

142. $C_{10}H_{16}$ = Peinne
 143. $C_{10}H_{16}$ = Carene
 144. $C_{10}H_{16}$ = Camphanene

Alcohols—*oles*:

145. $C_{10}H_{18}O$ = Isoborneol
 146. $C_{10}H_{18}O$ = Borneol, Borneo-camphor
 147. $C_{10}H_{18}O$ = Fenchol
 148. $C_{10}H_{18}O$ = Pinol
 149. $C_{10}H_{18}O$ = Carol
 150. $C_{10}H_{18}O$ = Cineol, Eucalyptol, Cajeputol
 151. $C_{10}H_{18}O$ = Subrerol

Ketones—*ones*:

152. $C_{10}H_{16}O$ = Camphor, laurel camphor
 153. $C_{10}H_{16}O$ = Fenchone
 154. $C_{10}H_{16}O$ = Pinone
 155. $C_{10}H_{16}O$ = Carone
 156. $C_{10}H_{16}O$ = Camphenone
 157. $C_{10}H_{16}O$ = Eucarone

COLLEGE OF PHYSICIANS AND SURGEONS,
 SAN FRANCISCO, CAL.

PURITY STANDARDS FOR ABSORBENT COTTON.

BY A. WAYNE CLARK, R. O. SMITH AND LEROY FORMAN.

Prior to the work of one of us during the years 1909 to 1911 on extraction methods, etc., for impurities in absorbent cotton, little or no work appears to have been done on the subject and no standards suggested. The U. S. Pharmacopœia VIII, then official, contains only rough standards for absorbency, for acid or alkali and for ash.

Tentative standards used for manufacturing control came into use during the above period. These were published in a monograph issued from this laboratory (1912).

METHOD OF TESTING ABSORBENT COTTON LABORATORY NOTES No. 1, 1912.

Acid or Alkali.—Ten grammes of sample are saturated with 100 Cc. neutral distilled water, the water pressed out and divided into two portions, each of which is placed in a white porcelain dish. To one portion is added three drops phenolphthalein test solution, and to the other portion one drop methyl orange test solution. Neither portion should develop any pink color.

Ash.—Five grammes, on incineration in a weighed platinum crucible, should leave not more than 0.2 percent ash.

Oil and Fatty Matter.—Extract 20 grammes of sample in a narrow percolator with ether until 200 Cc. percolate is secured. The percolate, on evaporation to dryness in a weighed beaker, should leave not more than 0.5 percent residue. A blank test should be made with an equal quantity of the ether used.

Coloring Matter Resins and Soap.—Extract 20 grammes of sample in a narrow percolator with alcohol until 200 Cc. percolate is secured. The percolate should not be of a greenish or bluish tint, and on evaporation to dryness in a weighed beaker should leave not more than 0.5 percent residue. A blank test should be made with an equal quantity of the alcohol used.

Water-soluble Salts and Soap.—Extract 20 grammes of sample in a narrow percolator, with hot distilled water (80° to 90° C.) until 200 Cc. percolate is secured. The percolate should

not be cloudy—if it is so, soap is present, which should not be the case. The percolate on evaporation to dryness in a weighed beaker should leave not more than 0.2 percent residue. A blank test should be made with an equal quantity of the water used.

These standards and methods continued in use in this laboratory until the publication of the U. S. P. IX, in the year 1916, which then, of course, became official, and which contained a method like in purpose and very similar in procedure to that of the 1912 publication.

Obviously, extraction methods of the Soxhlet type are the only correct chemical procedure for accurate work of this character, and in attempting to promulgate simple percolation methods, the original workers in this laboratory were well aware that they lacked completeness. They were written into the standard method because of their simplicity so that they might be applied in laboratories of very modest equipment and for workers of moderate ability.

METHOD OF TESTING ABSORBENT COTTON U. S. P. IX (1916).

When Purified Cotton, previously compressed in the hand, is thrown on the surface of cold water, it readily absorbs the latter and sinks.

Incinerate 5 Gm. of Purified Cotton; not more than 0.2 percent of ash remains.

Thoroughly saturate about 10 Gm. of Purified Cotton with 100 mls of distilled water, then with the aid of a glass rod press out two portions of the water, 25 mls each, into white porcelain dishes. Add to one portion 3 drops of phenolphthalein T. S. and to the other portion 1 drop of methyl orange T. S.; no pink color develops in either portion (alkali or acid).

Extract 5 Gm. of Purified Cotton, tightly packed in a narrow percolator with ether, until the percolate measures 20 mls, and evaporate this to dryness; the residue does not exceed 0.6 percent (fatty matter).

