Procion MX Dye

advanced “Percentage Dyeing” technique

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Background

If you want to achieve reliable, reproducible dyeing results with Procion MX dyes, are interested in dyeing to match or achieve exact results, or wish to produce a carefully regulated series of colors, you will have to use dyes with great accuracy. This requires precise and consistent methods of weighing and measuring. The most accurate way to do this is with calibrated metric equipment--gram scales, graduated cylinders and liter containers, and syringes. This equipment is available from most dye companies, chemical supply houses, pharmacies, and cooking supply stores. While this is the most accurate and universally understood method of controlled dyeing, feel free to develop your own methods. All that is really necessary is that you use the same equipment and procedures each time.

If this is your first time dyeing fabric or using Procion MX dyes, I recommend you read through my information booklet on easy dyeing with Procion dyes and try out that method first. This will give you an idea of the general process before jumping into this much more specific method.

Supplies and Equipment

Dye Supplies

- 2 oz. containers of Procion MX Dye
- 1 lb Soda Ash
- 2 lbs Salt
- 1 lb Water Softener (if you have hard water)
- 1 bottle of Blue Dawn
- Cotton fabric

Equipment

- Digital gram scale that measures to .001 grams
- Plastic bottles with lids for stock solution storage
- Dust mask (for particulates, available at hardware stores)
- Rubber gloves (regular kitchen dish washing gloves are perfect)
- Plastic spoons
- Graduated Cylinders or liquid measuring equipment with ml markings
- Small plastic syringes that meausre 1cc, 3cc, 10cc, and 60cc (availalbe on amazon and at some pharmacies(
- Small plastic cups (disposable plastic cups or yogurt cups for dissolving dye)
- Larger plastic buckets (such as quart, gallon, 3 gallon, 5 gallon)
- Long handled plastic spoons
- Clear Plastic box with lid for measuring dye powder and storage
- Newspaper
- Spray bottle filled with water
- Old towels for clean up

Key Concepts

I recommend always using the metric system when dyeing. Using grams rather than ounces is a much easier method because it allows you to work with very small amounts of dye and fiber using numbers that are easier to calculate. It is also easy to convert grams to liters or milliliters. In addition, there are two concepts that will help you in understanding controlled use of dyes.

1. Depth of Shade (also called Depth of Dye)

This refers to a ratio of a certain weight of dye to a given weight of fiber. Depth of shade is usually expressed as a percentage. For example: 3% depth of shade (dos) = .03 grams of dye per 1 gram of fiber.

To calculate the amount of dye for a given depth of shade on any weight of fiber, multiply the depth of shade by the weight of the fiber. For example, to find out how much dye to use for 5 grams of fiber at a 3% depth of shade, multiply .03 x 5 grams = .15 grams of dye. This tells us that .15g of dye powder will give us a 3% depth of shade on 5g of fiber/fabric.

2. Stock solution

A stock solution is simply powdered dye dissolved in concentrated form in water. It is one way of measuring and adding powdered dye to a dye-bath. One of the best reasons for making stock solutions is that dyes are safer to use once they are in solution. The largest health risk in using these dyes occurs through breathing in the powder. Also, when the dye is in solution it mixes more quickly and readily with the larger volume of water in the dyebath, it is more convenient, and it is easier to measure very small amounts of dyes when you are trying to get very light colors or to dye very small quantities of fiber or fabric. Once the powder is mixed into solution, you can convert the measuring system from weight to volume (from grams to liters). Stock solutions also eliminate measuring or weighing and pasting dye for each dye-bath.

The strength of the stock solution is a ratio of the weight of the dye to the volume of the water. It is expressed either as a percentage or as a decimal equivalent. For example, 50 grams of dye in 1 liter of water (1000ml) would be expressed as either a 5% solution or a .05 solution.
50 grams of dye ÷ 1000ml water = .05 or 5% stock solution

The strength of the stock solution can be adjusted to facilitate measuring but should not exceed 10% because most dye powders will not dissolve into solution at greater concentrations than this. A 4% stock solution is a useful and workable percentage for most jobs. For very light depths of shade, it is helpful to make a weaker stock solution, such as 1% or 2%.

