

Dyeing: the art of coloring yarn or cloth; has been practiced from the most remote antiquity. The fibers and fabrics usually dyed are either cotton, linen, silk, or wool. (See TEXTILE FABRICS.) The coloring-matters employed are either the natural products of animals or plants, or are the results of chemical processes. (See DYESTUFFS.) Thorough cleansing of the fibers is an indispensable preliminary to dyeing. Resinous and oily matters must be removed to give the dye liquors free access to the fibers, and natural coloring-matters must be destroyed in order to secure the brightest and clearest tints of the dyes. Cotton is successively boiled with lime, soda-ash, and rosin soap; it is then soured with dilute sulphuric acid, and finally treated with hypochlorite of lime (bleaching-powder). Linen is subjected to repeated treatment with water, alkalies, acids, and hypochlorite of lime, alternating sometimes with exposure on the grass to air and sunlight. Silk is boiled in a solution of fine soap to remove the gelatinous, resinous, and fatty matters which make up a large proportion of its weight. Wool is thoroughly cleansed by washing in weak soap or carbonate of soda solution, putrid urine, or weak ammonia. For the details of these operations, see BLEACHING.

The dyeing is effected upon loose or unspun fibers, yarn, and woven cloth, and the operations performed differ according to the nature of the fiber, its condition, and the dyestuff used. Loose materials are dyed in tubs or vats, yarn is hung over sticks which rest upon the top of the vat and is turned from time to time; or warp yarns are dyed in long chains, while pieces are dyed in a continuous dyeing machine, divided into a series of compartments which contain the necessary mordants and dyestuffs, or upon the jigger, a machine consisting of two rollers placed above a tank which contains the dyeing liquor; the pieces are wound back and forth through the dye-bath upon the rollers.

Some colors combine with the fibers very readily as soon as they are immersed in their solutions; such colors have been called *substantive*. Silk and wool take colors much more readily than cotton and linen; many dyes are therefore substantive for these animal fibers. Many of the aniline colors belong to this class. With such colors the operations of dyeing are very simple. They consist in the mere immersion of the yarn or cloth in cold or hot solutions of the dye, with sufficient handling to secure the even distribution of the color. Agents are often added to fix or set the color, or to obtain a more even shade [*assistants*], such as acids, alkalies, tin salt, alum, etc.

For adjective dyes, those which will not unite directly

with the fibers, the aid of *mordants* is necessary. Mordants are bodies which possess an affinity for the colors, and which can be fixed in an insoluble condition on or within the fibers. Some are metallic oxides or salts, as alumina, oxide of iron, oxide of chromium, oxide of tin, tannate of tin, etc.; others, as tannin, are of a different character. The mode of applying the mordant depends on the fabric, as well as on the character of the mordant itself. Silk and wool, when immersed in a solution of alum, take up a considerable quantity of the salt without decomposing it. The acetates of alumina, iron, and chromium are easily decomposed, with the liberation of a portion of the acetic acid and the formation of an insoluble basic acetate. By boiling cotton in their solutions the fibers become thoroughly impregnated with the insoluble compounds, and when the yarn is transferred to the solution of the dyestuff the color unites with the mordant, forming insoluble colored bodies in or upon the fibers, which are called *LAKES* (*q. v.*). The goods thus become permanently dyed. The same decomposition of the aluminous or ferrous salt occurs if the goods are simply immersed and then hung up in the air. Chloride of tin is decomposed by boiling its dilute solution, with the liberation of hydrochloric acid and the formation of insoluble oxide of tin. Sometimes the insoluble oxide or salt is produced by first immersing the goods in a soluble salt, and then passing them through a second solution of another agent. Exposing fabrics to an iron salt, and then to an alkaline lye, fixes oxide of iron. A lead salt and an alkaline lye fix oxide of lead. Stannate of soda, followed by a solution of nutgalls, sumach, etc., fixes tannate of tin in the fibers.