Extract 10 Gm. of Purified Cotton, in a narrow percolator with alcohol until the percolate measures 100 mls. When observed downward through a column 20 cm. in depth, the percolate may show a yellowish color, but no blue or green tint (dyes); and on evaporating this percolate to dryness, the weight of the residue does not exceed 0.5 percent (resins and soap).

The tests given in U. S. P. IX appear to be an abridged assembly of the methods suggested in the foregoing, the amounts of solvents used in extraction being reduced to so small a quantity as practically to destroy the value of the method. (Criticism of the U. S. P. IX text was undertaken in a later issue of the publication referred to (1920).)

Immediately on the outbreak of the World War the medical branches of the military were called upon to secure surgical supplies, including absorbent cotton, in quantities and at a speed never before considered. Both the U. S. Army and the Navy adopted specifications for surgical dressing material, unfortunately not alike.

The following are the U. S. Army specifications for purity of absorbent cotton:

U. S. ARMY SPECIFICATIONS FOR SURGICAL ABSORBENT COTTON.

Reaction.—An aqueous extract obtained by boiling 50 Gm. of cotton in 500 mls of distilled water for 5 minutes, the water drained from the cotton to a volume of 100 mls, cooled and divided into two equal parts, the one shall be neutral to phenolphthalein, the other to two drops of methyl orange T. S.

Soluble Coloring Matters and Impurities.—A full layer of cotton, not less than 6 × 6 inches square, is carefully placed on the surface of distilled water contained in a white porcelain dish and allowed to slowly sink therein. The water rises through the mass of cotton, but no coloration or dirt must be observable at the moment it reaches the surface of the latter.

Absorbency.—Five (5) grammes contained in a small wire basket weighing not over 3 grammes, placed on the surface of distilled water at 25° C., shall be completely submerged in 30 seconds; and upon removing it from the water, allowing it to drain 10 seconds, not less than 120 grammes of water shall have been absorbed.

Moisture.—Ten (10) grammes dried at a temperature of 105° C. for three hours shall not lose more than 5 percent in weight.

Ash.—On incineration of 10 grammes in a platinum crucible it shall yield not more than 0.2 percent of ash.

Extractive Matters; Water.—An aqueous extract obtained in the same manner as for the reaction shall show no reaction for stearic acid, starch, dextrin or other foreign substances.

Twenty (20) grammes boiled in 500 mls of distilled water for one-half hour, the volume of liquid maintained by addition of boiling distilled water, the water pressed out and the cotton rinsed twice with 250 ml portions of distilled water, the total volume evaporated to dryness in a platinum dish, then kept at 100° C. until constant in weight, shall yield a residue of not more than 0.2 percent.

Alcohol and Ether.—Separate portions of 20 grammes, extracted with 95 percent alcohol and ether, respectively, in a Soxhlet extractor, for five (5) hours, shall yield a solution having no blue, green or brownish color, which, when evaporated and dried to constant weight at 100° C., shall yield a solid extract of not more than 0.55 percent in each.

The purpose of this paper is to summarize the situation. The several methods that have been used have left the matter in a tangled state. The text of the U. S. P. IX is very unsatisfactory.

The enormous number of tests made during the war gave us much additional information. Running concurrently with the cotton tests, there were standard Army tests for purity of absorbent gauze. This material is simply absorbent cotton in cloth form and there is no inherent reason why the procedure of testing should be decidedly different. During the war period the Army water extraction method required for gauze was with the Soxhlet extractor under a reflux condenser run for six hours, whereas it will be observed that the method for cotton was quite different. Upon this we have expended considerable experimental work and we here take up our critical examination in detail, as follows:

DEGREE OF ABSORBENCY.

We find ourselves unable to formulate a satisfactory method for testing this most important quality of absorbent cotton and gauze, and expressing the results in any scientific way.

The U. S. Army method for gauze is fairly satisfactory for gauze, but not at all so for cotton. It consists in dropping a folded square of gauze upon the surface of distilled water at 25° C. and noting the time for complete submersion.

The U. S. Army absorbency test for cotton is given in full above. It is quite unsatisfactory. Such tests depend on the degree of compression of the sample, condition under which it is drained, etc., etc.

The U. S. Navy requirement for cotton is simply that it shall absorb sixteen times its weight of water. No one can say how this is to be done.

With gauze the U. S. Navy entirely omits all reference to absorbency.

The method of the U. S. P. IX is a rough-and-ready one, wholly unscientific and highly influenced by the personal equation.

We have covered a wide range of methods in the way of percolation and wick tests but have not arrived at a satisfactory conclusion.