Making a Stock Solution

1. Decide on the strength of stock solution you want to make. For a wide range of values, 4% is a good strength. If you are only planning to dye very pale colors, make a 1% or 2% stock solution. Likewise, if you are only going to dye very dark colors, make an 8% or 10% solution.

2. Decide how much stock solution you are going to make. Stock solutions of Procion MX dyes will last about 2 weeks in the refrigerator. After that amount of time they are still usable but will begin to lose their strength and accuracy. Don't make more stock solution than you think you can use in that time period. I normally make only 200 - 500ml at a time.

3. Measure the volume of water needed for your stock solution into a clean container. Using distilled water alleviates the problem of impurities and lengthens the shelf life of the solution.

4. Weigh the amount of dye powder. needed for your specific stock solution needs. Wear your dust mask when working with powdered dye and try to minimize spilling and contamination. Never place dye or chemicals directly on the pan of the weighing scale. When weighing the dye powder, place an empty container on the scale. Press the "tare" or "zero" button on the scale to zero it out. Then measure your dry dye powder into the container. To find the correct amount of dye powder, multiply the amount of water times the desired percentage of stock solution.

Example: to make one cup (240ml) of 5% stock solution, multiply:
240ml x .05 = 12 grams of dry dye powder

5. Paste the dye. Add a small amount of warm water, from your total water needed, to the dye and stir into a smooth paste.

6. Add the rest of your pre-measured water and stir well.

7. Label the stock solution with the type of dye, the color name or code, the strength of the solution (expressed as a decimal or a percentage), and the date the solution was mixed.

8. Store the solution in an air-tight plastic container or squeeze bottle out of direct sunlight. The shelf-life of a stock solution varies with the type of dye and the storage conditions. Storing the stock solution in the refrigerator will extend the shelf life. Be sure to stir or shake the solution carefully and thoroughly before each use. Over time, all stock solutions will hydrolyze and lose their strength and permanence.

Dyebath Calculations

Stock Solution

To calculate how much stock solution to use in your dyebath, first you have to decide how dark you want your color to be. The chart below provides guidelines to use as a starting point. Some colors are stronger than others, so adjust your depth of shade according to the needs of the color.

Value/Shade	Depth of Shade as a Percentage
Pastel	0.125% - 0.5%
Pale	1% - 3%
Medium	3% - 5%
Dark	5% - 8%
Black	8% - 12%

Once you have decided on the depth of shade (dos) needed, there is an easy formula for calculating the correct volume of stock solution to use in your dyebath:
(depth of shade x weight of fiber) ÷ strength of stock solutions = volume of stock solution to use in the dyebath
For Example: You have made a 4% stock solution and you want to produce a 1% depth of shade on 20 grams of fiber. You would multiply:
(.01 depth of shade x 20 grams of fiber) ÷ .04= 5 ml. stock solution

Water

You need enough water for the fabric to be submerged and move freely in the dyebath. Not enough water will make the dyebath hard to stir and will result in splotchy color. Too much water can dilute the color a bit. A good starting amount is 20 x WOF. For example: if you have 50g of fabric you would calculate 50g x 20 = 1000ml water. If your fabric is very lightweight, you may need to increase your calculation to 30 x WOF or more. Use your best judgement. As long as you are consistent with your water equation you will ge consistent dye results.

Salt

Salt helps the fabric open up to accept the dye. It also allows the dye to distribute more evenly throughout the dye-bath. This allows for very even dye results.
Use 0.5 grams of salt per gram of fabric (i.e. 50g fabric x 0.5 = 25g salt)

Soda ash

Soda ash activates the dye. Without soda ash, Procion mx dyes are not wash or light fast and the color will not turn out as desired.
Use 0.09 grams of soda ash per gram of fabric (i.e. 50g fabric x 0.09 = 4.5g soda ash)

Dye Process

Always pre-wash any fabric (even if it is labeled PFD) in hot water with laundry detergent or ½ tsp synthrapol and 1 tsp soda ash.

