

Assessment of Dyeing Behavior of Thermocool and Polyester Yarns

Ms. Divyansha Sharma¹, Dr. Chanchal²

Guest Faculty, Dept. of Fabric and Apparel Science, Institute of Home Economics, University of Delhi, India¹

Associate Professor, Dept. of Fabric and Apparel Science, Institute of Home Economics, University of Delhi, India²

ABSTRACT: The great appeal of textile lies in their color and their comfort property which is used to create a fabric. Polyester has taken the foremost position in textile all over the world. This material that has many uses like strength, light weight, resistance to shrinking, stretching, mildew, creasing and ultraviolet radiations but comes few drawbacks also that are causes wearer to get overheated and sweaty, gives the wearer a rather cheap and scruffy look, does not feel very nice on the skin & hydrophobic in nature. These drawbacks have been overcome by a new fibre named Thermocool which has introduced three developments using its thermo regulating, moisture-wicking Thermo°Cool™ technology. Purpose of this study is to understand and compare the kinetics of dyeing of the thermocool and polyester fiber on the basis of the structure and the reactive groups present in it. For optimizing the dyeing parameters i.e. time, temperature and pH, dyeing behavior was observed by studying k/s values & dye exhaustion %. It was found that thermocool gave better results than polyester in all parameters and best optimized values observed were time-45minutes, temperature-130°C and pH-8. Samples were dyed with the standardized recipe and were examined for their color fastness properties. The wash fastness, light fastness and perspiration fastness was found to be good for both thermocool and polyester yarns.

KEYWORDS: Polyester, Thermocool, K/S Value, Dye Exhaustion %, Wash Fastness, Light Fastness and Perspiration Fastness.

I. INTRODUCTION

Textile material has its great appeal in comfort as well as color which is enhanced while creating fabric. Clothing for most part of the day remains in contact with human skin. Among synthetic fibers, polyester fiber has taken the foremost position in textile all over the world, while synthetic clothing in general is perceived by many as having a less natural feel compared to fabrics woven from natural fibers. Polyester is the material that has many uses, but it also comes with quite a few drawbacks. Polyester fibre has some advantages like strength, light weight, resistance to shrinking, stretching, mildew, creasing and ultraviolet radiations. As far as polyester clothing goes, it gives the wearer a rather cheap and scruffy look. Polyester also does not allow air to travel through it very well, and this causes wearer to get overheated and sweaty. It does not feel very nice on the skin. Since polyester is hydrophobic in nature, problems are encountered in dyeing. The orientation of polyester fiber shows higher percentage of crystallinity which requires higher temperature for dyeing. But higher temperature leads to fabric degradation most of the times. So it is important to improve the structure of polyester by some surface modification which can have an improved effect on hand, thermal properties, permeability and hydrophilicity.

Therefore, to overcome all the drawbacks of polyester fiber a modification has been done by Netherlands based polyester manufacturing company "Advansa" which has introduced three developments using its thermo regulating, moisture-wicking Thermo°Cool™ technology [Textile news 2010]. Thermo°Cool fibre have following benefits are evaporative cooling, knows when to keeps things cool and comfortable, thermo buffering, protects the user from temperature changes, comfortable, fabrics are fast-drying, breathable, and moisture wicking, renewable and biodegradable - Eco-friendly options are fabricated from corn, a renewable resource that is 100% biodegradable, plus all Thermo°Cool fibers are made from recycled polymers.

Differences in polyester and thermocool fibers have been studied in terms of their structural and physical properties

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•Both polyester and thermocool are man-made synthetic fibers. These materials are polymerized into long, linear chemical chains that bond two adjacent carbon atoms but they differ in chemical compounds which are used to produce different types of fibers.

•The difference between these fibers can easily be studied under microscopic view in which cross-sectional view shows that the polyester has a solid structure which takes it more into the crystallinity where as in thermocool, hollow structure has been seen which magnifies amorphous region [Rajeev 2013].

Cross sectional view of polyester Cross sectional view of thermocool As the polyester is a hydrophobic in nature, problems are encountered in dyeing which is the main consideration. The history of research and development on synthetic dyes stretches back to about 150 years. Major contributions to dyeing practices have been the provision of dye ranges for both natural and synthetic fibers of a sufficiently wide color gamut to obtain a multitude of colors. Dye standardization, with the associated analytical, testing and evaluation methods, has ensured that products are fit for purpose. Purpose of the study is to understand and compare the kinetics of dyeing of the thermocool and polyester fiber.

