Practical notes

Coloration on the small scale

In practical dyeing, even on a small and experimental scale, patience is usually necessary to produce a satisfactory result. Simply dissolving the dye in the water and entering the goods is almost certain to result in disappointment, which may easily be avoided by taking a few simple precautions.

Wetting out the fabric

Whatever the scale of the operation, it is essential to ensure that there is an even distribution of dyebath auxiliaries in the fibre mass. For this reason it is generally best to allow the goods to soak in the bath with all the ingredients except the dye for about 5–10 minutes at 40–45 °C, before adding the dye. This procedure is referred to as *wetting out*.

The dye can then be added in portions with vigorous stirring. Better still, the goods can be removed whilst the dye is added and mixed into the liquor, and the goods are then re-entered. Dyeing can then begin.

Adequate movement of dye liquor

A steady flow of dye liquor through the goods during dyeing is essential for the production of a level dyeing. Exhaustion in localised areas leads to unlevel dyeing. A uniform distribution of dye is best obtained by ensuring that the liquor does not at any time become stagnant within or around the fabric. The bath should therefore be constantly stirred throughout the operation, or the fabric or yarn moved within the dyebath; the latter arrangement is adopted in most laboratory dyeing machines.

Where specially designed laboratory dyeing equipment for small-scale dyeings is not available, this movement of liquor between dye and fibre is best achieved by constantly moving the fabric up and down in the liquor. If there is sufficient fabric to form a closed loop, then a support can be provided over the top of the dyebath around which the fabric can be moved by lifting a section and allowing it to fall forward over the support and into the dye liquor. By repeating the process the liquor is kept circulating over the fabric.

A similar system may be adopted for dyeing yarn. For the purposes of craft dyeing, yarn is best dyed in hank form and a similar system for moving the hank may be adopted. Figure 8.1 shows the yarn looped over a bent glass rod, the latter being so positioned that the top of the hank is always just immersed in the liquid. The yarn may then be lifted and moved forward a few inches at a time over the support.

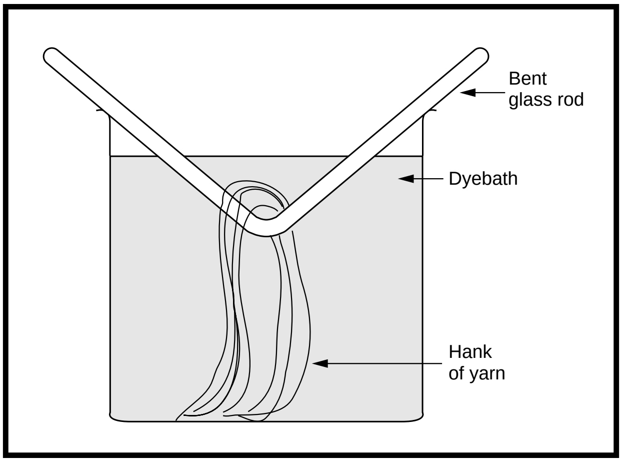

Figure 8.1 *Yarn dyeing on a small scale*

Liquor ratio

The intensity of the colour produced by a given mass of dye on a given mass of fabric is dependent upon the total volume of the dyebath used, that is, on the liquor ratio (see page 95). For the best reproducibility of the dyeing it is advisable to keep the volume of the dyebath constant, adding water occasionally to replace that lost through evaporation. The easiest way of keeping check on the volume is to put a mark on the side of the container with a water-resistant marker or wax pencil at the starting level of the liquid.

Depth of shade and dyebath composition

The depth of colour applied is expressed as a percentage on the dry weight of the fibre (o.w.f.) to be dyed. Care must be taken to avoid confusion between the percentage depth of shade and the percentage composition of the solution. The latter refers specifically to the concentration of the stock solution and not to the composition of the dyebath.

A recipe may indicate that a 1% shade is required and that 10% Glauber's salt should be added to the dyebath to promote exhaustion. These details mean that for every 100 g of fibre 1 g of dye and 10 g of Glauber's salt must be present in the dyebath, irrespective of the total volume of the dyebath. It does *not* mean that the fibres are to be dyed in a 1% solution of dye containing 10% of Glauber's salt.

The required total volume of the dyebath is calculated from the intended liquor ratio, which for craft purposes is likely to fall within the range of 30:1 to 100:1.

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It is possible of course to weigh out the requisite amount of dye and dissolve it before starting the dyeing. For small-scale operations, however, the amounts required may be too small to weigh out accurately, making it difficult to repeat the procedure with any degree of precision. For example, a 0.5% shade for 5.0 g of fibre requires 0.025 g of dye.

