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Technical Report on

Dyeing Eqwools™ blended fibre, yarn, and fabric

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Dyeing of the Cotton-Wool (Eqwools™) blended materials

The dyes and chemicals used in this report were sourced from CHT Australia. Thiotan R Pa was sourced from Archroma, Vietnam.

Where g/l is used, this is the mass of chemicals in grams for every litre of treatment solution within the dyeing machine. i.e. for 3,000 ml of solution, 1.0 g/l would be 3.0 g of treatment chemical.

Where % is used in a recipe, then this is the mass of the chemical as a percentage of the mass of fibre/fabric. i.e., for 300 g sample, 1.0% would be 3.0 g of treatment chemical.

Details of the sample Pretreatment (Scouring & Bleaching) Process:

The liquor ratio for the fabric pretreatment process was 1:10, which means for 1 kg of fibre/fabric, there were 10 litres of liquor. Therefore, if treating 300 g samples, the liquor volume will be 3,000 ml of pretreatment liquor solution, including water.

Pretreatment before dyeing is important to remove impurities and waxes on the cotton fibre. If these impurities are not removed, they will further inhibit dye uptake on the cotton fibre. Bleaching can be used to improve the base colour before dyeing. Where possible, pretreat with scouring only in preference to bleaching, as it will improve light fastness of the wool.

Pretreatment Recipe (Scouring only):

Chemicals	g/l or %
Kollasol CDS (Anti-foaming agent)	0.5 g/l
Felosan Fox (Detergent)	2.0 g/l
Heptol ESW (Sequestering agent)	1.0 g/l
Biavin BPA (Gliding/Levelling agent)	3.0 %

Procedure:

1. Determine the sample size and liquor ratio for the pretreatment process.
2. Considering the recipe, calculate the required portion of water needed.
3. Add the required cotton-eqwools blended materials (fibres/yarns/fabrics).
4. Place all the chemicals and water into the pretreatment bath/chamber.
5. Run the machine at room temperature for 10 minutes.
6. Raise the temperature from room temperature to 50˚C at 1˚C/min.
7. Run the machine at 50˚C for 60 minutes.
8. Drain and rinse the sample for 10 minutes.
9. Block wash at 40˚C for 10 minutes and drain. Repeat this step 2 times.

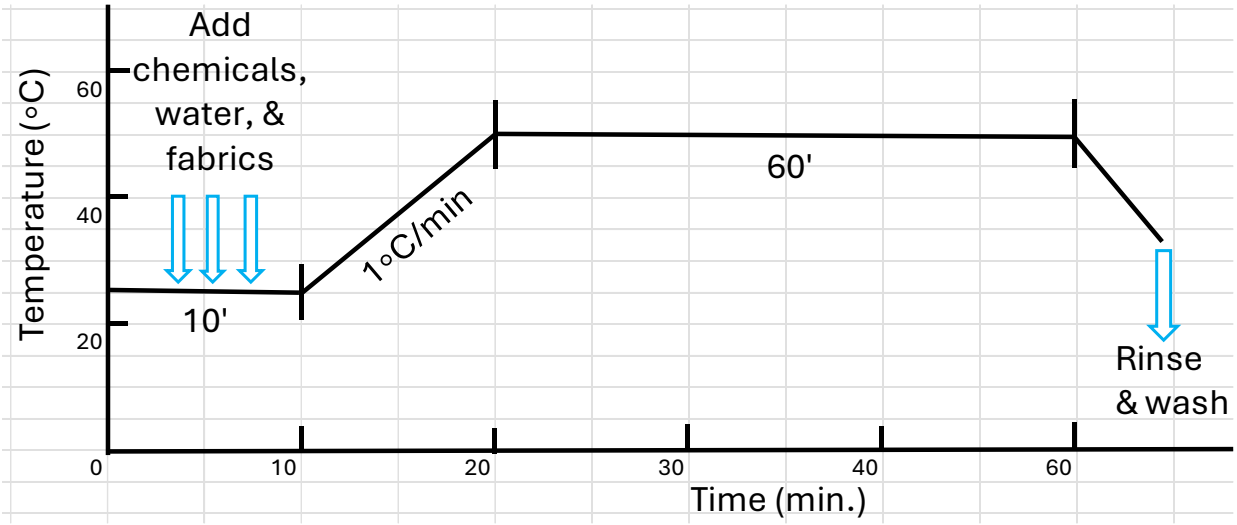

Figure 1. Scouring process curve.