II. EXPERIMENTAL

1. **Materials and Dyes:** 100% polyester & thermocool yarns, disperser dyes - Foron Lemon Yellow S4GLI, Foron Brill Red SRI, auxiliaries- acetic acid, sodium dithionite, sodium hydroxide, detergent.

2. **Dyeing process (dyeing of thermocool and polyester yarn with disperse dye and standardizing the dyeing parameters)**

The yarns were dyed with disperse dyes using High Temperature High Pressure method as it is the most popular method of dyeing on commercial scale with the advantage that it does not require carrier and have good dye exhaustion. It provides uniform dyeing.

For deriving the optimized dyeing recipe, following tests were carried out. The conditions for dyeing were standardized by studying the effect of time, temperature and pH. Total 4 yarn leas were prepared with 2 of thermocool and 2 of polyester each lea weighing 10g for yellow and red color with 3% dye shade. 400ml of water was added to each beaker to maintain MLR of 1:40.

- Effect of time: It was studied by dyeing yarns for different time periods viz, 30 min, 45 min and 60 min. The dyeing was carried out keeping other factors constant i.e. temperature 130°C, pH of 4.5.
- Effect of temperature: In case of dyeing with disperse dye, temperature plays an important role. After optimizing the time, effect of temperature was studied by dyeing each lea at different temperature viz, 110°C, 130°C, 150°C and 170°C. The dyeing was carried out keeping other factors constant i.e. time 60 min and pH of 4.5.
- Effect of pH: An indicative test was carried out to optimize pH for dyeing process. For this 3 different pH values i.e. 2, 5 and 8 were taken. The dyeing was carried out keeping other factors constant i.e. time 60 min and temperature 130°C.

3. **Kinetic study to standardize the dyeing parameters**

- Dye exhaustion: The degree of dyebath exhaustion as a function of time describes the rate and extent of the dyeing process. The mass of dye taken up by the material divided by the total initial mass of dye in the bath, but for a bath of constant volume. The dye exhaustion percentage (%E) is calculated by using the following equation

$$\% \text{dye exhaustion} = [A_0 - A_e / A_0] \times 100,$$

Where A_0 and A_e are the absorbance of the dye bath before and after dyeing respectively.

- Color strength measurement: Strength of any colorant (dyestuff / pigment) is related to absorption property. It measure reflectance and not absorbance. It is known to us that when reflectance is more, absorbance is less and when reflectance is less, absorbance is more. Kubelka – Munk theory gives the following relation between reflectance and absorbance:

$$K/S = \left[\frac{1-R}{2R} \right]$$

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Where R is the reflectance, K is absorbance and S is the scattering. K/S Vs Wavelength curve is always characteristics of every colorant. Instrument used to measure the K/S value was MACBETH COLOR- EYE 3100

4. Color fastness properties

Color fastness is one of the important factors in case of buyers demand which is refers to the resistance of color to fade or bleed of a dyed or printed textile materials to various types of influence.

- Color fastness to washing: The resistance of a material to change in any of its color characteristics, when subjected to washing is called color fastness to washing. The test was performed under standard of ISO 105 C10 C (3).
- Color fastness to light: The purpose of color fastness to light test is to determine how much the color will fade when exposed to a known light source. It needs to know how much protection ability have a fabric to sun light. It is determined by an experiment called color fastness to light. The test was performed under the standard of IS 2454.
- Color fastness to perspiration: The garments which come into contact with the body where perspiration is heavy may suffer serious local discoloration. This test is intended to determine the resistance of color of dyed textile to the action of acidic and alkaline perspiration. This test was performed under ISO 105 –E04:2008(E).

