



THE EQUIPMENT NEEDED FOR DYEING AND THE COLORS FORMED BY OXIDATION: BY PROFESSOR CHARLES E. PELLEW, OF COLUMBIA UNIVERSITY: NUMBER III

BEFORE discussing the next class of dyestuffs, probably the most important of all for the arts and crafts worker, it may be well to say a few words about the general equipment necessary for dyeing, and to give some general rules which may be of assistance to the beginner.

The articles which are necessary for even quite elaborate work are, fortunately, few and comparatively inexpensive. For dye pots by far the most useful are agate ware vessels, large cups being used for class work, and for practical work boilers in sizes varying from one to five gallons capacity, according to the quantity of material to be dyed at one time. It is always best, especially for amateurs, to dye in one batch enough material to complete the work on hand, whether rug, portière, piece of tapestry or the like, so as to avoid the necessity of exactly matching the shade afterward. For three and a half or four pounds of cotton rags, such as is used for rag carpets, $3\frac{1}{2}$ -gallon pots are about the right size. This amount of material will be enough for one rug 6×4 feet or so, woven on a hand-loom.

For heating it is best to use a gas stove with four or five ring burners,

and it is always best to have one or two large pots set aside for heating water, or for boiling out the raw goods, and another used, when very fast colors on cotton or linen are employed, for boiling out, and brightening the finished materials with soap. These pots should be reserved for these purposes and not used for dyeing, to avoid danger of staining the goods.

The top of a kitchen range will, of course, do for heating, but whenever possible it is best to have a separate stove, set low, so that the top of it will not be more than two or two and one-half feet from the ground. This enables the operator to look down into the dye pot, and stir the goods without straining or excessive fatigue.

While the material is being dyed it should be kept constantly in motion. When working with small amounts of material, or light goods such as straw, raffia, muslin and the like, or delicate or easily spoiled material like silk in skeins, it is far more satisfactory in every way to use for stirring heavy glass rods, thirteen or fourteen inches long, well rounded at the ends. These can be obtained, at little expense, from any dealer in chemical apparatus, and

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are always clean and smooth if carefully handled and thoroughly washed. Of course, they are liable to crack and chip if exposed to sudden variations of heat and cold, and when working with large quantities of heavy materials, ten pound batches and upward, are liable to break and do injury. In these cases it is best to use wooden dyesticks, as, for instance, broomsticks cut into two-foot lengths and with ends carefully rounded by whittling with a sharp penknife. But for really careful work it is necessary to have several sets of these dyesticks, two for each main color, and they must be carefully washed each time after being used, or they will stain cloth that is being dyed in light shades, and will soon get soft and rotten from the action of the alkali in the dye baths.

Good rubber gloves are extremely useful, while dyeing, to protect the hands not only from being stained and discolored by the dyes, but also from the action of the chemicals, especially in dyeing with indigo and other vat dyes, where caustic alkalies are used.

Both before and after dyeing it is very important to have at hand a good clothes wringer, preferably with metal frame. In fact, for very careful work there should be two wringers, one to wring out the raw materials, after boiling them in soap and water, or, if clean, in plain water to insure that they are thoroughly wet, and the other to wring out the excess of dye liquor from the goods before rinsing, or, as in some cases, before hanging up to oxidize.

Sufficient room should be provided for hanging and drying, and usually ordinary clothes lines conveniently fastened are all that are necessary. For special purposes, as in class work, for instance, or when working on very delicate material like silk in skeins, it may be necessary to build simple clothes-horses made of thick glass tubing, one

inch or so in diameter, supported on wooden frames.

One word of warning here about the use of the colors. Nothing more marks the unskilled workman than the dependence for his shades on individual dyes. The most difficult and the most important part of the art of dyeing, and one that can only be mastered by constant practice and application, is the mixing of simple "primary" colors so as to get the desired color effects. Three, or, at the most, four good colors—a red, blue and yellow, with perhaps a black to save trouble—are all that are really necessary in any one class to get any conceivable shade. Another important matter is to study the gradation in tone that can be produced by "topping" one color with another. For instance, in dyeing some particular shade of green,—say that produced on cotton by Katingen Green 2 B, Elberfeld,—this color can be fairly matched in shade by mixing in proper proportions solutions of one of the sulphur blues with a sulphur yellow, and dyeing the cloth in this mixture. Or the same shade can be reached by first dyeing the cotton blue and then topping it with yellow, or by dyeing it yellow and topping it with blue. The shade will be the same in each case, but the tone will be more or less different, and, almost invariably, the effects from mixing or, better, topping the colors will be more interesting than from the use of a single dye. This is very marked in some other materials, as, for instance, in leather staining.

CLASS II.

Colors Formed by Oxidation on the Fiber.

- (a) Sulphur dyes.
- (b) Vat dyes.

The dyestuffs belonging to this class are particularly valuable for our purpose because, while applied in one bath and with but little difficulty, they pro-

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duce colors which are exceedingly fast to washing and, in most cases, to light.

