

Section of Physics and Chemistry.
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The Scouring of Cotton.

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1. *Introductory.*—Before cotton can be properly dyed or bleached, it is necessary that the waxy matters surrounding the fibres should be removed. As these are water-repellent, it is very difficult to impregnate the cotton fibre with solutions if such impurities are present. This may be rendered easily apparent by placing raw cotton in water, even at a boiling temperature, and noticing how long a time is required for the fibres to become wet through.

Unless it is to be dyed or bleached in the loose state, cotton in this form, is seldom scoured out, as the amount of foreign matter on the fibre is nowhere comparable to that on wool, and it in no way interferes with the carding or spinning. In fact, the waxy matters on the cotton fibre are of great assistance in the proper carding and spinning of the material, as it gives a coherence to the fibres which would otherwise be lacking. Cotton that has been scoured and bleached in the loose state is very difficult to properly spin, and oil must be added to the stock in the same manner as with wool.

2. *Nature of Impurities in Cotton.*—The cotton fibre, though usually considered as consisting of practically pure cellulose, contains about five per cent. of foreign matter other than the true fibre. The majority of this consists of a thin layer of vegetable wax and pectin, which forms a coating over the surface of the entire fibre. This wax, as already noted, gives the raw cotton fibre its water-proof or water-repellent character, and is also very serviceable in giving the fibre a certain degree of plasticity during the spinning operations. Underneath the layer of wax

is a very thin cuticular tissue, which also covers the fibre proper. This, no doubt, consists of an alteration product of cellulose, produced through the action of the air, and merely acts as a limiting surface to the matrix of cellulose beneath. In the inner portion of the fibre, forming the wall of the central canal, there is also a very thin integumental tissue, or skin, which is, perhaps, of somewhat the same character as the outer skin. Within the canal itself there is also always more or less dried-up protoplasmic matter, consisting of nitrogenous substances and resinous matters derived from the dried-up sap, which during the life of the fibre circulated through this canal. There is also a small amount of oily matters present in the fibre, derived, no doubt, from the oil of the cotton seed, and **contaminating** the fibre as a result of the process of ginning. Finally, the cotton fibre contains a minute quantity of coloring-matter, doubtless of a catechin-tannin variety. In some varieties of cotton, as in the Egyptian and Nankin, this coloring-matter may become quite pronounced, and give to the fibre a distinct yellowish-brown color.

It is customary to consider the impurities of the cotton fibre under two general headings: (a) *cotton wax*, and (b) *pectin bodies*; the latter consisting of the albuminous or nitrogenous substances already spoken of.

Dr. Schunck has made a careful investigation of the impurities existing in the cotton fibre, and the following summary of his results may be given: Besides the hygroscopic moisture, crude cotton appears to contain about five per cent. of non-cellulosic matters, which may be classified as follows:

(a) *Cotton-wax*, bearing a strong resemblance to carnaüba wax; it is insoluble in water, but soluble in alcohol and also in ether.

(b) *A fatty acid* which has a melting point of 55.5° C., and appears to be either margaric acid or a mixture of palmitic and stearic acids.

(c) *Two brown coloring-matters* of a nitrogenous character; one is easily soluble in alcohol, and the other but sparingly so.

(d) *Pectic acid*; a light yellow amorphous substance, similar in character to gelatine or a gum. It is soluble in water, and is acid in reaction. It exceeds all the other constituents in amount.

(c) *Albuminous matter* of a nondescript character.

3. *Theory of Cotton Scouring*.—The process of cotton scouring is most generally spoken of as “boiling out.” The state in which cotton is usually operated on is either yarn or cloth; loose cotton is only scoured when it is desired to have it bleached in this form, more especially for the preparation of absorbent cotton or for use in cotton bats. Cotton yarn and cloth, however, must always be thoroughly scoured previous to bleaching, and also frequently before dyeing or mordanting; although in the latter case, the object of the scouring is only to cause the cotton to wet-out readily and absorb the solutions with which it is treated; consequently the scouring in this case is by no means as thorough as when it is desired to subsequently bleach the cotton, when all the impurities must be completely removed.

There are two general processes by which cotton may be scoured; the one is by the use of alkalies, such as soda ash, caustic soda, or lime, whereby the waxy matters on the fibre are removed in the form of an emulsion, and the pectin and other matters are decomposed by the alkali into soluble substances; the other method is by the use of certain oils, such as Turkey-red oils, sulphated cotton-seed oil, etc., whereby the waxy matters are dissolved-off and very rapidly removed from the fibre; although the other impurities are but slightly affected. The former method removes or decomposes all of the impurities, whereas the latter only removes the wax and makes the cotton absorbent towards water, so that it may be readily dyed. In some cases of bleaching, both methods are combined, and as we shall afterwards see, both possess certain special advantages of their own.

The treatment of cotton in scouring or boiling-out, will depend on the purpose for which the cotton is intended. If the scouring is merely for the purpose of wetting-out the fibre so that it may be more readily dyed, then the scouring is only a partial one, chiefly with the object of removing the waxy matters. If, however, the scouring is for the purpose of completely cleansing the fibre of all impurities in order that the cotton may be well bleached, then the boiling-out is a very thorough one. We will discriminate between these two methods by calling them “wetting-out” and “boiling-out.”