Pretreatment recipe (single bath scouring and bleaching):

Chemicals	g/l or %
Kollasol CDS (Anti-foaming agent)	0.5 g/l
Felosan Fox (Detergent)	2.0 g/l
Tubotex OW (activator & stabilisator for H_2O_2)	5.0 g/l
Heptol ESW (Sequestering agent)	1.0 g/l
Biavin BPA (Gliding/Levelling agent)	3.0 %
H_2O_2 50% solution (Oxidizing agent for the bleaching)	20.0 g/l

Procedure:

1. Determine the sample size and liquor ratio for the pretreatment process.
2. Considering the recipe, calculate the required portion of water needed.
3. Add the required cotton-eqwools blended materials (fibres/yarns/fabrics).
4. Take all the chemicals and water into the pretreatment bath/chamber and check the pH of the solution. It needs to be around 12.
5. Run the machine at room temperature for 10 minutes.
6. Raise the temperature from room temperature to 50˚C at 1˚C/min.
7. Run the machine at 50˚C for 60 minutes.
8. Drain and rinse the sample for 10 minutes.
9. Block wash at 40˚C for 10 minutes and drain. Repeat this step 2 times.

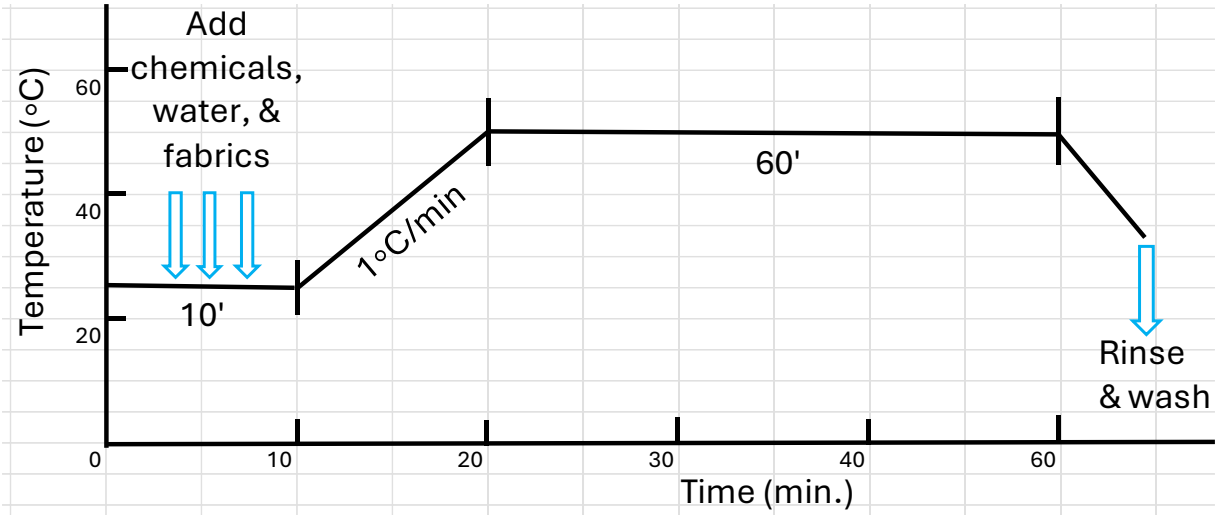

Figure 2. Scouring and bleaching process curve.

Pretreatment with Thiotan R Before Dyeing:

Wool has a higher uptake of dye than cotton due to the high number of dye sites present in the fibre. When wool and cotton are dyed together the wool will scavenge more dye than the cotton which can lead to unlevel and uneven dyeing and Barre. Thiotan R treatment can be utilized to enable a more even uptake of dye between wool and cotton. Thiotan R works by inhibiting the dye uptake onto the wool fibre to enable a closer dye pickup for the two fibres. A side effect of Thiotan R treatment is that the total shade will be slightly lighter in depth as some of the dye is stopped from exhausting onto the fibre.

For deeper shades Thiotan R treatment can be omitted from the dyeing recipe. The increased depth of dye is often enough to cover the Barre effect of the wool/cotton dye uptake difference. Avoiding Thiotan R pretreatment also saves time and chemicals in the dyeing process. Each colour should be assessed for its suitability for dyeing without Thiotan R as some colours may be more prone to Barre than others.

The temperature of the treatment will influence the difference between the two fibres. A higher treatment temperature will provide a closer shade between the wool and cotton. A lower treatment temperature will be quicker to undertake and require less energy however will not provide as great of an effect. For difficult to achieve shades 85°C is recommended. For easier to achieve shades 65°C has been found to provide the best results.

- The liquor ratio for the pretreatment process will be 1:10.
- In this process, a pretreatment of the fibre/yarn/fabric with Thiotan R is required for better dye uptake by the cotton.
- The use of 6% Thiotan R is recommended for the dye concentration up to 2%.
- For shades above 2% dye, Thiotan R pretreatment is not required.

❖ For colours above 2% dye, it is recommended to check that the level of Barre is acceptable before going to bulk dyeing. If the Barre is too high, then Thiotan R pretreatment may be used to reduce it.

Thiotan R pretreatment process:

Chemicals	g/l or %
Thiotan R Pa (blocking agent)	6.0 %*
Cotoblanc Sel (Soaping agent)	1.0 g/l

(*) These chemicals will be variable and need to be adjusted according to the dye/shade concentration.

Procedure 1 – Higher temperature pretreatment:

This step is needed for achieving optimum shade levelness with lower dye concentration.