III. EXPERIMENTAL RESULTS

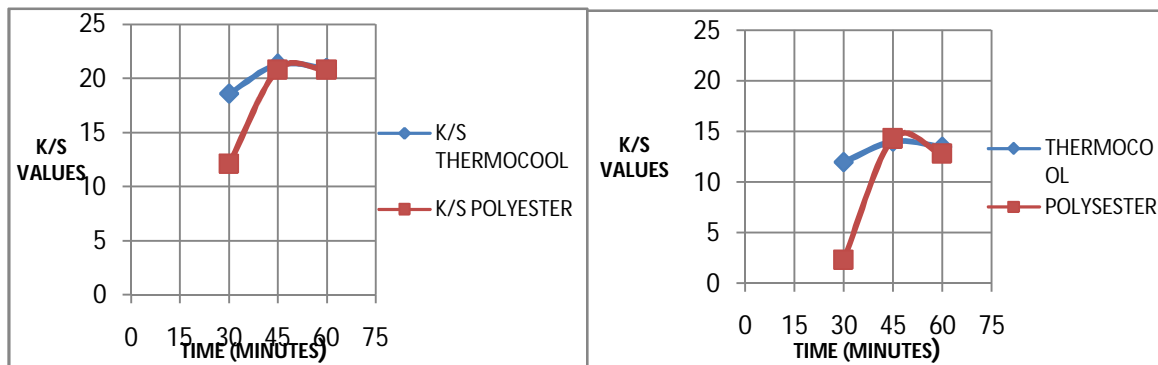
thermocool and polyester yarns were dyed with disperse dye in two colors yellow and red using high temperature and high pressure method with the variables of time (30min, 45min & 60min), temperature (90°C, 110°C & 130°C) and pH (2,5 & 8).