Mordants often affect the natural tints of the dyes, thus enabling the dyer to produce a variety of shades with the same dye. Oxide of iron is most remarkable in this respect; it changes the red color of madder, logwood, Brazil-wood, etc., to shades of purple, lilac, chocolate, and even black, according to the proportions in which it is employed. The oxide of tin tends to brighten the shades, while alumina fixes them in their natural tints. This is a very important circumstance in calico-printing, as it enables the dyer to produce several colors on the same cloth by one operation of dyeing. (See *CALICO-PRINTING, Madder Style*.) Metallic pigments are often produced in the yarn or cloth by the successive application of the agents necessary for their production. Thus when cloth mordanted with oxide of iron is passed into an acidulated solution of ferrocyanide of potassium, an insoluble Prussian blue is at once produced. Goods impregnated with oxide of lead by immersion in acetate of lead become bright yellow in a solution of bichromate of potash, owing to the formation in the fibers of insoluble chromate of lead. By subsequently boiling with lime-water the yellow is changed to orange basic chromate. Indigo blue is produced in cotton by immersing in a solution of colorless reduced indigo (see *CALICO-PRINTING, Indigo Styles*) and exposure to the air, when the indigo blue is regenerated by oxidation in an insoluble form.

The following methods of dyeing are in use:

- (1) Direct dyeing in water, usually with an assistant; as example, see receipt 3.
- (2) Direct dyeing with the mordant in the dye-bath; as example, see receipt 5.
- (3) Mordanting followed by dyeing; as example, see receipt 15.
- (4) Dyeing (called here *stuffing*) followed by mordanting (called *saddening*); as in receipt 55.
- (5) Mordanting, dyeing, and saddening.
- (6) Production of the coloring-matter upon the fiber, as in the case of some azo-reds.

The following are a few typical ways of dyeing; more detailed statements are given in the articles on the various dyestuffs:

REDS.

On Cotton.—(1) The most beautiful red on cotton, Turkey red, is produced by means of alizarin dyed upon an alumina mordant. This has been largely superseded by the alizarin red, dyed frequently as follows: The bleached cotton is thoroughly impregnated with a water solution of alizarin assistant (made by the action of sulphuric acid upon castor oil), dried, steamed, mordanted in acetate of alumina, dinged with arseniate or phosphate of soda, dyed in an alizarin bath, again treated with alizarin assistant after thorough washing, steamed, and very carefully washed with hot soap. (2) Aniline reds and pinks on cotton mordanted

in nut-galls or sumach, followed by a tin or antimony salt. (3) Substantive reds produced by benzopurpurin and Congo red upon unmordanted cotton, and dyed in a bath containing soap or carbonate or phosphate of soda.

On Wool.—(4) Mordant with alum and tartar and dye with alizarin. (5) Cochineal, with cream of tartar, sumach, and fustic. (6) An artificial red (azo-red) in a bath containing sulphuric acid and sulphate of soda. (7) *Pink*. An eosine in a bath containing alum. (8) Aniline shades are fixed on wool without mordants in acid baths.

On Silk.—(9) Peach-wood and fustic, followed by red spirits, with annatto for scarlets, cochineal and safflower for finer tints. (10) *Pink*. Safranin or rhodamine in soap bath, or an eosine in a soap bath acidulated. (11) Benzidine reds in a soap bath, or basic anilines. (12) Acid artificial reds are applied to silk in a warm bath, slightly acidulated with acetic, tartaric, or sulphuric acid.

BLUES.

On Cotton.—(13) Prussian blue produced by an iron mordant, followed by ferrocyanide of potassium. (14) Indigo vat, a solution of reduced indigo. (15) *Aniline blues*. Mordant with sumach or tannin, then a salt of antimony or of tin; dye in warm bath.

On Wool.—(16) Prussian blue, as for cotton. (17) Indigo extract, with argol and alum. (18) Aniline blue, with sulphuric acid and sulphate of soda.

On Silk.—(19) Prussian blue, as for cotton. (20) Indigo extract and alum. (21) Anilines, with soap and sulphuric acid.

YELLOWS AND ORANGES.

On Cotton.—(22) Chromate of lead, produced by bath of acetate of lead, followed by bichromate of potassa. (23) The chrome yellow is deepened to orange by boiling in lime-water. (24) Mordant with tannin and dye with chrysoïdine or auramine. (25) Mordant in weak protochloride of tin, dye in quercitron bark, fix with protochloride of tin. (26) Chrysin in a bath containing soap or phosphate of soda.