1. Soak fiber in warm water. When you are ready to dye, gently squeeze out excess water before adding the fiber to the dye-bath.

2. Make dye-bath. Combine required amounts of water (20 x WOF) and salt (0.5 x WOF) in a container. Stir well to dissolve salt.

3. Add required amount of stock solution to the dye bath. Use a syringe for small amounts. Stir well to distribute dye evenly through the dye bath.

4. Add damp fiber to dye bath. Stir well and often for 15 minutes.

5. Dissolve required amount of soda ash in a small amount of water (0.09 x WOF). Move the fabric to one side of the dye bath and add the soda ash to the other side. Stir well and often for 30 - 60 minutes. The more you stir, the more evenly dyed your fabric will be.

6. Wash fabric. First rinse fabric in cold water until the water runs clear. Then increase water temperature to warm and add a few drops of blue dawn. Continue rinsing with warm to hot water and blue dawn until the water runs clear. This may take several changes of water. Gently squeeze out excess water and hang to dry or iron on a towel to speed up drying process.

Useful conversions

1 liter = 1000 milliliters
1% = .01
.1% = .001
.01 % = .0001
1/8 tsp = .625 ml
1/4 tsp = 1.25 ml
1/2 tsp = 2.5 ml
1 tsp = 5 ml
1 T = 15 ml
1 cup = 240 ml
1 pint = 480 ml
1 quart = 960 ml
3 tsp. = 1 Tbsp.
16 Tbsp. = 1 cup
2 cups = 1 pint
2 pints = 1 quart

Gradations - Principles

Gradations are gradual changes of color, usually from one piece of fabric to the next, in a sequence of dye baths. The steps of change from one to the next are usually orderly and measured. They may vary in speed - the number of steps required to move from one color to another. Rapid change may provide visual jerks or be difficult to read as a sequence. Slow change can yield a smooth evolution or fluid transition in which the stepped colors seem to melt into each other. Color gradations can be of several varieties:

Analogous – movement from hue to hue in order around the color wheel, but concentrating on groups of color that are close to each other (for example: yellows and oranges or blues and purples).

Complementary – movement between one hue and its complement across the color wheel (red to green, yellow to purple, blue to orange). These sequences create a range of neutral hues.

Shade – additions of increasing amounts of black to a hue (for instance: adding black to red).

Value/ Monochromatic – increasing/decreasing depth of dye (for example: adding increasing amounts of blue to successive dye-baths).

Tonal – additions of increasing/decreasing amount of a toner to a hue. A toner usually contains a pair of complementary colors and sometimes black and is added to a hue to affect intensity and value. (For example: you can mix a toner containing black, green and red in whatever ratios you like, then add increasing amounts of it to yellow in successive dye baths.) These make brownish grayish colors, or earth tones.

All gradational series rely on keeping certain things constant while varying others. A constant is a given color (which may be a mixture of several hues) at a given depth of shade or strength that remains a consistent ingredient throughout a progression. Therefore, the constant can be mixed up ahead of time and added in the same amount to each dye bath. A variable is a given color, or a consistent mix of colors, which changes or moves along a specified depth of dye range, throughout the progression of dye baths. The movement of the variable can be from a smaller depth of dye to a larger one or vice versa. A gradational progression can be composed of any number of variables and constants working together.

If you like setting up systems, you can have a lot of fun playing with this kind of control of color. Mixing and experimenting with gradations is one way to locate unusual colors in combination. It can expand your color vocabulary dramatically. In addition, gradations of colors, because they usually contain some kind of constant, usually work well together in a composition because they have a common ground that connects visually.

Gradations - Monochromatic Procedure

Increase the depth of shade of a hue (could be one hue, or a couple mixed together). The general procedure here involves adding increasing amounts of this color or composite color to successive dye baths.

