Teri Dyes

DYEING WOOL

And other related fibres

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HOT DYEING

How often have you heard wool dyes referred to by the terms, acid or reactive and wondered what they meant? Have you then been faced with the option of using cold or hot dyeing methods and been even more confused? Which method should you use and what type of dye is best for each method of dyeing? In this and a later article I will give you some background information which I hope will assist you in making your choices.

This article explains the differences between acid and reactive dyes, particularly in relation to the hot dyeing of wool and other animal fibres. A following article will give some insight into cold dyeing techniques and which are the best dyes to use for this.

Acid Dyes

Acid Dyes are so named because they have acid groups in the dye molecule, and also because the dyeing takes place in an acid solution. An important characteristic of *Acid Dyes* is that during the dyeing process the dye can **migrate.** This takes places through three activities. The dyes are absorbed onto the fibre, can diffuse through the dye bath and also be desorbed from the fibre back into the bath. These activities are all occurring at the same time. This means that during the dyeing process the dyes have a chance to become evenly distributed throughout the fibre before being fixed.

Fixation to the fibre becomes more pronounced as the temperature is raised. This is why dyeing processes with *Acid Dyes* commence with warm water (about 50^{o}C), and then the temperature is slowly raised to boiling. If the dye bath is too hot to start with, or is heated too quickly, the dyes would fix rapidly and the resultant dyeing would be uneven. In other words they would not have the chance to go through the absorption, diffusion, desorption process to become evenly distributed through the fibre.

This ability of the *Acid Dyes* to dye very evenly is enhanced further by the use of two chemicals – Glaubers Salt and a levelling agent (a chemical which promotes even dyeing of fabric or fibre).

Glaubers Salt helps the migration of the dyes and is particularly useful if even pastel colours are required. It is generally not needed for dark colours.

Levelling agents – most dye manufactures develop specific levelling agents for use with their own ranges of acid dyes. An example of this is Lyogen MF developed for use with the Acid dyes. These chemicals promote the penetration of the dye into the fibre and are also particularly good at reducing the variation in colour between the root and the tip of the wool fibre.

Fleece wool is frequently dyed using only acetic acid (or white vinegar, which is essentially a 5% solution of acetic acid). There is always some variation in the colour obtained when dyeing a fleece due to the differences in dyeing characteristics of the fibres from different parts of the fleece. This variation can then be used as a feature in the further processing of the wool; or it can be blended in during carding. I recommend using a small amount of levelling agent in fleece dyeing, because as well as helping promote the dyeing of any damaged fibre, particularly weathered tips, it also helps the penetration of the dye into the fibre.

Fibre Reactive Dyes

These dyes are so named because they react directly with the fibre in a different manner to the *Acid Dyes*, and form much stronger bonds with the fibre. Once they react they stay put and are not able to migrate. Thus a different dyeing technique from the *Acid Dyes* is required if even dyeing is to be obtained in a hot dyeing process. As with the *Acid Dyes*, acetic acid is used as the fixing chemical, and Glaubers Salt and a levelling agent can be used to promote even dyeing.

Glaubers Salt exerts a powerful restraining effect on the reactive dyes so that it reduces the rate at which the dyes fix to the fibre, thus improving the ability to obtain even dyeing. Use of too much Glaubers Salt prevents complete exhaustion of the dye, particularly in dark colours.

Levelling agents – as with the *Acid Dyes*, dye manufactures develop specific levelling agents for use with their own ranges of reactive dyes. As an example, Lyogen FN has been developed especially for use with our *Fibre Reactive* dyes. It also retards the dyeing rate, and enhances even distribution of the dye prior to fixation.

When hot dyeing with reactive dyes it is usual to start with luke warm water (40^{o}C). This prevents the binding of the dye to the wool fibre from taking place too quickly at the beginning of the process. The dye bath is then heated slowly to about 65^{o}C, held at this intermediate temperature for about 20 minutes, and then raised slowly to the boil. This whole process is designed to ensure that the dye is evenly distributed through the dye bath and fibre, before any significant fixation to the fibre takes place.