1. Add 6% Thiotan R Pa along with the required amount of water at a liquor ratio of 1:10 into the dyebath.
2. Add the necessary quantity of Acetic Acid to reach pH 4.
3. Add scoured or bleached cottonwool samples to the solution and run the machine for 20 minutes at 85°C. Temperature increment can be done at 1.5°C/min.
4. Lower the temperature from 85°C to 40°C at 1.5°C/min and rinse well for 10 mins.
5. Use a soaping agent and run the machine at 40°C for 10 minutes and drain.

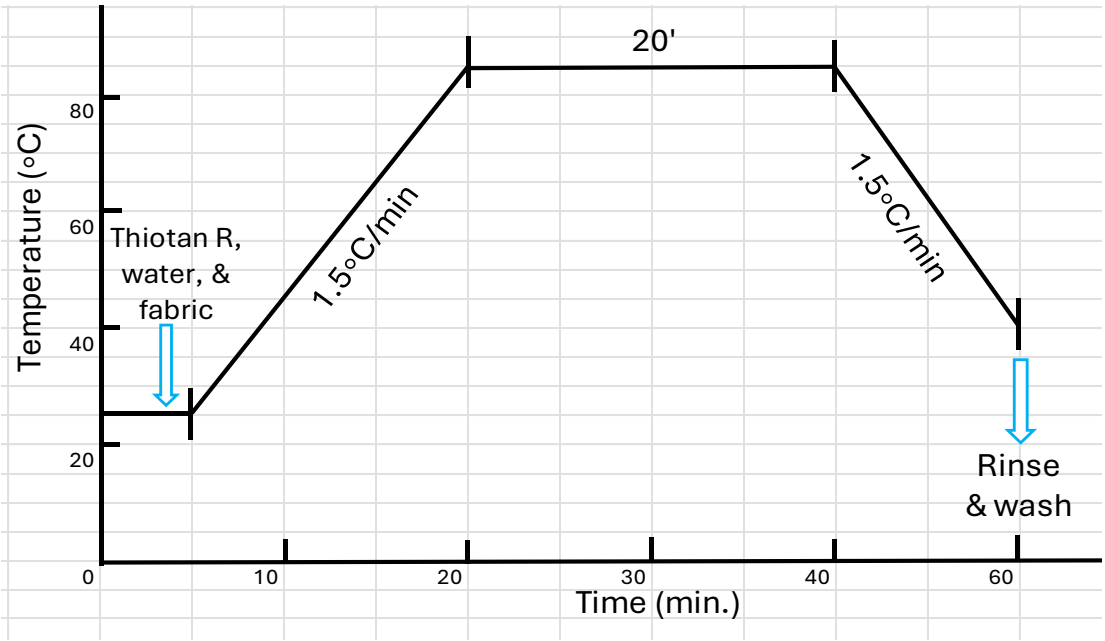

Figure 3. Pretreatment with the Thiotan R Pa at a higher temperature.

Procedure 2 – Lower temperature pretreatment:

This step can be followed if the customer accepts a slight mélange effect on the fabrics.

1. Add 6% Thiotan R Pa along with the required amount of water at a liquor ratio of 1:10 into the dyebath.
2. Add the necessary quantity of Acetic Acid to reach pH 4.
3. Add scoured or bleached cottonwool samples to the solution and run the machine for 20 minutes at 65°C. Temperature increment can be done at 1.5°C/min.
4. Lower the temperature from 65°C to 40°C at 1.5°C/min and rinse well for 10 mins.
5. Use a soaping agent and run the machine at 40°C for 10 minutes and drain.