We have recently done some further work on absorbency and have only this interesting list of figures to submit, showing the effect of the temperature of the water used in making absorbency tests by the usual or U. S. P. IX method.

Absorbency of Cotton as Influenced by Temperature of Water Used.—Balls of cotton were made by rolling up two and a half gramme pieces and tying with a cotton thread to make balls of similar size (about 1½ inches in diameter). These were thrown on the surface of distilled water.

Temperature of water.	Seconds for cotton ball to become wetted and sink.
5° C. (41° F.).....	12
10° C. (50° F.).....	9
15° C. (59° F.).....	7
20° C. (68° F.).....	6
25° C. (77° F.).....	5
35° C. (95° F.).....	5
50° C. (122° F.).....	3
90° C. (194° F.).....	2

WATER EXTRACT.

A specification as to the quantity of water-extractive material is important. Not only may it be expected to give figures showing the relative completeness of the removal of the natural salts and gross dirt in cotton, but it also should be an index of the removal of the chemical salts used in the bleaching and boiling processes applied to the cotton as well as of the purity of the water used in the rinsing of them from the fiber after this treatment. In common language, therefore, a water-extractive test should tell us whether the cotton is clean or dirty.

The method as given in the 1912 pamphlet of this laboratory is only approximate and not entirely satisfactory.

The U. S. P. IX contains no water extraction test.

The war-time U. S. Army specification for water extraction of gauze does not specify the method to pursue, and the U. S. Navy specification is quite similar. Chemists would, we think, be expected to use a Soxhlet extracting device where the method is not stated. The fallacy of this will presently be shown.

The U. S. Army method for cotton is similar to that of the Navy and is apparently essentially the correct procedure (see text above). The Navy specification is identical in character.

The following figures show the futility of attempting to extract cotton with water in a Soxhlet apparatus as usually carried out:

Absorbent Cotton—Water Extraction—Soxhlet.—Extraction in all-glass Soxhlet under reflux condenser. Run on electric hot plate at rate of 18 to 20 drops per minute. 10 grammes cotton:

	%
1st 6-hour extraction.....	0.460
2nd 6-hour extraction.....	0.458
3rd 6-hour extraction.....	0.400
4th 6-hour extraction.....	0.386
5th 6-hour extraction.....	0.386
	<hr/>
	2.090

Two flasks were used in this extraction. One of them lost 0.0326 gramme (= 0.326 percent of the weight of the cotton used) and the other lost 0.0317 gramme (= 0.317 percent of the weight of the cotton used).

Trial runs of Soxhlet extraction apparatus, containing no cotton.

Run for 24 hours—0.104 grammes.

(This would be 1.040 percent on a 10-gramme sample of cotton.)

These figures indicate that the hot water dissolves the glass of the apparatus and at the same time there appears to be some other and unexplained additional regular gain in weight.

Absorbent Cotton—Water Extraction—U. S. Army Method.—Cotton boiled in 250 mls distilled water, 100 mls poured off, 100 mls water added and poured off cold, then 100 mls more added and poured off cold. Run in two series. Series A, first run as above. Series B, a second run on same sample.

	A. %.	B. %.
1st pressing.....	0.057	0.025
1st wash.....	0.025	0.010
2nd wash.....	0.000	0.002
	<hr/> 0.082	<hr/> 0.037

It is evident from these figures that while in Series A the hot-water extract is entirely removed by one cold-water wash, yet further boiling in more water (Series B) gives a further extraction of solids.

Absorbent Cotton—Water Extraction—Experimental Method.—Boil 10 grammes 5 minutes in porcelain dish with 250 mls distilled water. Pour off 100 mls and add 100 to 125 mls distilled water so as to keep total volume on the cotton at about 250 mls. Boil 5 minutes, pour off 100 mls, and repeat three times more.

Each 100 mls poured off was evaporated and weighed separately with the following results:

	Water soluble. %.
1st extraction.....	0.024
2nd extraction.....	0.024
3rd extraction.....	Spoiled
4th extraction.....	0.014
5th extraction.....	0.020

It is evident from these figures that this method is valueless.

Discussion of Results of the Foregoing Three Experiments with Water Extraction Methods.—The large amount of glass decomposed by steam and water at the boiling point as shown by the blank determination in the first method (Soxhlet) renders this method unsuitable for this determination, as the blank alone exceeds the Army specification of 0.2 percent.