Which Dye Should You Use For Hot Dyeing

Both the acid and *Fibre Reactive* dyes are suitable for dyeing fleece wool and are commonly used for this without using Glaubers Salt or a levelling agent.

For any project where even dyeing is important, the *Acid Dyes* are the simplest to use because of the migration properties described previously. Glaubers Salt and the appropriate levelling agent should be used in quantities recommended by your dye supplier.

Wash fastness of the dyes is another factor you may need to consider in making your choice.

Acid Dyes are suitable for hand washing but not for machine washing. Because of the ability of the dye to migrate, the vigorous nature of machine washing together with the use of harsher detergents can cause some loss of colour.

On the other hand, fibre dyed with the reactive dyes is machine washable, as the very strong bonds these dyes make with the fibre resist the vigorous nature of machine washing.

COLD DYEING

Theory of Cold Dyeing

In hot dyeing of wool and we saw how we used particular chemicals to help achieve even dyeing and to slow down the rate of fixation as the dye was heated. In cold dyeing of wool and other animal fibres we still use acetic acid to fix the dye but do not have heat available as the other fixing agent.

For cold dyeing a special mixture of chemicals is used to assist the dyeing process. The mixture promoted by Teri Dyes (which we call Base Solution – also known as chemical water) contains the following

UREA - One of the effects of heat in hot dyeing is that it swells the wool fibre so that the dye molecules can enter into the fibre more quickly. Since we do not have heat available in cold dyeing we must look for another method of swelling the fibre to speed up the penetration of the dye. UREA is used in the base solution to achieve this.

LEONIL K – this chemical has been developed especially for cold dyeing. It assists in wetting of the fibre, helps penetration of the dye liquor into the fibre, and improves the evenness of the dyed wool. It is not essential to use this. (*Prior to 2008, a chemical known as Irgapadol P was used instead of Leonil)*

ACETIC ACID – as in hot dyeing acetic acid is used to promote the fixing of the dye

A small amount of the levelling agent used for hot dyeing (see previous article) can also be added to the mixture to assist in achieving even dyeing. This solution can be made up and will keep for many months.

Which Dyes Should You Use For Cold Dyeing?

A basic fundamental of chemical reactions (in this case the fixation of dye to wool) is that the reaction rate doubles for every 10^{o}C rise in temperature. This means that at boiling point the reaction is many times faster than at 20^{o}C. At the lower temperature fixation will take days, rather than an hour.

The preferred dyes for cold dyeing are the *Fibre Reactive* dyes, because they will fix more rapidly to the wool fibre under cold dyeing conditions than the *Acid Dyes*. The *Fibre Reactive* dyes will take 24-48 hours to fix at room temperature, although dark colours will take longer. *Acid Dyes* generally take an extra 24-48 hours to fix. Some care must be taken in choosing which dyes are used in combinations for cold dyeing. For example Turquoise, Greens, and Violets are generally slower to fix than the other colours, and it may be difficult to get really dark shades with some of these. Your dye supplier will be able to give you more specific information about this.

Cold Dyeing Techniques

Some of the uses of cold dyeing include dyeing fleece, for painting warps, for skeined wool, for woollen garments, and for tops. Advantages of cold dyeing over hot dyeing are as follows

Felting is minimised – especially useful for dyeing merino wool

Multi coloured effects can be achieved – useful for rainbow dyeing of fleece wool, painting of warps and producing multi coloured skeins

Shrinkage is minimised – garments can be dyed with minimal shrinkage and no felting.

There are two main methods of carrying out cold dyeing.

The first is to soak the wool in the base solution until it is wet through. The excess solution is then gently squeezed out (and can be retained for reuse) until the wool is just damp. The dye solution can then be applied by a variety of techniques. Brushing, pouring and spraying are some of these. This method is particularly useful when multi coloured effects are required.