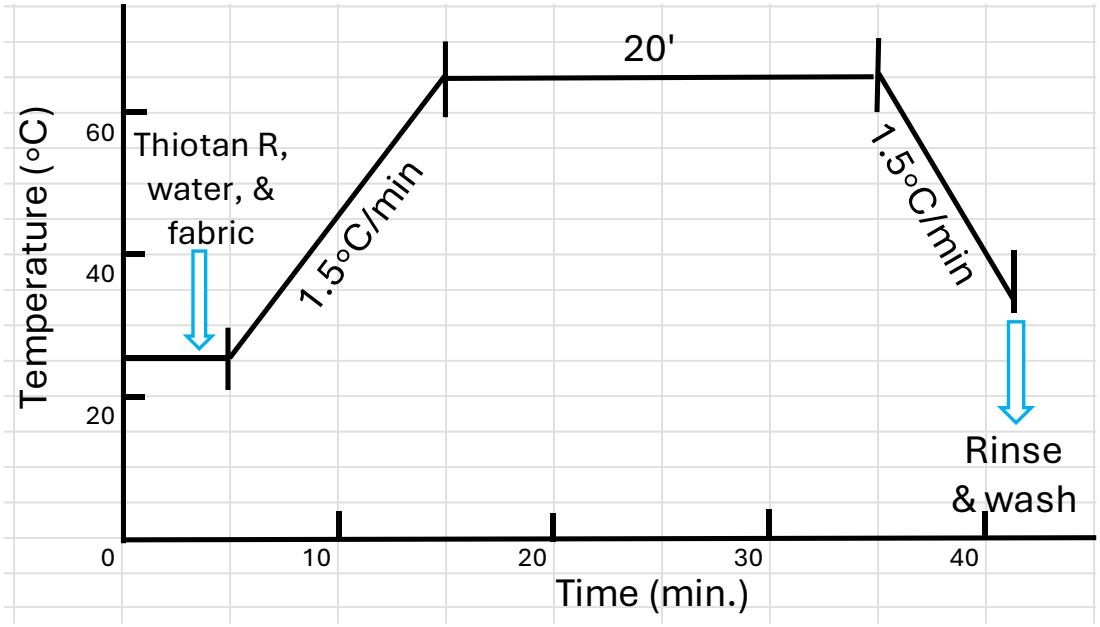

Figure 4. Pretreatment with the Thiotan R Pa at a lower temperature.

Details of the cottonwool blended samples Dyeing Process:

- ❖ The liquor ratio for the dyeing process will be 1:10.

Recipe for the dyeing process:

Dyes & Chemicals	g/l or %
Biavin BPA (Anti-creasing agent)	1.0 g/l
Sarabid LDR (Levelling agent)	2.0 g/l
Glauber salt	50.0 g/l*
Bezaktiv ONE Dyes (Cotton Reactive dyes)	1.0 %*
Soda Ash	16.0 g/l*
Acetic Acid	1.0 g/l
Heptol ESW (Sequestering agent) / Cotoblanc Sel (Soaping agent)	1.0 g/l

(*) These marked dyes and chemicals will be variable and need to be adjusted according to the dye/shade concentration. Here is the recommended table for salt & soda.

Dye concentration (%)	Glauber's salt (g/l)	Soda Ash (g/l)
<0.01	15	4
0.01-0.1	20	6.5
0.1-0.5	30	8
0.5-1.0	40	12
1.0-2.0	50	16
2.0-3.0	60	16
3.0 and above	80	18

Procedure:

1. Determine the sample size and liquor ratio required for the dyeing process.
2. Considering the recipe, calculate the required amount of water needed.
3. Add the required amount of chemicals, Glauber's salt, and water along with the fibres/yarns/fabrics and run the machine at room temperature for 10 minutes.
4. Raise the temperature from room temperature to 60°C at 1°C/min.
5. Run the machine at 60°C for 15 minutes.
6. Add the required amount of dyes (for industrial dyeing, dose the dye into the dyebath over 30 minutes).
7. Run the machine at 60°C for 30 minutes.
8. Add the required amount of Soda Ash (for industrial dyeing, add the Soda Ash in three lots, 10 minutes apart).
9. Run the machine at 60°C for 60 minutes.
10. Drain and rinse well for 10 minutes.

11. Block wash at 40°C for 10 minutes. Note that if the dye concentration is more than 2%, repeat this step two times.
12. Add Acetic acid at 1:10 and run the machine at 40°C for 10 minutes to neutralise.
13. Drain and rinse well.
14. Add the required amount of Heptol ESW and/or Cotoblanc Sel at 1:10 and run the machine at 40°C for 10 minutes to ensure the soaping process.
15. Raise the temperature from 40°C to 80°C at 2°C/min and run for 20 minutes.
16. Lower the temperature from 80°C to 40°C at 2°C/min and drain & wash properly.

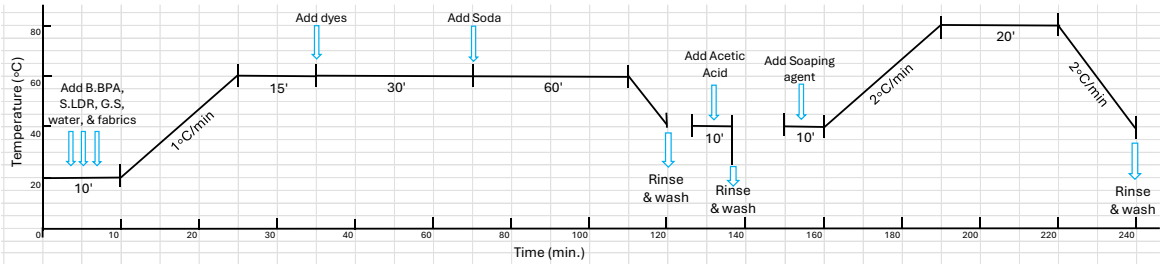

Figure 5. Dyeing process curve.

The image below shows the initial successful dyeing trial using Bezaktiv ONE reactive dyes (CHT Chemicals) and 6% Thiotan R Pa (Archroma) on the 70:30 cotton–superwash Eqwools™ fabrics. This dyeing trial followed the same procedures as mentioned above.