Of the two methods* (the second and third as above) of extraction it is evident that the longer boiling with larger volumes of water (second method) gives higher results than the shorter boiling periods with less water (third method) and results indicate that either the cotton is itself decomposed or dissolved (or both), or that the slight residue in distilled water, 5-10 milligrammes per liter, will seriously affect results. This points to the experimental method (the third) as being preferable to the second. The large volume of water to be evaporated in the second method makes the operation unduly tedious.

Even after reasonable allowances are made there is still no known way to account for the much higher results obtained by the first method than by the others. It is possible that the alkalis known to be liberated from the glass in the first (Soxhlet) method may have a greater solvent or decomposing action on the cotton than the purer water used in the methods in which the boiling is done in a dish and hence give the higher figure.

Although it is evident from the above experiments that an absolutely accurate method of determining the water-soluble content is not available, yet there is no reason to believe that a

satisfactory method cannot be devised by using a moderate amount of boiling water and proceeding in a definite manner. Such a method is suggested later in this paper.

The specification of the military authorities requiring a definite ratio between the organic and inorganic matter in the water extract, appears to be without value.

ALCOHOL EXTRACT.

When the original work on extraction methods was done in this laboratory more than ten years ago, the U. S. Pharmacopoeia VIII being official, the endeavor was to adhere to percolation methods because of their simplicity and also on account of the non-recognition of continuous extraction methods in that work.

The situation is now different because in the U. S. P. IX the continuous extraction method is given official sanction although extraction by ether only is recognized. As the equipment for ether extraction under a reflux condenser is entirely suitable for use with alcohol it may be fair to assume that no objection could be made to alcohol extraction by that method. Nevertheless, the percolation method being official for cotton, we thought it worth while to inform ourselves of the relative accuracy of the two methods.

Alcoholic Extraction of Cotton—Analytical Data.—In the U. S. P. IX method 10 grammes of cotton are packed tightly in a small percolator and extracted with alcohol (no time being stated as to the rate of percolation) until 100 mls are obtained. This is then transferred to a weighed dish, evaporated and dried to constant weight.

In the Soxhlet method 10 grammes of cotton are packed in a wire basket and extracted for six hours in an all-glass extractor on an electric hot plate, the alcohol siphoning over about every fifteen minutes.

The following figures were obtained on the two methods:

Soxhlet.—Six-hour extraction gave 0.47 percent. An additional two hours' extraction gave 0.015 percent more.

U. S. P.—Percolation for 15 to 20 minutes gave 0.155 percent. Two additional portions of 50 mls each of percolate gave 0.05 percent and 0.02 percent, respectively, or a total of 0.225 percent. A second percolation was made taking 45 to 50 minutes for the first 100 mls and this gave 0.22 percent and two additional portions of 50 mls each gave 0.03 percent and 0.02 percent, respectively, or a total of 0.27 percent.

It will thus be seen that the U. S. P. method, after using twice as much alcohol as specified, gave figures only about half that of the Soxhlet method.

Various modifications of the U. S. P. method were then made as follows:

(A) The cotton was packed in a percolator and macerated over night in the alcohol; then percolated in the morning, taking 45 to 50 minutes to obtain 100 mls.

(B) A percolation with hot alcohol was made, allowing 45 to 50 minutes to obtain 100 mls.

(C) By macerating with just enough hot alcohol to thoroughly wet the cotton and have about an inch in the percolator above the cotton, then percolating in the morning with hot alcohol to 100 mls.

Below are tabulated the figures obtained for both methods and all modifications of the U. S. P. method:

ALCOHOL EXTRACT—SOXHLET METHOD.

	%.
6-hour extraction.....	0.47
8-hour extraction.....	0.485

ALCOHOL EXTRACT—U. S. P. METHOD.

	First 100 Cc. %	First Add. 50 Cc. %	Second Add. 50 Cc. %	Total %
15-20 minutes' extraction.....	0.155	0.05	0.02	0.225
45-50 minutes' extraction.....	0.22	0.03	0.02	0.27
(A) Maceration over night, cold alcohol				
45-50 minutes' ext.....	0.29	0.02	0.01	0.32
(B) Hot alcohol, 45-50 minutes.....	0.36	0.02	0.01	0.39
(C) Maceration with hot alcohol over				
night and complete percolation				
with hot alcohol, 45-50 minutes....	0.42	0.02	0.01	0.45

The foregoing figures indicate that the modification of the U. S. P. method (C) gives a figure very close to the Soxhlet method. This procedure is, however, difficult, time-consuming and generally inconvenient. We believe that nothing would be lost by substituting the continuous extraction method.