The second is to add the dye to the base solution and apply directly to the wool. This is used particularly when a single colour is required or when really dark colours are required. The dye can be applied by any of the above methods or by soaking the wool in the solution. As a rule of thumb one should use about 3.5 to 4 times as much solution as wool, ie 3.5 to 4 litres of solution for 1 kg of wool. The wool retains this amount of solution without the liquid running out of it. Once the dye is added to the base solution it must be used the same day. It does not keep for as long as the individual dye and base solutions do.

Fixation Methods

Once the dye has been applied the wool is wrapped in plastic and can then be fixed using any of the techniques described below.

The normal fixation method for cold dyeing is to leave the dyed wool at normal temperatures for sufficient time until the dye is fixed. It is recommended that black plastic be used as it absorbs more heat from the sun. Care must be taken as on hot days in direct sunlight temperatures of over 50^{o}C can be achieved inside the package, particularly on the top surface.

This can lead to uneven fixation as the bottom of the package does not get nearly as hot as the top and fixes less quickly. The package should be turned at intervals as the dye liquid will slowly concentrate on the bottom leading to dark and light patches of colour.

Other methods include microwave fixation and steaming. In these methods extra heat is supplied by the microwave or the steam, to speed the fixation process to a matter of minutes in the case of microwaving or an hour or so in the case of steaming. Actual times depend on the depth of colour required and the amount of fibre being used.

More detailed descriptions of the application and fixing methods can be obtained from your dye supplier.

HOT DYEING (Exhaust Dyeing)

ACID DYES FOR WOOL or *FIBRE REACTIVE* DYES FOR WOOL

NB. This method is ideal for dyeing animal fleece and fibres, or silk fabric when an even colour is not required.
See note in step one for additional chemicals required to achieve an even colour.
Pre-scour the fibre with Imerol XND, or suitable detergent in warm water. Clean fibre or fabric is important.

For 100 gm of fibre or fabric (Adjust measures to suit for different quantities)

1) To **2 litres** of warm water ADD **10 mls of Acetic Acid 30%** (or 50 ml white vinegar) and well dissolved **dyestuff**

NB – if an even colour is required for skeined wool add 1 ml of Lyogen MF when using *Acid Dyes* **and 1 ml Lyogen FN when using *Fibre Reactive* dyes for wools. For very pale to pastel colours it can also help to add 5-10 grams of sodium sulphate (Glaubers Salts) powder**

2) ADD **wet clean fibre or fabric** and heat slowly to just below the boil, stirring regularly (the more stirring, the more even the dyeing will be, but also the fibre will be more prone to felting)

Hold just below the boil for; **20 minutes for pale**, or **45 minutes for deep** shades or until water is clear.

4) Cool down for 30 minutes, or until cold.

5) 1st Rinse – **Warm** using a little detergent or Imerol XND to remove any unfixed Dye. For silk, use Imerol or detergents designed for fine fabrics.

6) 2nd Rinse – **Cold** to remove the detergent.

7) Dry gently.

Silk Dyeing this requires greater care due to the delicate nature of the fibre.
Proceed as above with these changes;
a) start cooler $35^{o}C$ - $40^{o}C$
b) maximum dyeing temperature $80^{o}C$ - $90^{o}C$
c) extend dyeing time - 40 minutes pale to 60 minutes deep shades

Amount of dye to use – see page 12

Every care has been taken with the above recommendations, however they must be tested and adapted to suit your own requirements and dyeing conditions.

COLD DYEING PROCESS

USING CONCENTRATED BASE SOLUTION FOR WOOL/SILK

Suitable for *Fibre Reactive*, Drimarene Reactive & *Acid Dyes* on wool/silk and other animal fibres

METHOD 1

1) Scour or wash fibre thoroughly. Pad dry.

2) Dissolve 1 teaspoon dye powder in 500 mls of hot water to make a dye solution. This will store for several months.

3) Dilute the Base Solution concentrate with an **equal** quantity of water, sufficient to cover the fibre to be dyed.

