THE "MERCERIZATION" OF COTTON FABRICS.

Considerable interest has been aroused among cotton manufacturers by a new process of "mercerizing" under tension, in which the fiber under treatment, it is claimed, assumes a peculiar silk-like gloss that adds much to the appearance of the fabric. In order to explain exactly how this novel effect is produced, we have prefaced our article with an account of the old process of "mercerization" and reviewed the discoveries made by an Englishman nearly a half-century ago.

In 1850, the British government granted to John Mercer, calico-printer and chemist, a patent for a new and curious process of treating cotton cloth—a process which greatly increased the strength of the fibers and which imparted to the fabric "greatly augmented and improved powers of receiving colors in printing and dyeing."*

Mercer's process, in brief, consisted in treating cotton cloth with caustic alkalis, with acids, or with zinc chlorid. The individual fibers, it was found, became shorter and thicker after treatment, the strength of the cloth was greatly increased, the cotton assuming a translucent appearance and dyeing far more rapidly than ordinary vegetable fiber.

Scientifically considered, the process of mercerization forms one of the most interesting chapters in the chemistry of cellulose. Treated with caustic soda-solution (sp. gr. 1·23 to 1·28) at ordinary temperatures, the remarkable thickening and contraction in length already alluded to, takes place. The effect on cotton cloth may be described in Mercer's own words: "I spotted bleached cambric with single drops of caustic soda-solution (1·3 sp. gr.), and noticed that the central portion of each drop became semi-transparent and contracted; around this was a rim neither semi-transparent nor contracted."

In cloths, the contraction is about 20 to 25 per cent; the increase in strength measured by the breaking strain on isolated threads, about 50 per cent. Moreover, an increase in weight over ordinary cotton is noticeable after mercerization, due probably to the excess of hygroscopic moisture. According to Mercer's own experiments, it seems that the action of the alkali is the result of a combination with the cellulose of the cotton, represented by the chemical formula $C_{12}\,H_{20}\,O_{10}\,Na_2O$, cellulose having the formula $C_{12}\,H_{20}\,O_{10}$. On washing, water takes the place of the sodium oxid, and the hydrate, $C_{12}\,H_{20}\,O_{10}.\,H_2\,O$, is formed, a degree of hydration producing an increase in weight of 5·5 per cent.† This water of hydration is readily expelled by heat, but is reabsorbed on exposing the fiber to the atmosphere. The change in the physical and chemical condition of the cotton cloth after mercerization is therefore permanent. Dr. Gladstone‡ in his experiments on mercerized cotton found that after exhaustively treating the fiber with alcohol to remove the excess of alkali, a proportion of the latter is still retained corresponding to the formula $2\,(C_{12}\,H_{20}\,O_{10}).\,Na_2O$, the compound being easily decomposed by water and carbon dioxid.

These reactions of cotton fiber with caustic soda vary considerably with the temperature of the solution, "the variations being the inverse of those usual in chemical reactions, the effect being retarded by increase in temperature." § Solutions at the ordinary atmospheric temperature seem to act most effectively. It is also found that hydrated zinc oxid increases the action of the alkalis. Zinc chlorid in strong solution acts on cotton fiber in a manner similar to that of the caustic alkalis, and is therefore included by Mercer in his patent.

Like results are obtained by treating the cotton with dilute sulfuric acid. Although the changes which occur during the acid treatment are also to be attributed to hydration, the effects produced are sometimes different and opposite in character.‖ Sulfuric acid of 1·35 specific gravity, nitric acid of 1·3 specific gravity, and concentrated hydrochloric acid gradually disintegrate the cellular fibers at ordinary temperatures. The first action, however, is the toughening accompanied by linear shrinkage so characteristic of mercerized cotton.

Crum,‖ who examined mercerized cotton microscopically, found that the action of the caustic alkalis produced changes in the physical structure of the fiber, in every way similar to those which take place in the ripening of the fiber while still on the plant. From a flattened tube with a large central cavity, the fiber changes to a thick-walled cylinder with small lumen. In their normal state the fibers are, moreover, spirally twisted about their longitudinal axes, and when spun or woven still retain this formation. When mercerized, the fibers are no longer twisted, but become more or less rounded and compact. From a cellular tissue, the fiber changes to a glutinous, colloidal, and ductile substance.