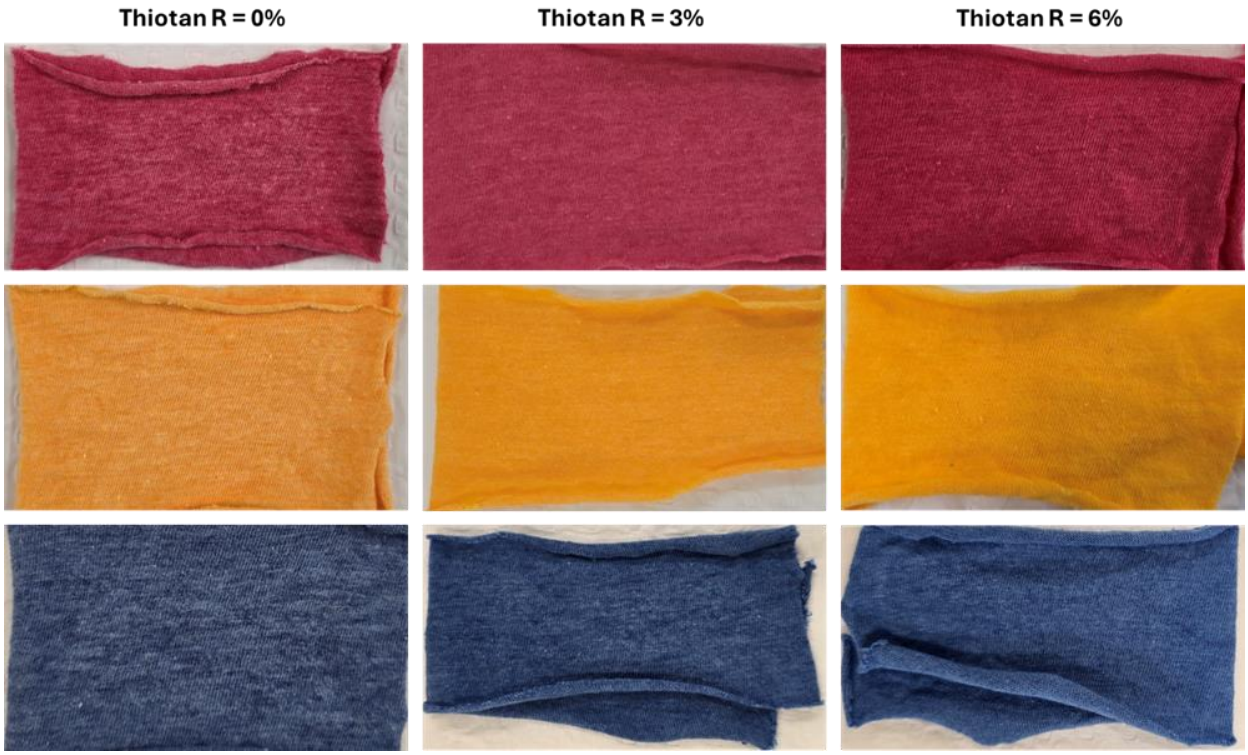

Figure 6. Visual effect of varying Thiotan R on wool to cotton dye evenness in a single jersey 70/30% cotton/eqwools blended fabric.