4) Prepare a work area by laying out a sheet of plastic large enough to hold the fibre being dyed, and still give room to turn the edges over later. Lay old absorbent material on the plastic to take up surplus dye.

5) Soak the fibre in the Base Solution, and when thoroughly wet gently squeeze out the excess solution until the fibre is damp. You can re-use the excess base solution.

6) Set out the fibre on the plastic and then apply the dye solution - either paint, pour on, brush etc. Dry dye could also be added for extra random effect, or you can merge the dyes and obtain a multi-colour effect. This is where your creativity can take over.

7) Remove absorbent material, fold edges of plastic over fibre to prevent the colours running. Roll plastic end over end and secure the outer end to prevent the fibre drying out.

METHOD 2

1) Carry out steps 1, 2, and 3 above.

2) Add some dye solution (1 - 2 dessertspoons) to the diluted base solution (a thickener can also be added if required - use Selleys wall paper paste or Alginate type). This mix must be used within a few hours.

3) Set out the fibre as in 6 above, and apply the base solution/dye mix.

4) Carry out step 7 above.

FIXATION OF THE DYE

Cold Batch - Leave the roll for 24-96 hours at room temperature, give a 1/4 turn every few hours. Dark shades and/or cold temperatures will require the longer batch time.

Microwave - Excellent for small articles or sample colour development. Cover with microwave plastic to prevent drying

NB place a small container of water in the microwave. Microwave on mediumhigh for 2 minutes and allow to stand. Repeat this process until the dye is fixed

Steam - 10 - 20 minutes for *Fibre Reactive* and Drimarene dyes
- 30 - 60 minutes for Acid MF dyes

Rinse cold, then warm with 1 ml of Imerol XND per 5 litres of water to remove any unfixed dye. Give a final cold wash to remove the detergent.

Every care has been taken with the above recommendations, however they must be tested and adapted to suit your own requirements and dyeing conditions.

DISSOLVING DYES

Powders

Paste the required amount of powder with a little cold water to form a smooth slurry. Add hot water to make up the required amount of dye solution

Granules

Add a quantity of cold water (about ¼ of the total quantity of water required) to the granules with stirring. Make up to the required volume with hot water. Note that many granular dyes can be dissolved readily by just pouring hot water over them with vigorous stirring.

Stock Solutions

Stock solutions can be made up containing one level teaspoon of dye powder or granules per 500 mls of water. This is equivalent to about 10 grams of dye per litre of solution. These solutions should be kept in a cool cupboard. Under these conditions they will keep for up to six months for most dyes and for longer periods for some.
Some Acid Dyes tend to separate out at this concentration and are best made up at 1 level teaspoon per 1 litre of water. Yellow R, Red G, Red B, dark red R, Violet R and Turquoise G should be made up at this strength.

MICROWAVE DYEING

Using a microwave for dyeing is a convenient way of speeding up the dyeing process for relatively small amounts of fibre. It is primarily a rapid source of heat, which cuts down dyeing time considerably. It can be used for most methods of dyeing, provided certain precautions are taken.

Dyeing Equipment

The vessels used for microwave dyeing must be glass, plastic, or ceramic. On no account should metal containers of any other piece of metal equipment be placed in the microwave.

Safety Precautions

Apart from the use of the correct type of containers there are some other safety precautions which must be followed. Containers with absolutely smooth inner surfaces can lead to superheating of the dyeing solution with the possibility of violent explosions occurring. To overcome this boiling chips (small broken pieces of plastic, ceramic or glass) can be placed in the container. These provide a rough surface for air bubbles to form on and then escape safely to the surface.

If you are covering your dye vessel with plastic or any other type of cover, remember to leave some holes for the steam to escape otherwise very high steam pressures can build up. This can result in nasty steam burns if the lid is lifted while the vessel is still hot. Also beware of acid fumes if removing the cover from hot dye vessels. These can be quite strong when carried in the steam.