(a) *Sulphur Dyes*.—These dyes, which are now very numerous, have all resulted from the discovery by one of the French dye manufacturers that by heating sawdust and other organic material with caustic alkali and sulphur a coloring matter could be extracted which has certain interesting properties. It was insoluble in water or acids, but dissolved readily in an alkaline solution of sodium sulphide. If cotton or linen was heated in this solution the color would be absorbed by the fiber quite readily, and then, on exposure to the air, the dye would become oxidized and would be fastened to the fiber so permanently that no amount of washing could dislodge it. This coloring matter, known as Cachou de Laval, gave orange brown shades of but little value, but, as in so many other cases, it started investigations which during the last four or five years have entirely revolutionized the dyeing industry.

Every important dye firm has discovered and put on the market a line of colors, blacks, blues, browns, violets, yellows and in one case a red, which have the rare peculiarities of being soluble in alkaline sodium sulphide, of adhering readily without mordants to vegetable fibers and of being set or fixed by exposure to the oxygen of the air.

Class Names.—While in general known and identified as the Sulphur colors, the different manufacturers have given special class names to their own series, thus:

Immedial, Katigen, Kryogene, Pyrogen, Thiogene, Thion, etc.

General Applications.—These colors are almost exclusively used for dyeing cotton and linen, when shades are required fast to washing, without the necessity of going through a mordanting process. They are dyed in one bath with very little more difficulty than the

Salt colors described in the last article, and while not faster to light than the very best of that class, they are not nearly so liable to bleed.

On wool they are very rarely, if ever, used. Wool is almost always dyed with the acid colors in an acid bath, and when there is need for extremely fast shades these are usually obtained by the aid of the mordant colors, as, for instance, Alizarines with chrome mordant.

But for silk they are occasionally valuable, as, for instance, in cases where silk yarns are used for embroidery on cotton or linen goods that are expected to stand washing with hot soap suds. Silk dyed in the usual way with acid colors will "strip" almost completely after a few minutes' immersion in boiling soap and water; while when dyed with Sulphur dyes the colors are permanent.

It must, however, be always remembered that hot alkaline solutions are very destructive to animal fibers, and so special care must be taken when silk is to be dyed with these dyestuffs.

On mercerized cotton and also on artificial silk these dyestuffs take easily and well—in cold or lukewarm baths.

DYEING DIRECTIONS.

For Cotton.—The color, carefully measured out, is dissolved in hot water to which has been added twice as much sodium sulphide (crystals) and a quarter or one-third as much soda ash. In all these formulæ cooking soda may be used in place of soda ash—only in quantities almost twice as large.

The cotton, well wetted, is heated in this dye liquor until it boils, and then salt is added, about two spoonfuls for every spoonful of the dye-stuff. After boiling for some fifteen minutes, keeping the cotton as far as possible below the level of the liquid, the heat is removed and the cotton, as soon as cool enough,

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is run thoroughly backward and forward through the wringer, till all extra liquor is squeezed out. It is then shaken out, hung up for half an hour or so to oxidize, after which it is well washed in a boiling soap bath, rinsed free of soap and again hung up to dry.

In case light shades are desired, or the material is tender, the dyeing can be done at lukewarm temperature, or, if at the boil, without the addition of salt.

For Silk.—For each spoonful of dye-stuff used, there is measured out one spoonful of sodium sulphide and two of glucose. These are dissolved in boiling water and added to the dyestuff, which should contain a little soda, some Turkey red oil and a considerable quantity of Glauber salt. (For three gallons of dye liquor the amount would be about one teaspoonful of soda ash, five of Turkey red oil and two or three table-spoonfuls of Glauber salt.) The silk is boiled in this dye liquor for ten or fifteen minutes, taken out, squeezed through a wringer, shaken out and hung in the air for half an hour, then washed in a hot soap bath and finished by passing through a bath containing a few teaspoonfuls to the gallon of acetic acid or strong vinegar.

Colors Produced.—These Sulphur colors are particularly strong in various shades of black, blue and brown. Some of the yellow shades, also, are very fast and good.

As a rule the shades are softer and deeper and much less brilliant than the

Direct Cotton or Salt colors described before. They are fast to washing and, in most cases, fast to light.

Selected Colors.—

- Badische—Kryogene Black T G O.
“ Direct Blue G.
“ Brown R B.
- Casella—Immedial Black N R 7.
“ Indone B B F conc.
“ Yellow Olive G.
- Elberfeld—Katigen Indigo B extra.
“ Yellow G.
“ Brown 2 R.
“ Green 2 B.
- Kalle—Thion Black 2 B X extra.
“ Blue B conc.
“ Yellow G G.
“ Indigo Red B.
- Metz—Thiogene Black M.
“ Cyanine C.
“ Gold Yellow O.
“ Brown G 2 T.

After Treatment.—The colors in the above list are all fast to washing, and in most cases fast to light. When exposed to very fierce sunlight some of them are liable to change their shade somewhat, but even then will be found to fade to nice soft shades not out of harmony with the original.

For very extreme cases it may be worth while to after treat them, as described in the last article, by keeping for twenty or thirty minutes in a hot bath (not necessarily boiling) containing small amounts of copper sulphate, bichromate of potash and acetic acid.