In such cases stock solutions of dyes and other ingredients are prepared as described above and the required volumes measured out accurately into the dyebath. For example, 1 g of dye dissolved in 200 cm^3 of water gives a 0.5% stock solution. For each 1 g of fibre, 0.01 g of dye is required to provide a 1% shade (o.w.f.); 0.01 g of dye is contained in 2 cm^3 of stock solution. Therefore for every 1 g of fibre, 2 cm^3 of stock solution will be required to produce a 1% shade. The same reasoning applies to other additives; for example, the composition of 10% Glauber's salt, based on the mass of fibre, is calculated in the same way as a 10% shade of dye.

The general formula shown in Equation 8.1 may be used for representing the amount of stock dye solution required:

$$V = \frac{D \times W}{C} \tag{8.1}$$

where V is the volume of stock solution required (in cm^3), D is the percentage applied depth of dye or additive, W is the mass of fibre (in g) and C is the percentage composition of stock solution. Thus to produce a 3% shade of dye, on 4 g of yarn, the volume of a 0.5% stock solution of dye required is $(3 \times 4)/0.5 = 24$ cm^3.

In this way the required volumes of dye solution and other additives may be calculated, added together and subtracted from the total volume of dyebath to obtain the amount of water required.

Preparing stock solutions

The first step in the preparation of stock solutions is to dissolve the dye in the appropriate amount of water. With water-soluble dyes it is sensible to use warm water and sprinkle the dye powder slowly from a spatula or from the centre of a small piece of folded paper into the water, stirring meanwhile. This avoids the formation of sticky clumps of dye particles that are difficult to dissolve. All the water-soluble dyes, except reactive dyes, can be readily dissolved by bringing the dyebath to the boil for a few seconds and then allowing to cool. With reactive dyes such treatment may cause some

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premature hydrolysis, but in any case these dyes are generally quite soluble in water and boiling is unnecessary.

As we have seen, dyes form colloidal solutions. On standing for long periods these may become unstable and some dye may settle out at the bottom of the container. It is always advisable therefore to invert the bottle of dye solution several times or stir the solutions before taking a sample. With some dyes, including milling acid dyes and direct dyes, it may be necessary to heat up the solution again.

The situation with disperse and vat dyes is different. Dispersions of these dyes are best prepared by adding a little warm water to the powder and mixing thoroughly into a paste using a glass rod, before adding the rest of the water with constant stirring.

Labelling the samples

It is always advisable to label the goods to be dyed before starting a range of dyeing experiments. For yarn samples this is best done by threading a piece of string through the hank, tying a knot to form an open loop and then numbering the yarn sample by tying simple knots in the loose ends of the string according to the number of the hank. Counting the number of knots will then serve to identify the sample after it has been removed from the dyebath and washed.

Samples of fabric may be labelled by making a small fold at one end, folding again in the opposite direction and cutting the corner. This produces a small hole. The sample may therefore be labelled according to the number of holes cut in this way. Alternatively the fabric can be marked with an indelible marker. Such markers are often used in industrial laboratories [1].

Coloration experiments

Selectivity of dye adsorption

It is relatively easy to demonstrate the selective nature of the adsorption of dyes by specific fibres. If sets of fibres, including cotton, nylon, polyester and acetate, are carefully labelled and dyed together in each of three separate dyebaths containing a levelling acid dye, a direct and a disperse dye respectively, effects resulting from the different substantivity of each dye–fibre combination will become apparent. The results will indicate how special effects can be obtained when fibre blends are dyed, particularly if the different dye classes chosen are applied from the same bath.

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Shirlastains

Shirlastains are used in the identification of unknown fibres [2], and as such they provide a good example of a practical application of the selective substantivity of dyes for fibres. The stains, which are used for undyed fibres only, contain appropriately selected dyes that will impart a characteristic colour to each different fibre type. There are four different Shirlastains, labelled A, C, D and E. As well as differentiating between different chemical types of fibre, some of the four stains are formulated to differentiate between fibres of the same chemical type but of different origins.

Shirlastain A serves to identify non-thermoplastic fibres – in practice, natural fibres and regenerated cellulosic fibres: for example, cotton gives a pale purple colour, viscose rayon (regenerated cellulose) pink and silk a dark brown. Shirlastain C provides a clearer distinction between the different types of cellulosic fibre. Shirlastain D is more specific, and distinguishes between cotton and spun viscoses. Shirlastain E provides distinctive colours for the various thermoplastic fibres.