To obtain the best results, cotton yarn or cloth should always be wet-out thoroughly before being dyed or mordanted, as if this is not done, there is danger of having spots or uneven streaks through the goods, by reason of insufficient penetration of the dye liquor. In the case of some dyes where the color goes on very slowly and evenly, and where the material may be boiled a long time in the bath before the dyeing is finished, this previous wetting-out may not be absolutely necessary, as the boiling water itself brings this about. This is usually true of the general class of substantive cotton dyes, though in this case a small amount of alkali or oil may be added to the dyebath itself, and in this manner the wetting-out is greatly facilitated. In case of dyes which go on the fibre quickly, or which dye at temperatures below the boil, it is almost an absolute necessity to have the cotton first wet-out before placing it in the dyebath. The same is also true in the case of mordanting, especially so, as cotton does not possess any great degree of attraction for the majority of mordanting salts, and unless well wet-out the fibre will only be poorly mordanted. In the case of mordanting with tannin, where a boiling bath is used (as is sometimes the practice), the previous wetting-out operation may be dispensed with, and the cotton wet-out in the mordant bath itself; the same is also true when the cotton is steeped in the tannin bath over night; but where the tannin bath is used at a lower temperature than the boil (as is most frequently the case), the cotton should always be first wet-out, otherwise when the material is dyed, small white specks will show up, caused by lack of penetration of the mordant.

For the proper bleaching of cotton goods it is absolutely essential that all of the foreign matters present in the fibre be removed, in order that the cellulose be pure and that a good clean white be obtained. This is true both where the cotton is bleached for the purpose of being left in the form of white goods, and also where it is to be subsequently dyed with such coloring-matters as alizarin for Turkey-red, and for the general purposes of printing. In the two latter cases the bleaching must be especially thorough in order to obtain the best results in dyeing and printing. These processes are more especially used on cloth; for yarn the bleaching does not have to be so thorough. As the boiling-out of the cotton is so intimately

connected with the actual process of bleaching itself, and as the one process really forms a continuation of the other, the two must be considered together under the one subject of bleaching.

Cotton which is intended to be dyed cold should be very thoroughly scoured, otherwise the dyeing will be imperfect. Also yarns made from Makko, or Egyptian, cotton require a more thorough treatment than usual, as they contain more fatty and waxy matters than ordinary yarn. In the scouring of very fine yarns the material should be enclosed in sacks in order to prevent it from becoming felted.

4. *Scouring Cotton with Alkalies.*—The usual method of wetting-out cotton with alkalies is to boil it for an hour or two in a weak solution of soda ash. After this process it is washed in clean water, and is then ready for dyeing. A weak bath of caustic soda may also be employed for this purpose, but this is not used as much as the former. Caustic soda is more difficult to remove afterwards from the fibre, and so causes loss of time in unnecessary washing, whereas liquors of soda ash are very readily washed out of cotton, and even in many cases, the washing may be entirely dispensed with, when the dye-bath to be used is alkaline in character. It requires at least an hour's boiling in the bath of soda ash before the cotton will be completely wet-out, although the operation should not be limited to any fixed time but should be continued until it is seen that the material is thoroughly impregnated with liquid; in the case of yarns, the inside of the hanks should be opened out and examined for any dry spots. Tightly twisted yarns will naturally require longer to wet-out than single and loosely twisted yarns. Sometimes yarns are spun with the addition of oil to the stock, in which case it is advisable to add a small amount of soap to the scouring bath.

Müller has studied the effect of different alkaline agents in the wetting-out of cotton for dyeing, and the summary of his results are as follows: Using a pure, well-made soap wets-out cotton better than a sulpho-ricinoleate, olive oil soap giving the best results and palm oil and olein soap a slightly inferior result. In using a hard water it is necessary to add some soda ash in order to obtain good results.

5. *Scouring of Cotton with Oils.*—It has been found that certain oils possess the property of readily dissolving waxy mat-

ters present in the cotton fibre, so they may be used for the purpose of wetting-out cotton for dyeing. The oils referred to fall under the general class known as sulphated or soluble oils, of which Turkey-red oil is the principal representative. Turkey-red oil is so called because it is largely used in the mordanting of cotton for the subsequent dyeing with alizarin for the production of a bright red. True Turkey-red oil consists of sulphated castor oil, produced by the action of concentrated sulphuric acid on castor oil. The resulting product is an oily looking substance which is soluble in water. Other vegetable oils may be used for the same purpose, and sulphated cotton seed oil is largely used, as it is considerably cheaper. A number of proprietary preparations of these oils are on the market, among which may be named Fankhausine, Solvine, etc. Some of them also contain small amounts of mineral oil, and some contain alkali, soap, tallow, etc., for the purpose of softening the cotton. They are known under the general name of "cotton softeners." Scouring with oil leaves the cotton in whiter and softer condition, the time required for wetting-out is much lessened and the scouring can be done at a much lower temperature. The amount of oil to be added to the bath need not be more than one to two per cent. on the weight of the cotton, and in many cases it may be added directly to the dye-bath, and the cotton be wet-out before the coloring-matter is added. In almost any case, it will hardly be necessary to wash the cotton off after scouring, as the small amount of oil which would be carried over into the bath would have no effect on the dyestuff. In the case of basic dyes, however, the oil cannot be added directly to the dye-bath, as an insoluble compound with the coloring-matter will be formed. When mordanting with tannin, also the scouring must take place in a separate bath.

Turkey-red oil causes a considerable bleaching of cotton when used for boiling-out; in fact, Hartel claims that a pure white can be obtained in the following manner: The cotton is impregnated with a solution of Turkey-red oil of about ten per cent. strength, wrung out and dried. The material is then boiled for six hours under pressure with about two per cent. of caustic soda, rinsed, slightly scoured, rinsed again, soaped slightly, rinsed and finally dried.