were aluminum hydroxide, barium sulphate and silver chloride, because they are more or less representative of the various classes of precipitates encountered in analytical work. The aluminum hydroxide, barium sulphate and silver chloride were prepared in such a manner as to make standard solutions, 100 cc. of which contained 0.1 gram Al_2O_3 , 0.1329 gram $BaSO_4$, and 0.1687 gram $AgCl$, respectively.

The cones were all thoroughly cleaned and ignited before making this test.

From Table V it will be noted that the first cone was found the most satisfactory for all purposes. The time factor as compared with the Gooch and filter paper was reduced considerably without reducing the accuracy to any appreciable extent.

The cleansing of the filter may be readily accomplished by inverting it on a rubber cork and reversing the flow, as is illustrated in Fig. 4.

On the whole the new conical filters proved to be far superior to those ordinarily used.

TABLE V.—FILTERING PROPERTIES.

	Al ₂ O ₃ .			AgCl.			BaSO ₄ .		
	Weight.	Differ-	Time	Wt.	Differ-		Weight.	Differ-	
Amount found.	Gram.	ence. Mg.	required. Min.	Gram.	ence. Mg.		Gram.	ence. Mg.	
By calculation..	0.0500			0.1687			0.1349		
With cone 320..	0.0510	+1.0	2.5	0.1650	-3.7		0.1329	-2.0	
With cone 321..	0.0510	+1.0	2.0	0.1644	-4.3		0.1331	-1.8	
With cone 327..	0.0502	+0.2	2.0	0.1651	-3.6		0.1331	-1.8	
With cone 321									
+ paper.....	0.0522	+2.2	45.0	0.1647	-4.0		0.1332	-1.7	
With cone 322									
+ paper.....	0.0522	+2.2	30.0	0.1662	-2.5		0.1327	-2.2	
With asbestos									
Gooch.....	0.0536	+3.6	11.0	0.1650	-3.7		0.1328	-2.1	
With paper filter	0.0519	+1.9	9.0	0.1642	-4.5		0.1349	0.0	

The authors have endeavored to point out the advantages accruing from the use of a filter of this improved type, the value and superiority of which have already been fully demonstrated by their successful application, under varying conditions, in general laboratory operation.

RESEARCH LABORATORIES, NORTON COMPANY,
WORCESTER, MASS.

CALCULATION OF SULPHURIC ACID STOCK BY APPROXIMATE vs. ACCURATE METHODS. A SPECIAL SLIDE RULE FOR THIS PURPOSE.

By H. C. MOORE.

Received May 25, 1912.

When taking periodical inventories of the amount of sulphuric acid stock on hand in the numerous tanks and chambers around a sulphuric acid plant it is customary to test the acid in each tank for density, in terms of degrees Baumé, and also for temperature. The depth of the acid is also measured, and knowing the dimensions of the tanks and chambers it is a simple matter to calculate the number of cu. ft. of acid in each container.

The next step is to calculate, from the data thus obtained, the acid in each lot to the same basis, as, for instance, to the basis of its equivalent in terms of 50° B., 60° B. or 66° B. acid at 60° F. The whole amount of acid on hand is then determined in terms of one grade.

Among fertilizer factories it is customary to calculate all acid in terms of 50° B. acid at 60° F. Tables, which are available, make it possible to determine the number of pounds of 50° B. acid equivalent to a cu. ft. of acid of any density and temperature. The tables as adopted by the Manufacturing Chemists' Association of the United States in 1904 are generally used as a basis for making all calculations.

Now it is no short task for the superintendent or

the chemist of a sulphuric acid plant to take a long row of figures, which represent the density and temperature of the acid in the numerous tanks and chambers, and calculate correctly from this data the exact equivalent in terms of 50° B. acid, unless a very voluminous set of tables has been especially prepared for this purpose. By calculating correctly the writer means that exact corrections are made for density and temperature instead of the rough or approximate corrections ordinarily made.

If, however, one is content when taking the acid inventory, to record the density reading to the nearest even degree Baumé and the temperature to the nearest ten degrees Fahrenheit, then the problem is not such a long task, especially if one also assumes that one cu. ft. of acid testing, say, 52° B. at a temperature from 90° F. to 110° F. is equivalent to one cu. ft. of acid testing 53° B. at 60° F. If all of these assumptions are made the summary of the acid inventory becomes very simple indeed, and if a few simple sets of tables have been compiled, practically no calculations are necessary. Such a method of figuring is not correct, however, and the error will vary, being greater for acid at higher temperatures.

Acid testing, say, 50° B. at 130° F. when cooled to 60° F. would have a density of 53.9° B., but one cu. ft. of this acid at 130° F. would have a volume of less than one cu. ft. if cooled to 60° F. while the shrinkage amounts to about 2.25 per cent., or an error too great to be overlooked.

By mentioning the above incorrect methods of calculating sulphuric acid stock, the writer does not wish to infer that such methods are generally used, but has simply referred to some methods which have come to his knowledge both by hearsay and observation. He has also heard chemists remark that they were not sure they were making their calculations with absolute correctness.

There is another slight error which the writer has often observed, which, however, is scarcely appreciable. In the tables adopted by the Manufacturing Chemists' Association, in 1904, will be found a table marked "Allowance for Temperature." This table indicates the correction necessary to apply to Baumé readings to correct from one temperature basis to another. The allowance for temperature for 50° B. acid is 0.028° B. and for 60° B. acid is 0.026° B., for each degree Fahrenheit. Therefore, acids of densities between these limits probably have an allowance-for-temperature value proportionately between the values given. By interpolation the allowance for 52° B. acid would be 0.0276° B. and for 54° B. would be 0.0274° B. for 1° F.

Take the case of acid testing 52.0° B. at 130° F. This acid when cooled to 60° F. would be about 54° B., and, therefore, the value 0.0274° B. for 1° F. should be applied, and 52.0 plus (70 × 0.0274) = 53.9° B. at 60° F. These allowance-for-temperature values were determined, as the writer understands from the original paper on this work, by heating the acid, starting at 60° F. and noting the density variation for rise in temperature. To further illustrate this