1. Choose the number of steps and a depth of shade sequence, for instance a six step gradation that increases smoothly: 0.25%, 0.5%, 1%, 2%, 4%, and 8% (doubling the depth of shade with each step).
2. Calculate the amount of stock solution you will need for ***each individual*** dye bath using this formula:

weight of fabric x depth of shade ÷ strength of stock solution= ml. of stock solution

3. Add up the amounts of stock solution for each dyebath to get the total amount needed for the entire sequence. I will usually round this number up to a larger, round number to make measuring easier and to allow some buffer in case I mess up. For example, if my total amount of stock solution needed is 257ml, I might round up to 300ml just to be safe.
4. If you are mixing colors and you want to find out how much of each color stock solution you need for each color, multiply the percentage of each color in the mix times the total ml. of stock solution needed (or the rounded up amount). For example, if I want to mix 80% of my red stock solution and 20% of my yellow stock solution, I would do the following:

0.8 x 300ml (total ml. of stock solution needed) = 240 ml. of red stock
0.2 x 300ml (total ml. of stock solution needed) = 60 ml. of yellow stock

This will give you enough stock solution of your special color mixture to do the entire sequence of dye baths. These two colors can then be mixed together and you can then draw your individual dye bath needs from this master stock solution.
5. Add the specific amount of dye needed to each dyebath and proceed with the usual dyeing process.

Example

1. I am doing a 5 step gradation where each piece of fabric weighs 15 grams and my sequence goes 0.5%, 1%, 2%, 4%, 6%. My color is 30% blue and 70% yellow and I have a 4% stock solution of each color.
2. calculate dye for each bath:

15 x 0.005 ÷ 0.04 = 1.875ml
15 x 0.01 ÷ 0.04 = 3.75ml
15 x 0.02 ÷ 0.04 = 7.5ml
15 x 0.04 ÷ 0.04 = 15ml
15 x 0.06 ÷ 0.04 = 22.5ml

3. So, I need 50.625 ml of stock solution total (1.875 + 3.75 + 7.5 + 15 + 22.5 = 50.625).
4. I will round that up to 60ml and can figure out that I need:

60 x 0.3 = 18 ml blue stock solution
60 x 0.7 = 42 ml yellow stock solution

5. I will measure those out, mix them together, and then use the amounts I figured out in step 2 to add the right amount of mixed stock solution to each dye bath in my sequence.

Gradations - Two Color Procedure

This sequence gradates *from* one color *to* another color. The overall depth of shade will remain consistent in each dye bath, but the percentage of color will vary. Rather than use percentages for this sequence, I like to think of the dyebaths as containing *parts* of color.
For example, a sequence of 7 steps might be set up like this:

	Dyebath 1	Dyebath 2	Dyebath 3	Dyebath 4	Dyebath 5	Dyebath 6	Dyebath 7
Color 1	0 parts	1 part	2 parts	3 parts	4 parts	5 parts	6 parts
Color 2	6 parts	5 parts	4 parts	3 parts	2 parts	1 parts	0 parts

So, there are a total of 6 parts in each dye bath. In this case, one part = 1/6 of the total amount of stock solution. You will add the 2 colors to the dye baths in the appropriate relationships. With this scenario, an odd number of dye baths is usually the easiest to figure out mathematically, and also provides a nice half and half mixture of the colors in the middle dye bath.

1. Decide how many steps you want in the sequence (odd numbers work best).
2. Select a depth of shade as a constant. Then select two hues or composite hues to vary throughout the sequence.
3. Calculate the number of ml of stock solution of each hue that constitutes one part, using the standard formula. Example: if you have a 4% stock solution, your DOS is 8% and your weight of fabric is 20g for each dye bath, total stock solution for each dye bath is: 0.08 x 20g ÷ 0.04 = 40 ml. We also need to know the volume of one part: 40ml ÷ 6 = 6.667ml per part.
4. We can also make a master stock solution for each color for this gradation sequence. If we add up all the parts (1 + 2 + 3 + 4 + 5 + 6) x 6.667ml/part, we get 140ml of each color total. We can then figure out how much solution to mix together if we have compound colors. See the example on the next page for more details.
5. Line up your dye baths and place the appropriate number of parts of each color in each dye bath.
6. Complete the dye process as usual.

Example

1. I am doing a 7 step sequence that goes from Red to Green. My weight of fabric for each dye bath is 30g. My stock solution is 4%.