1 K/S VALUE

k/s values at different time, temperature and pH

K/S Yellow Color

K/S Red Color



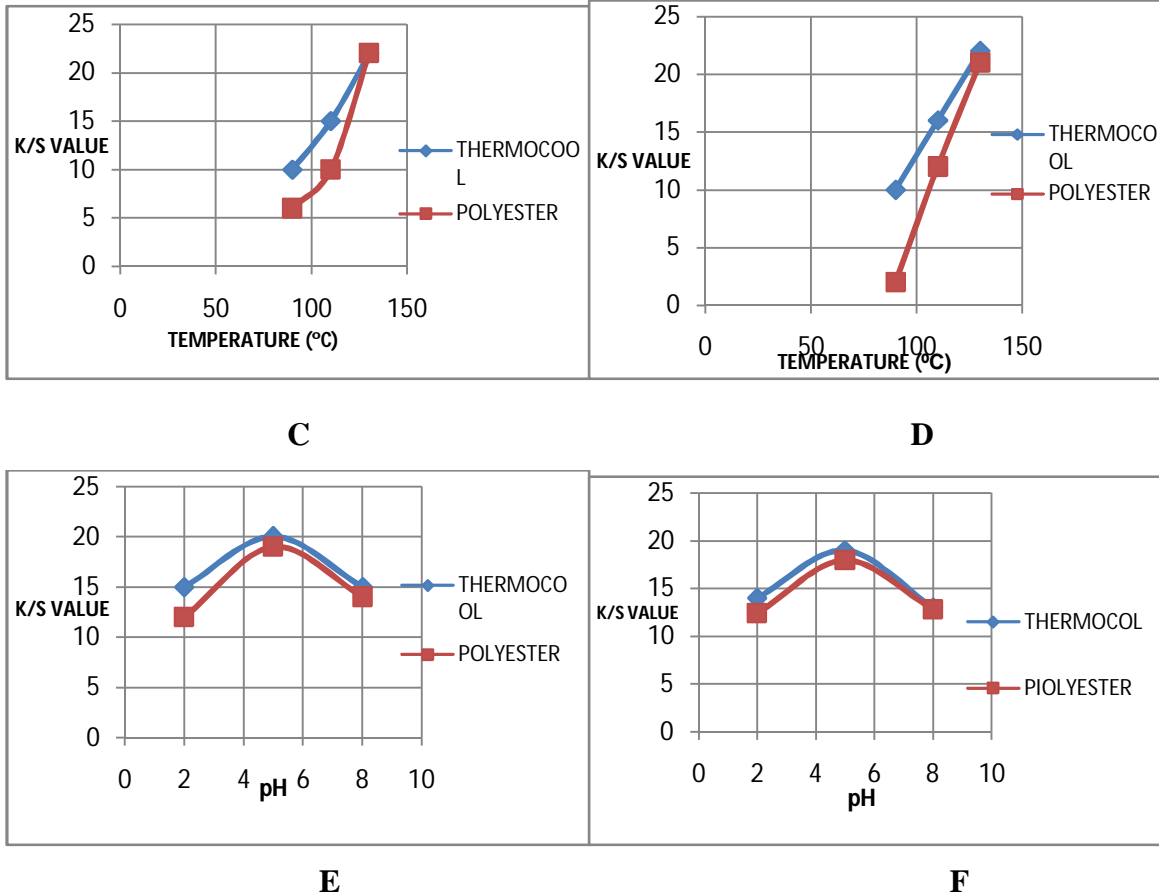
A

B

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It is clear from the Figure A to Figure F, that in almost all cases of parameters, thermocol yarns showed better k/s results than polyester yarns. With the increase in time duration (Figure A,B), temperature (Figure C,D) and pH (Figure E,F), K/s value increases. However at 60 minutes time interval the increase in K/s value is almost stopped & is similar to the k/s value obtained at 45 minutes dyeing time. Therefore in the further study of dyeing, 45 minutes time duration was selected. At 130°C the K/s value is found to be higher in all the cases. The dyeing study was not carried out after 130°C as there were chances of fibre degradation. Therefore in the further study of dyeing, 130°C temperature was selected and at pH 5, the k/s value is maximum. It is also clear that value of k/s obtained at pH 2 is similar to the value obtained at pH 8. For further study of dyeing, pH 5 was selected

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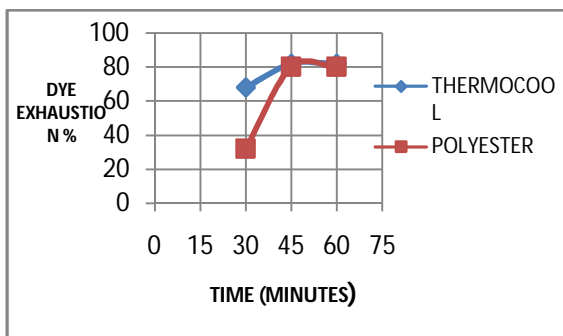
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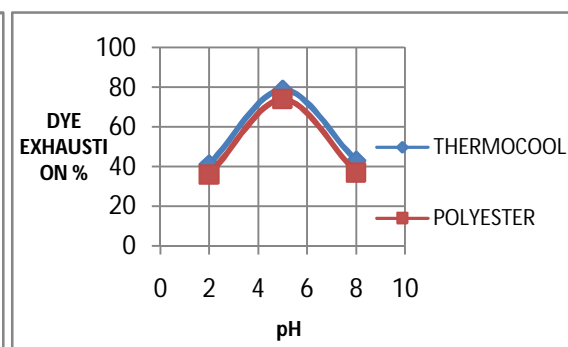
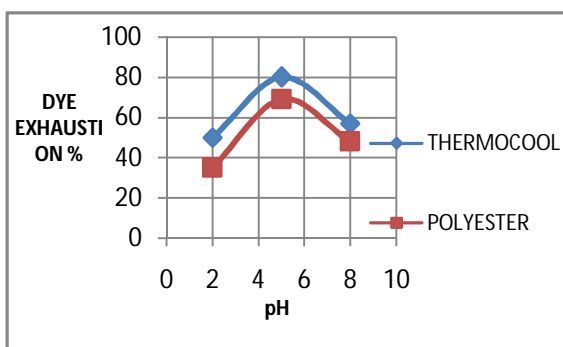
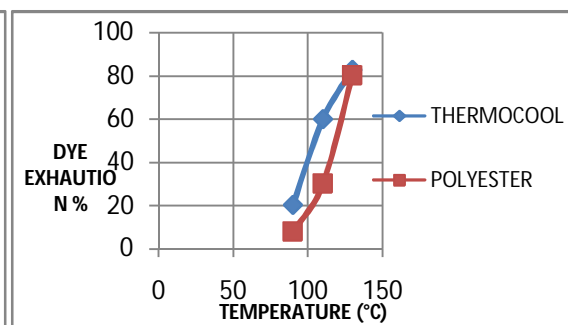
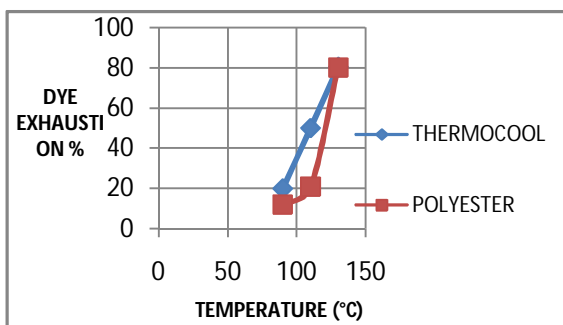
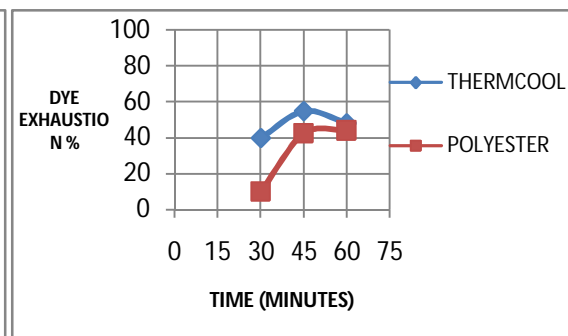
4.2 DYE EXHAUSTION %