In spite of the many advantages possessed by mercerized over ordinary cotton, its great shrinkage increases the cost of manufacture to such an extent, that the process has not been generally used.* Technically, mercerization has hitherto been employed chiefly in the preparation of piece-goods for turkey-red dyeing and in the manufacture of calico-printer's blankets for machine printing.† In France the property possessed by vegetable fiber of becoming shorter after mercerization has been employed by a Lyons firm to produce peculiar embossed effects in silk webs containing cotton threads.

In order to overcome the great shrinkage produced by mercerization, many manufacturers have attempted either to stretch the cotton while under treatment, by clamping it in the stretching machines usually found in dyeing and finishing establishments, or to subject it to tension after mercerization, in order to bring it back to its original length. In both these operations the short, loosely spun fibers slip over one another and thus produce an elongation of the material.

Following in the footsteps of previous experimenters in attempting to stretch long fiber and hard spun mercerized cotton to its original length, Richard Thomas and Emanuel Prevost, of Germany, found that the machines ordinarily used for the purpose were not powerful enough. They therefore devised more powerful apparatus, which would subject the fabric to a greater tension and which would sufficiently elongate the cotton. During this powerful stretching of long fiber or hard spun cotton, they made a most remarkable discovery. The cotton cloth, it was found, assumed a brilliant silk-like luster, a certain glossy appearance, which the discoverers claim was due to the fact that the fibers no longer merely slipped over one another, but to the fact that the individual fibers were themselves stretched, thus producing the peculiar glossy effect. An important element of this process, besides the increased stretching, seems, therefore, to lie in the use of long fiber or hard spun cotton. This silk-like luster produced by mercerizing under increased tension has many analogies in the arts. We find it present, for example, in "pulled" candy or drawn molten glass.

The new process, therefore, presents the advantages not only of producing a strong, easily dyed textile fabric, but of adding a gloss which materially adds to the value of the fabric. So far as the results obtained by the process are concerned, it seems immaterial whether the cotton is first stretched and then mercerized, the latter process causing the fibers to contract sufficiently to produce the silken appearance, or whether the cotton is first mercerized, and while subjected to the action of the caustic bath, is elongated by machinery. This attenuated condition of the fiber is rendered permanent, either by maintaining the tension until the mercerizing alkalis or acids have been completely removed or neutralized, or by stretching the fiber previously beyond the necessary amount and then allowing the threads to contract to the required length while subjected to the process of mercerization.

Ordinary mercerized cotton, it is true, possesses a certain natural gloss of its own; but between this natural gloss and the artificial silk-like brilliancy produced by stretching, a very sharp line can be drawn. Ordinary mercerized cotton merely has a semi-transparent, parchment-like appearance; long fiber or hard spun mercerized cotton, stretched according to the Thomas and Prevost process, possesses more the characteristic luster of silk—a distinction, it seems, which is not very generally understood.

An impression appears to prevail among cotton-manufacturers, that the new process of mercerizing under tension is by no means new, that the patent granted to Thomas and Prevost is merely a renewal of a patent for an old, long-forgotten process. True it is, that mercerizing under tension has been known for some time. We find it employed by many manufacturers both at home and abroad. But it is claimed by the inventors that no one has hitherto stretched mercerized, hard spun, or long fiber cotton to an extent sufficient to produce the effect which we have described. Something analogous to the Thomas and Prevost treatment is found in a process which subjects cotton to a preliminary mercerization and stretching, and then treats it with a solution of silk to impart the well-known appearance of silk. Although both tension and mercerization are used in this process, it does not necessarily follow that the silken gloss is produced by tension; it appears to be due rather to the silk solution. Small as the departure of the Thomas and Prevost process has been from the means previously employed in mercerization, the results nevertheless appear to be widely different and valuable.

It has been already observed that the expense incurred by the old process has affected the general use of mercerization. Whether a similar cause will affect the manufacture of fabrics by the new process, or whether the superior silken quality produced will compensate for the increased cost, only a cotton manufacturer can say.