2. My DOS is 5%. My Red mixture is 90% red dye + 10% yellow dye. My green is 70% golden yellow dye + 30% cerulean blue dye.

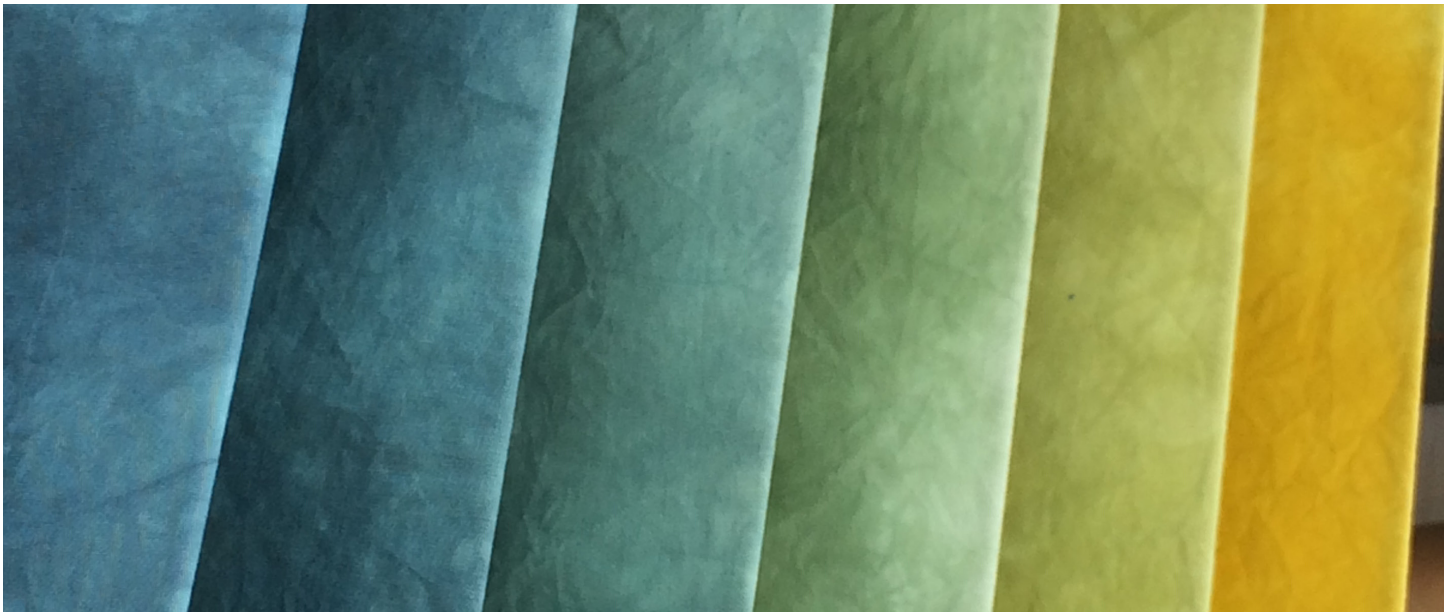
3. I need to calculate how much dye goes in each dye bath.
DOS x WOF ÷ SS = 0.05 x 30g ÷ 0.04 = 37.5ml SS per dye bath.
Now, I can calculate the volume of 1 part. 37.5 ÷ 6 = 6.25g per part. And now I can fill out my chart with the actual volume of stock solution needed for each dye bath.

	Dyebath 1	Dyebath 2	Dyebath 3	Dyebath 4	Dyebath 5	Dyebath 6	Dyebath 7
Red	0 ml	6.25ml	12.5ml	18.75ml	25ml	31.25ml	37.5ml
Green	37.5ml	31.25ml	25ml	18.75ml	12.5ml	6.25ml	0ml

4. I also want to know how much of each color I need total so I can make my master batch of stock solution. First, I will add up the total amount of stock solution for each color
6.25 + 12.5 + 18.75 + 25 + 31.25 + 37.5 = 131.25. I'll round up to 150 to make it easier to measure.