DYE EXHAUSTION % AT DIFFERENT TIME, TEMPERATURE AND pH

DYE EXHAUSTION % YELLOW COLOR



DYE EXHAUSTION % RED COLOR



It is clear from the Figure G to Figure L that in almost all cases of time variation, thermocool yarn showed better exhaustion results than polyester yarn. With the increase in time duration (Fig. G, H), temperature (Fig I, J) and pH(Figure K, l) , dye exhaustion% increases. The % of dye exhaustion obtained at 60 minutes time interval is similar to the % of dye exhaustion obtain at 45 minutes dyeing time. Therefore 45 minutes time duration was selected for further study. Similarly in case of temperature (Fig. I, J) at 130°C, the dye exhaustion% value is maximum. Further study of dyeing, 130°C time duration was selected. And so in the case of pH (fig K, L) that at pH 5, the dye exhaustion% is maximum. It is also clear that dye exhaustion % obtained at pH 2 is similar to dye exhaustion % obtained at pH 8. Therefore in further study of dyeing, pH 5 was selected.

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4.3 Color Fastness Properties

Both thermocool and polyester yarns showed a very good result and was found color fast in terms of wash fastness and perspiration fastness with the scale of 4/5 to 5. For light fastness the result recorded was all above 5 which makes them more color fast to light.

IV. CONCLUSION

A kinetic study carried out for the optimization of dyeing parameters by examining their k/s values & dye exhaustion % and showed better results of thermocool than polyester. Color fastness properties of yarns dyed with the standardized recipe of optimized value showed very good results in terms of wash fastness, light fastness and perspiration fastness. From the above results we could assume that some surface changes had occurred in the polymer structure of thermocool during its manufacturing which have multi-channel fibers that enable condensation to move quickly from the inside to the outside, improving the wearer's comfort, improved hydrophilicity and also retaining high insulation values owing to the combination of differently engineered cross sections in the fiber mix.

REFERENCES

- [1] <http://40plusstyle.com/what-is-polyester-advantages-disadvantages/>
- [2] Sekar Chandra, "Dyeing Mechanism", Academia Education
- [3] https://www.academia.edu/4543770/Dyeing_Mechanism
- [4] <http://textilelearner.blogspot.com/2013/04/technical-terms-of-textile-dyeing.html>
- [5] <http://drnsg.wordpress.com/2013/05/19/computation-of-color-strength/>
- [6] <http://textilelearner.blogspot.com/2012/11/different-color-fastness-tests.html>
- [7] <http://www.schmincke.de/additional-information/lightfastness-a-measure-of-the-durability-of-artists-colours.html?L=1>
- [8] <http://thermocool.invista.com/technology/benefits/>
- [9] http://www.iso.org/iso/catalogue_detail.htm?csnumber=31775
- [10] <http://textilelearner.blogspot.com/2012/05/color-fastness-test-to-light-light.html>
- [11] Islam Mazharul , "Color Fastness to Perspiration" (May 2014)
- [12] <http://www.textilehelpline.com/color-fastness-to-perspiration/>