* Mercer: quoted by Thorpe: "Dictionary of Applied Chemistry."

† Thorpe: "Applied Chemistry." Article on Cellulose.

‡ Journal für praktische Chemie, Vol. 56. See also Quarterly Journal of the Chemical Society of London, Vol. 5.

§ Thorpe: *Loco citato.*

‖ Journal of the Chemical Society of London, 1863.

* Knecht, Rawson, and Loewenthal: "Handbook of Coloring and Spinning Fibers."

† Thorpe.

Exploring Coral Reefs.

An interesting preliminary report of the scientific investigations by the Agassiz expedition in the Fiji Islands has just been brought to Sydney, New South Wales, and from there to San Francisco. The report was written by Prof. E. C. Andrews, who led the expedition. It states that the progress of boring through the reef at Fannafuti is very rapid. The explorers have secured several rare specimens of coral. The most important undertaking of the expedition in the matter of Crater Lake exploration was the trip of Profs. Sawyer and Andrews to Taviuni and its crater lake, 2,800 feet above the sea level. The start for the lake was made over Razor Back, that led them 3,000 feet above the sea, and from which height they could get a fine view of the lake. The ascent was made with the greatest difficulty and much suffering on their part. The tropical vegetation to the edge of the crater was marvelous in its density. The report says that the growth was so dense that at midday, while cutting paths toward the summit, the sun was entirely obscured, the effect being the same as in a forest when the sun is down and its refracted rays have all but vanished. In some parts it was pitch dark, and their path had to be changed to places which were less hampered by brush and closely interwoven branches overhead.

Passing through this belt into a less wooded part of the mountain they made their way through mud holes which brought them to the crater's edge. From there to the level of the lake was a hard climb down the steep hillside covered with decayed vegetation. A swamp lay between them and the clear water. The two professors sank to their hips in the muck, and the stench from the ground was almost overpowering. It was noon when they landed on a piece of hard ground at deep water. The lake itself is blue and clear, but sounding lines failed to find bottom even when 600 feet of cord had been paid out. Numerous specimens of great scientific value were secured.

The expedition next goes from Taviuni to Mango, where there is a crater whose rim is a raised coral reef.

The "Indiana's" Punch Bowl.

The "Indiana" has a silver service of twenty pieces, and one of them, a punch bowl, has received an honorable scar resulting from a too near approach to the Zocapa mortar battery, near the entrance to Santiago Harbor. On July 3, while the "Indiana" was cruising near this battery, a shell struck the quarter-deck, piercing the armor, and burst in the wardroom. A fragment of shell 5 inches long, and varying from 2 to 4 inches in width, hit the bowl on the engraved side, but fortunately not until its speed was well spent. The dent covers a space of about 4 inches, and it is regarded with great pride by the officers and crew. The punch bowl has been sent to Messrs. Tiffany & Company to have an account of the injury engraved across the damaged portion of the gilt lining. The fragment of shell has been preserved and will be mounted on an ornamental openwork silver cover for the bowl.

The Current Supplement.

The current SUPPLEMENT, No 1188, contains a number of addresses, papers, and articles of more than general interest. "The French on the Upper Nile" is accompanied by a map which will be of value, now that Gen. Kitchener's army is so much in the public eye. "Bottle Drifts" has a map which shows the pilot chart of bottle drifts on the Atlantic Ocean for August, 1898. "Greenhouse Heating," by Thomas N. Thomson, is a very practical article, and is accompanied by clear diagrams. "The Division of Clock Dials" describes some very curious dials on old clocks. "The Use of Bamboo Among the Annamites" is an interesting article which describes the use of bamboo to make enormous norias, or immense wheels for raising water. This issue of the SUPPLEMENT contains three important addresses and lectures. "The Inaugural Address" of Sir William Crookes, President of the British Association, is begun in this number. Prof. Barnard's "The Development of Photography in Astronomy" is continued, and Prof. F. P. Whitman's "Color Vision" is begun.

The attention of our readers is called to the fact that the SUPPLEMENT each year publishes a number of lectures, papers, etc., by scientists both at home and abroad, and in many cases these lectures are not published elsewhere.

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(Illustrated articles are marked with an asterisk.)