The wool must be thoroughly scoured before dyeing as any residual grease can form hot spots.

Always place a separate container of water in the microwave to ensure that the atmosphere does not dry out. Microwaves work by interacting with the water molecules to produce heat. If your wool dries out the microwaves will work directly on the wool and char it.

You will need to discover the best settings for your own microwave. The power ratings and available heat settings of microwaves vary so much that it is impossible to give more than general guidelines for times and settings.

Exhaust Dyeing

This can be carried out as for normal exhaust dyeing (see page 7), using fleece or spun wool, and using the same amounts of chemicals and dyes. Ensure that the wool is covered with water and ‘cook’ in intervals of about 3-5 minutes – probably 2-3 times until the dye is exhausted or almost exhausted.

If you want an even colour turn the wool two or three times during dyeing, otherwise leave it untouched. Remember also that the dyeing process will continue

while the dye container is cooling down.

The same principles of starting at a low temperature and heating slowly apply as described in Hot Dyeing article on page 2. Because of the rapid heating and short dyeing times microwave dyeing is not prone to felting to the same degree as with conventional heating methods.

Random Dyeing

Random dyeing can be carried out very successfully in the microwave. Once again you can transfer the same methods you normally use to the microwave. To achieve the best fixation it is recommended that the wool be soaked first in acetic acid (or vinegar) using the same amounts as for standard dyeing processes. Squeeze out excess liquid before transferring to your dyeing vessel. This ensures that the fixing agent is well distributed through the wool before dyeing.

Place a rack in the bottom of your dyeing vessel to keep the wool out of the water in the bottom. Two options are to use a glass container placed upside down in the bottom of your vessel, or perhaps a plastic lid with holes punched in it to allow the steam to rise through the fibre.

The random effect can be obtained by sprinkling dye powder on the wool or by pouring/dropping dye solution onto it. If using powder keep the spots small. If they are too large they will create small explosions as they heat up. The dye container needs to be covered with gladwrap or other suitable plastic to retain the steam. However do not forget to leave a hole in one corner or make a few small holes in the cover to avoid build up of steam pressure.

You may wish to turn the wool gently to help the dye penetrate through the skein rather than staying in one place. This is particularly so if you have added dye powder.

Cold Dyeing

For cold dyeing you can fix the dye with the microwave instead of standing the fibre in a warm place or steaming. Preparation is exactly the same, with the dyed wool being wrapped in plastic in the conventional manner. Place the prepared bundle in the microwave on the turntable, or in a plastic container and heat in short bursts.

Be very careful not to over heat as the wool can dry out and char, or the plastic in which the wool is wrapped can swell up and burst with the steam which is generated.

Don't forget to put a container of water in the oven before heating.

Enjoy your microwave dyeing. It can add a new dimension to your armoury of dyeing techniques.

WOOL AND SILK BASE SOLUTION

For cold dyeing wool/silk and other animal fibres

Preparation of 1 litre of base solution (This solution is ready to use and will keep for some months)

100 grams Urea
8 mls Leonil KS-C (replacement for Irgapadol P)
10 mls Acetic Acid 30% (or 50 mls of white vinegar)

Mix urea with sufficient hot water to dissolve.
Then ADD the Leonil KS-C**
ADD Acetic Acid
Make up to 1 litre with cold water

** See the article on cold dyeing for the function of Leonil. When preparing for silk dyeing the Leonil can be omitted.

DYE USAGE CHART

DEPTH OF COLOUR	Grams dye for 100 grams fibre	Teaspoons dye for 100 grams fibre	Mls of 10 gm/Litre dye solution for 100 grams fibre
PALE	0.1 – 0.5	1/10 teaspoon	10 to 50
LIGHT	0.5 – 1.5	1/8 to 1/4 teaspoon	50 to 150
MEDIUM	1.5 – 4.0	1/3 to 3/4 teaspoon	150 to 400
DARK	4.0 – 6.0	1 teaspoon	400 to 600