Red Mixture	Green
Red dye = 150 x 0.9 = 135 ml red dye	Golden yellow dye = 150 x 0.7 = 105 ml g.y. dye
yellow dye = 150 x 0.1 = 15 ml yellow dye	Cerulean blue dye = 150 x 0.3 = 230 ml c.b. dye

5. I can now create my two mixtures and I will draw from those master batches according to the dyebath chart above.



Resources

Supplies

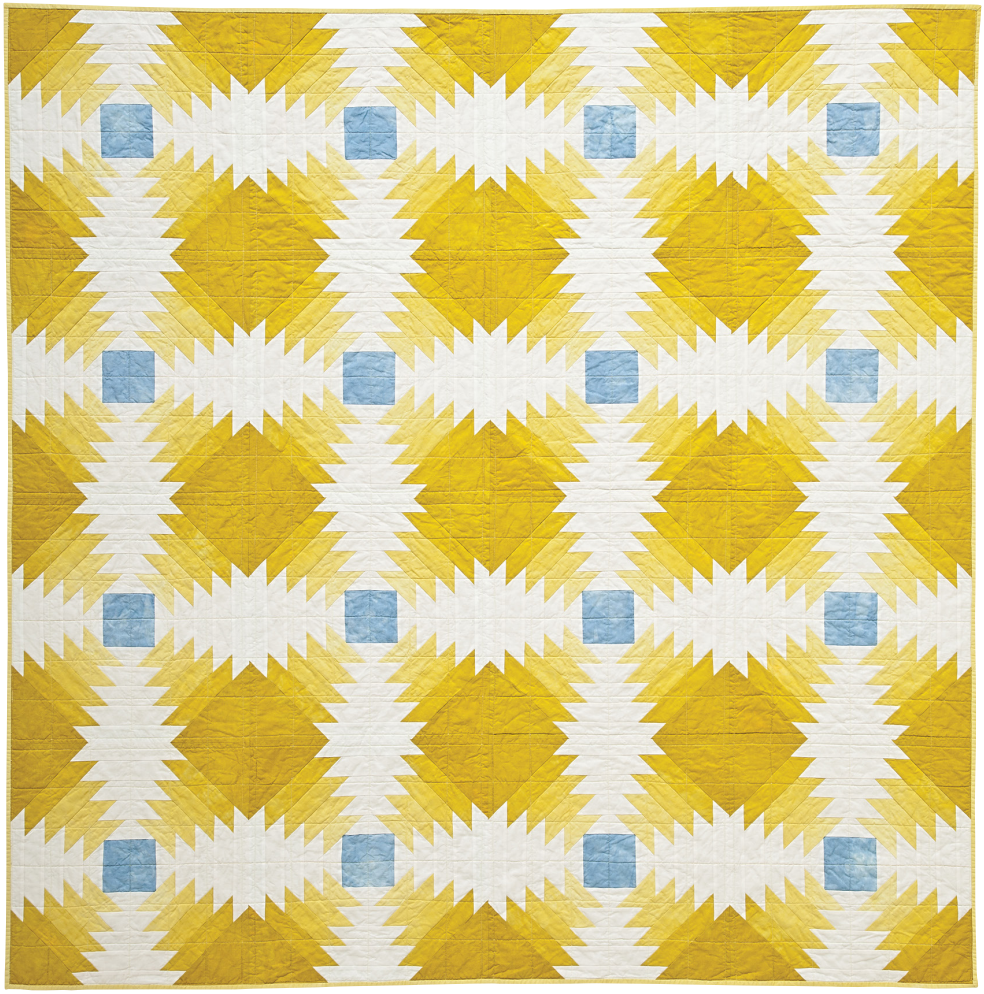
Dharma Trading Company
Fabric, dyes, auxilliaries, information
www.dharmatrading.com

Pro Chemical and Dye
Dyes, auxilliaries, information
www.prochemicalanddye.com

Colorado Wholesale Dye Corp.
Dyes, auxilliaries
www.grateful-dyes.com/

Dick Blick
Jacquard Procion dyes
www.dickblick.com

Amazon for syringes



Feel free to get in touch!
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Please tag me if you post your fabric dyeing adventures on instagram. I would love to see what you make!