We doubt the value of and need for *any* alcohol extraction test for absorbent cotton. It seems to us that a water extract and an ether extract will tell the story. Only as a test for dyes added for "bluing" would an alcohol extract be useful. That is a very simple procedure and can be carried out as directed in the present U. S. P. IX, omitting the later evaporation and the weighing of the percolate. Hot-water extraction should give the soap and salts remaining from the chemical treatment of the cotton fibers. Ether extraction should indicate the degree of completeness of the removal of oil by the chemical treatment. These, with ash, ought to be sufficient. The original idea of the alcohol extraction was intended as a check on resinous material, possibly not soluble in ether and not removed by hot water.

ETHER EXTRACT.

This is an easy and simple process. The following experimental work was carried out to determine whether there appeared to be any pre-eminently satisfactory method.

Ether Extract of Cotton—Analytical Data.—Three methods for obtaining the ether extract of cotton were compared and the length of time for complete extractions. These methods were:

Ether Extract—Soxhlet Method.—Extracting 10 grammes of cotton in Soxhlet apparatus for 6 hours. Four-hour and eight-hour periods were also tried.

	%.
4-hour extraction.....	0.35
6-hour extraction.....	0.44
8-hour extraction.....	0.45

A six-hour extraction obtains practically all ether-soluble matter.

Ether Extract—U. S. P. Method.—Packing 5 grammes of cotton in percolator and percolating until 20 mls of ether are obtained. Additional portions of 20 mls of percolate were obtained until no weighable residue was found.

	Mils.	%.
First.....	20	0.18
Second.....	20	0.20
Third.....	20	0.04
	—	—
Totals.....	60	0.42

This method, with U. S. P. amounts, gives about 40 percent of the total ether extract. If three times the amount of ether is used the ether extract is then practically the same as by the Soxhlet method and the time is greatly reduced.

Ether Extract—Aliquot Method.—10 grammes of cotton in a large flask, adding 200 mls of ether, shaking occasionally during 4 or 5 hours and allowing to stand over night; then taking off a 100 mls aliquot, representing 5 grammes of cotton, evaporating, drying and weighing.

Ether extract..... 0.24 per cent

This method gives only about 50 per cent of the total ether extract.

ASH.

The U. S. P. requirement for ash is satisfactory. It is essential in determining ash that a sufficient quantity be used to represent a fair sample.

ABSORBENT COTTON IN THE NEW PHARMACOPOEIA.

The following standard requirements are suggested as suitable for the forthcoming revision of the U. S. Pharmacopoeia:

GOSSYPIMUM PURIFICATUM.

Purified Cotton.

Gossyp. Purif.—Absorbent Cotton.

The hairs of the seed from one or more of the cultivated varieties of *Gossypium herbaceum* Linné (Fam. Malvaceae), freed from adhering impurities and linters and deprived of fatty matter.

Purified Cotton occurs in white, soft, fine filaments, appearing under the microscope as hollow, flattened and twisted bands, spirally striate, and slightly thickened at the edges; inodorous and almost tasteless; insoluble in ordinary solvents but soluble in an ammonia solution of cupric oxide.

When Purified Cotton, previously compressed in the hand, is thrown on the surface of cold water (25° C.) it immediately absorbs the latter and sinks.

Incinerate 5 Gm. of Purified Cotton; not more than 0.2 percent of ash remains.

Thoroughly saturate about 10 Gm. of Purified Cotton with 100 mls of distilled water, then with the aid of a glass rod press out two portions of the water, 25 mls each, into white porcelain dishes. Add to one portion 3 drops of phenolphthalein T. S. and to the other portion 1 drop of methyl orange T. S.; no pink color develops in either portion (alkali or acid).

Extract 10 Gm. of Purified Cotton, tightly packed in a narrow percolator, with ether, until the percolate measures 200 mls, and evaporate this to dryness; the residue does not exceed 0.6 percent (fatty matter).

Extract 10 Gm. Purified Cotton in a narrow percolator with alcohol, until the percolate measures 50 mls. When observed downward through a column 20 Cm. in depth, the percolate may show a yellowish color, but no blue or green tint (dyes).

Place 10 Gm. Purified Cotton in 200 mls of boiling distilled water, using a porcelain casserole. Boil for five minutes, pressing the cotton through the water with a glass rod. Press out with the rod and pour off 100 mls of the water. Add 50 mls cold (25° C.) distilled water, working it thoroughly through the cotton and press out and pour off 50 mls. Use two more 50 ml portions of cold distilled water as above directed, to wash the cotton. Evaporate the collected waters to dryness. The weight of the residue does not exceed 0.25 percent of the weight of cotton used.

RESEARCH LABORATORY
JOHNSON & JOHNSON
NEW BRUNSWICK, N. J.