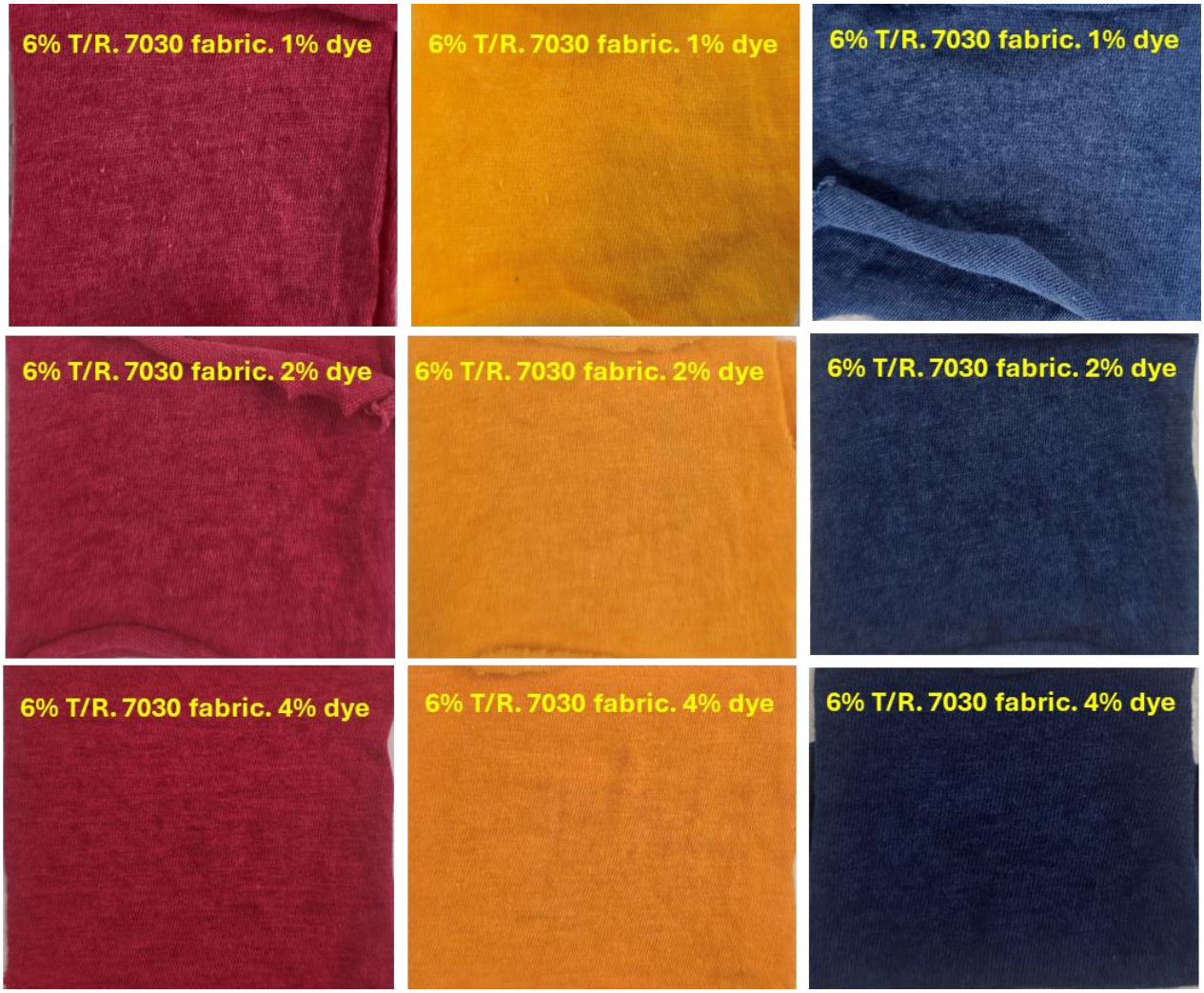

Figure 7. 6% Thiotan R on the 70/30 cotton-eqwools™ fabrics at 1%, 2%, and 4% dye.

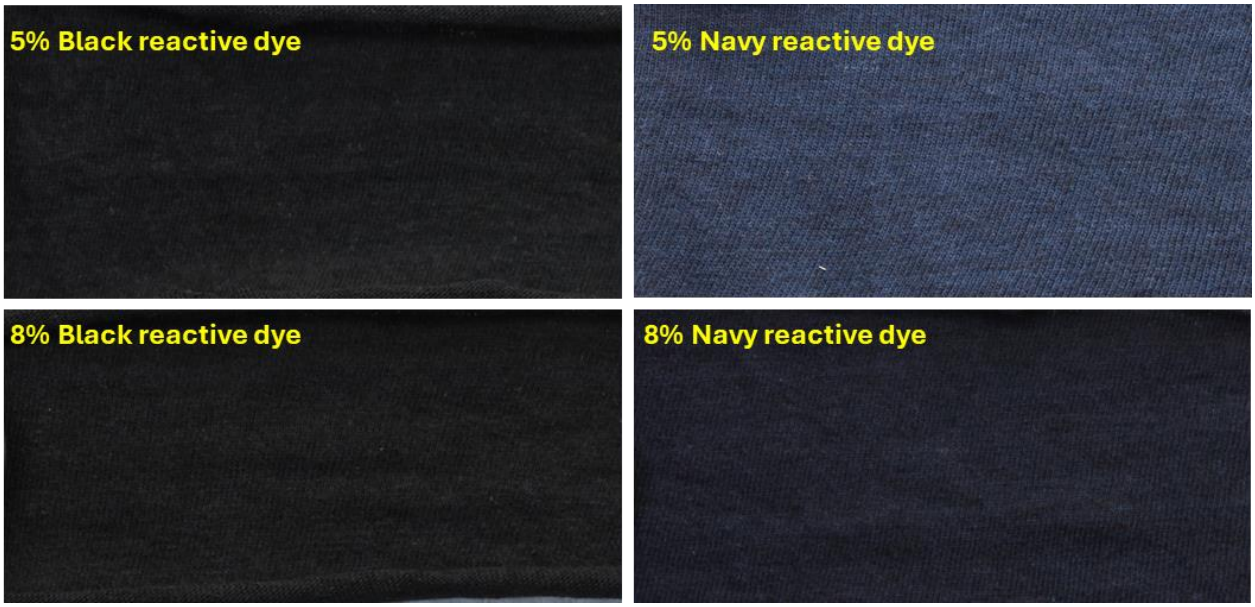

Figure 8. Black & Navy colours on the 70/30 cotton-eqwools™ superwash fabrics.

Figure 9. 6% Thiotan R on the 70/30 cotton-eqwools™ fabrics at 1% dye trichromat.

Colourfastness to Washing (Colour change & colour staining):

The colourfastness to Washing of all the 70/30 cotton-eqwools™ fabric samples produced with different dye percentages has been evaluated using the ISO 105-C06:2010 method, both at 40°C and 60°C. All the fabrics depicted acceptable colourfastness to washing (colour change & staining) rating between 4 & 5, while only showing staining to the cotton part of the adjacent multifibre fabric. Representative data is shown in the following table.