On Wool.—(27) Mordant in tartar and alum; dye in mixture of quercitron, sumach or fustic, and red spirits. (28) Weld, with alum and tartar. (29) Picric acid. (30) Acid coal-tar yellows. (31) Flavine, with a tin mordant. *Orange*. (32) Alizarin orange with alumina mordant. (33) Acid artificial orange.

On Silk.—(34) *Yellow to orange*. Annatto, with alum and white soap. (35) Weld, with alum and tartar. (36) Picric acid. (37) Artificial neutral and basic yellows and oranges in soap baths. (38) Acid artificial yellows in acid baths.

GREENS.

On Cotton.—(39) Dye blue, then yellow with fustic quercitron bark or chrome yellow. (40) Aniline green, on cotton mordanted with sumac.

On Wool.—(41) Dye yellow with fustic and alum, then blue with indigo. (42) For olive, use fustic with logwood, madder, and peach-wood, following with copperas. (43) Aniline green. (44) Picric acid and indigo carmine.

On Silk.—(45) Fustic, with sulphate of indigo and alum, using logwood and copperas to darken shades. (46) Basic artificial greens in a soap bath. (47) Acid aniline green, with sulphuric acid or cream of tartar. (48) Picric acid and indigo carmine.

PURPLES, VIOLETS, AND LILACS.

On Cotton.—(49) Mordant with red spirits, and dye with logwood, to which a little red spirits and acetate of alumina have been added. (50) Dye light blue, then redden in logwood with alum. (51) Mordant in sumach, then in red spirits, and dye in logwood. (52) *Safflower lavender*. Dye light blue, then cover with safranin. (53) Dye alizarin on a mordant of alumina and oxide of iron. (54) *Aniline colors*. Mordant with sumach, followed by perchloride of tin or tartar emetic.

On Wool.—(55) Cudbear, logwood, barwood, camwood, or peach-wood, with alum. (56) Basic aniline violets in a neutral or soap bath. (57) Acid violets in acid baths.

On Silk.—(58) Basic and acid violets, as for wool.

BLACKS.

On Cotton.—(59) Sumach, followed by copperas, then by logwood, then by weak copperas; the color is improved by adding fustic and replacing the second copperas bath by acetate of iron. (60) For blue-black precede 59 by the in-

digo vat. (61) Aniline black. Impregnate with aniline salts and an oxidizing agent. Oxidize by dunging or in an oxidizing machine, and treat with bichromate of potash. See CALICO-PRINTING.

On Wool.—(62) Mordant with copperas and blue vitriol, then logwood, finally copperas. (63) Mordant in bichromate of potassa; hang in the air; dye in logwood, barwood, and fustic; sometimes finish in copperas.

On Silk.—(64) Copperas and logwood repeated; the addition of nitrate of iron and fustic improves. (65) For blue-black, dye in Prussian blue and follow with 64. Artificial blacks in acid or soap baths.

DRABS.

On Cotton.—(66) Sumach, followed by weak copperas, then fustic, Lima-wood, and logwood; raised with alum.

On Wool.—(67) Madder, peach-wood, logwood, fustic, with alum and copperas.

On Silk.—(68) Sumach, fustic, and logwood, with copperas.

BROWNS.

On Cotton.—(69) *Catechu brown.* Boil in catechu, pass through hot bichromate of potassa, wash in hot water containing a little soap. (70) *Chocolate or French brown.* Dye in spirit yellow, 25, then in logwood, and raise with acetate of alumina. Basic aniline browns on tannin mordants.

On Wool.—(71) Pass through a bath of fustic, madder, peach, and logwood; then through dilute copperas. (72) Bath of bichromate of potassa, argol, and alum; then of madder, peach, and logwood. (73, 74) Neutral and acid coal-tar browns.

On Silk.—(75) Neutral and basic coal-tar browns in soap baths. (76) Acid coal-tar browns in acid baths.

For further details, see Sansone's *Dyeing*; Delmart's *Echtfärberei der losen Wolle*; Soxlet's *Färberei der Baumwolle*; Hurst's *Silk Dyeing, Printing, and Finishing*; Hummel's *Dyeing of Textile Fabrics*; and Kertesz's *Die Anilinfarbstoffe*.

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