Multifibre strip

The preparation of known fibres stained with the appropriate colorants is recommended to confirm the colours obtained with Shirlastains using the unknown sample. For this purpose a multifibre fabric strip is available [3], into which bands of all the common fibres have been woven in a defined sequence. It is therefore possible to produce the appropriate colours by dyeing a fresh sample of the strip in each of the stains. The multifibre strip is also a convenient and useful substrate for illustrating the differing substantivities of the different dye classes for different fibre types. Its incorporation into wet fastness tests as an 'adjacent fabric' will also indicate the likely level of staining of other fabrics. The strip contains secondary cellulose acetate (Dicel), bleached unmercerised cotton, nylon 6.6, polyester, acrylic (Courtelle) and wool worsted.

There is no difficulty in finding books dealing with the practical aspects of coloration on the craft scale. Theoretical concepts together with dyeing and related experiments are to be found elsewhere [4]. A further good example, intended specifically to meet the small-scale experimental needs of the DIY enthusiast, also deals clearly with the different application classes of dye used in industrial coloration [5]. This text indicates how to set about shade formulation and the production of specific effects. Since the same dyes and ingredients available to the coloration industry are used in the

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experiments described therein, the publication is particularly relevant to the commercial application methods described in Chapter 6. It also embodies detailed precautions for safe working when carrying out coloration on a small scale.

All the chemicals and dyes required may be obtained in suitable quantities for the small-scale worker from specialist suppliers, who package and supply commercial dyes, appropriate chemicals and technical information [6].

Colour physics systems

One development that stems from the application of colour physics to modern colour specification (Chapter 7) has appeared in a form useful to small-scale printing operations, such as the printing of designs for tee-shirts and sweatshirts. It is called the Pantone Colour Matching System. In essence nine basic colour standards have been chosen from a range of colorants, together with a suitable white and black. They are presented alongside a colour reference system that consists of coloured chips and formulations for almost 750 colours, which can be increased to 1000 by the use of additional pigments, thus saving the printer considerable time and effort in shade formulation.

In effect, the system is based on a colour space and is widely used for the selection, presentation, communication and matching control of colour. It is serviced by an international network of companies registered with the producers of the system.

Readily available condensed ranges of colorants capable of producing a broad colour gamut have also been devised for use by the small-scale worker. Whilst the representation of the possible colours are not specified using colour coordinates, there is a back-up colour-matching service for the user [7].

Examination of fabrics

It is not always easy to obtain fabric of known finishing history on which to carry out straightforward examinations into the quality of colour, but various textiles, and other goods incorporating textiles in their construction, can usually be tracked down for use in demonstrations. Various published articles, for example, on the use of textiles in footwear [8], furnishing fabrics [9–12] and motor car upholstery [13,14] provide background information concerning the consumer expectations from the appropriate materials.

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Thus materials obtained from old seat covers, canvas shoes and discarded clothing can provide a useful indication of how well the colour and the fibres from various parts of the goods have stood up to wear and tear. Opening the seams of an old jacket or removing the lining will enable the unexposed side of the fabric to be compared with the outside, thus showing the extent to which the colours have faded.

Washing tests (see below) may also be carried out on the best preserved areas of the fabric, according to the recommendations given elsewhere [15], to provide an assessment of the different levels of fastness inherent in the coloured goods. Such experiments also enable the effects of aftercare conditions to be established, covering tests of varying severity that do and do not match those suggested by the aftercare labels on the goods.

Fastness to washing

The conditions of standard tests for the fastness of dyes to washing, and the procedures for assessing and presenting the results are published in the relevant standards [15] and briefly outlined in Chapter 1 (page 11).

Further information about the effects of fastness tests on other fabric properties may be readily obtained using separate pieces of fabric. For example, the effects of wet treatments on length and area shrinkage may be investigated by indelibly marking pieces of fabric [16].

Other wet fastness tests

A wide variety of other wet fastness tests can be carried out using simple equipment, such as water spotting, fastness to salt water, effect of acids (such as vinegar and battery acid), alkalis and so on. Relevant details are to be found elsewhere [15].

Fastness to light

Reliable testing of light fastness is a complex subject but the relative effects of the various regions of daylight spectrum that cause fading may be obtained by exposing samples of the same fabrics, side by side under identical conditions, at 45° to north daylight, behind appropriate filters. Filters are available from several suppliers [17], and relevant background information can be found in the *Journal of the Society of Dyers and Colourists* [18]. The experiments are usually carried out under

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conditions of known humidity, which for small samples can be controlled by including a saturated solution of the appropriate salt in the enclosed container alongside the pattern [19]. This will not of course control the temperature of the pattern, which will vary according to the intensity of the illumination, but it will show the effects of gross differences by exposure in a desiccated atmosphere and in one of high humidity.

Construction of textiles

Those with an interest in the construction of textile articles will also find assistance in the British Standards for stitch types [20] and seam construction [21]. Similar experiments may be extended to samples of carpet, for example, by studying the effects of water and shampoo used to remove stains such as coffee, tea, wine, etc.

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