Table 1: Colourfastness to Washing

Colour & Dye%	Method & Temp.	Fastness rating to Colour change (Datacolor)	Fastness rating to Colour change (Gray scale)	Fastness rating to Colour staining (Gray scale)
Red – 1%	A1S - 40°C	4	4	5, 5, 5, 5, 5, 5
Yellow – 1%	A1S - 40°C	4/5	4/5	5, 5, 5, 5, 4/5, 5
Blue – 1%	A1S - 40°C	4/5	4/5	5, 5, 5, 5, 5, 5
Black – 5%	A1S - 40°C	5	5	5, 5, 5, 5, 5, 5
Navy – 5%	A1S - 40°C	5	5	5, 5, 5, 5, 5, 5
Red – 1%	C1S - 60°C	4	4	5, 5, 5, 5, 4/5, 5
Yellow – 1%	C1S - 60°C	4/5	4/5	5, 5, 5, 5, 4/5, 5
Blue – 1%	C1S - 60°C	4	4	5, 5, 5, 5, 4/5, 5
Black – 5%	C1S - 60°C	5	5	5, 5, 5, 5, 5, 5
Navy – 5%	C1S - 60°C	4	4/5	5, 5, 5, 5, 5, 5

Bleaching process for cotton/wool blends (White):

- ❖ The liquor ratio for the bleaching process will be 1:10.

Bleaching recipe for the bright white colour (2-step method):

STEP 1: Peroxide bleach

Chemicals	g/l or %
Kollasol CDS (Anti-foaming agent)	0.5 g/l
Felosan Fox (Detergent)	2.0 g/l
Tubotex OW (activator & stabilisator for H_2O_2)	5.0 g/l
H_2O_2 50% solution (Oxidizing agent for the bleaching)	20.0 g/l

Procedure:

1. Determine the sample size and liquor ratio for the peroxide bleaching process.
2. Considering the recipe, calculate the required amount of water needed.
3. Add the required amount of chemicals, water, and the fibres/yarns/fabrics and run the machine at room temperature for 10 minutes. pH needs to be 12.0 - 12.5
4. Raise the temperature from room temperature to 45°C at 1°C/min.
5. Run the machine at 45°C for 60 minutes.
6. Drain and rinse well and then Block wash at 40°C for 10 minutes.

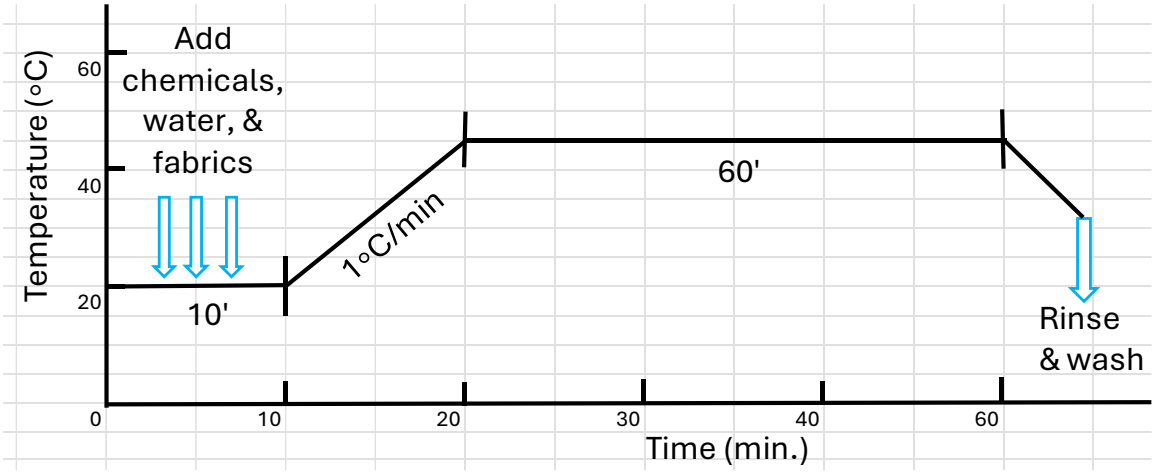

Figure 10. Peroxide bleaching process curves.

STEP 2: Reductive bleach with OBA

Chemicals	g/l or %
Sodium Hydrosulfite (Reducing and bleaching agent)	5.0 g/l
Felosan Fox (Detergent)	2.0 g/l
Tuboblanc COL (Optical Brightening Agent, OBA)	1.0 %

Procedure:

1. Determine the sample size and liquor ratio for the peroxide bleaching process.
2. Considering the recipe, calculate the required amount of water needed.
3. Add the required amount of chemicals, water, and the fibres/yarns/fabrics and run the machine at room temperature for 10 minutes. pH needs to be 6.5 - 7.0
4. Raise the temperature from room temperature to 60°C at 1°C/min.
5. Run the machine at 60°C for 60 minutes.
6. Drain and rinse well and then Block wash at 40°C for 10 minutes.
7. Finally, wash with 0.5 g/l H2O2 35% at 40°C for 10 minutes to eliminate residuals of the sodium hydrosulfite reducing agent, to avoid unpleasant odour and yellowing when drying.

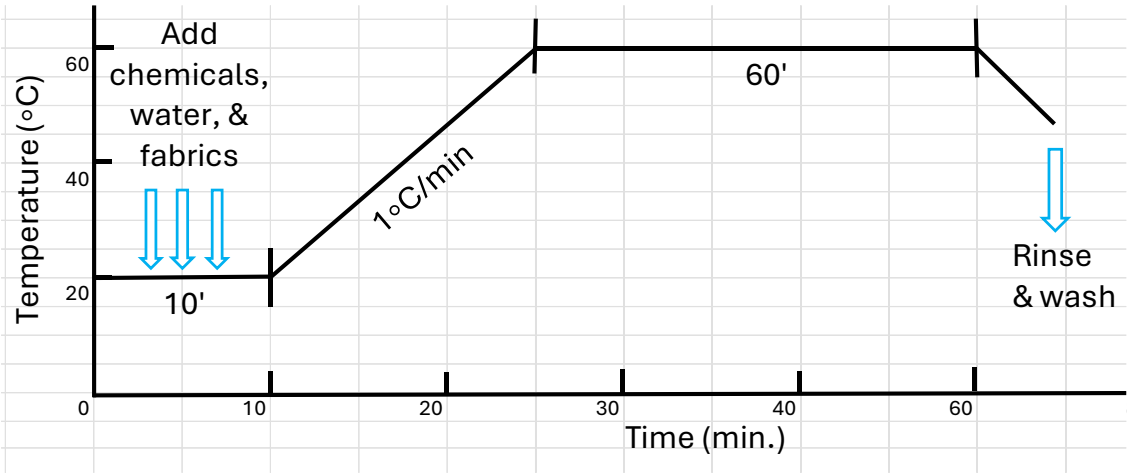

Figure 11. Reductive bleaching process curves with OBA.

Recipe for the bright white colour dyeing process (Single-step method):

- ❖ The liquor ratio for the dyeing process will be 1:10.

Chemicals	g/l or %
Kollasol CDS (Anti-foaming agent)	0.5 g/l
Felosan Fox (Detergent)	2.0 g/l
Tubotex OW (activator & stabilisator for H_2O_2)	5.0 g/l
H_2O_2 50% solution (Oxidizing agent for the bleaching)	20.0 g/l
Tuboblanc COL (Optical Brightening Agent, OBA)	1.0 %

Procedure:

1. Determine the sample size and liquor ratio for the bright white dyeing process.
2. Considering the recipe, calculate the required amount of water needed.
3. Add the required amount of chemicals, water, and the fibres/yarns/fabrics and run the machine at room temperature for 10 minutes. pH needs to be 12.0 – 12.5
4. Raise the temperature from room temperature to 60°C at 1°C/min.
5. Run the machine at 60°C for 60 minutes.
6. Drain and rinse well and then Block wash at 40°C for 10 minutes.

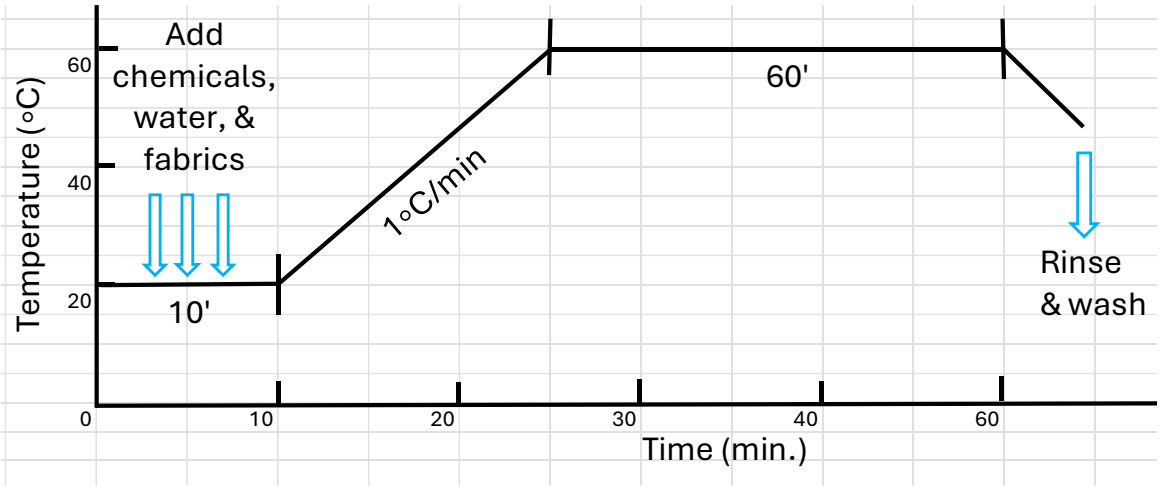

Figure 12. Single bath white dyeing process curves with OBA.