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Application of Acrylic Colour on Cotton Fabric: Using Tie and Dye Technique

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Abstract: ***Traditionally, the cotton fabrics were generally dyed with direct dyes during the process of tie and dye. However, the process results in consumption of very high amount of water at high temperatures, which not only leads to wastage of water, but the high temperature also destroys the natural texture of fabric (especially delicate fabrics). Furthermore, usage of direct dyes poses sustainability challenges due to water pollution and alkaline pH, thus, causing serious environmental stress.***
In this research, a new method of dyeing cotton fabric with acrylic colours using tie and dye technique has been explored. The primary acrylic colours (red, yellow and blue) were characterized for their physical parameters like pH, ash content, moisture content; structural parameters using spectroscopic techniques.
Keywords: Cotton fabrics, Tie and Dye, Acrylic colors, Dyeing and printing,

I. INTRODUCTION

Color is a strong tool for design and aesthetics in textiles. Dyeing and printing make significant contribution to the coloration process. However, these processes generate enormous amounts of effluent as they contain different types of chemicals that are harmful for the environment and human body. Tie and Dye is one of the most widely accepted and the traditional method of dyeing textiles. The basic concept behind Tie and Dye is to provide color to the fabric and to make them attractive. The process typically consists of folding, twisting, pleating, or crumpling fabric or a garment and binding with threads or rubber bands, followed by application of dye (s). The manipulation of the fabric prior to application of dye is called resist, as they partially or completely prevent the applied dye from colouring the fabric. More sophisticated tie-dye involves additional steps, including an initial application of dye prior to the resist, multiple sequential dyeing and resist steps. Further, nowadays, there is a new digital wave that is influencing the conventional Tie and Dye. Modern tools and technology are also being used to produce products for the same. However, it just produces a print effect and can in no way replace the original authentic effect of traditional Tie and Dye art which comes from actual dyeing of the fabric. While the digital effect may be suitable for mass production, many designers prefer Tie and Dye effect obtained by actual Tie and Dye for its uniqueness

A. Research Question

It is a global challenge to fight the problem of textile waste. Although studies have been undertaken to solve the problem of effluent and provide a substitute of direct dyes, but still the problem seems to persist. To address this predicament, acrylic colours have been used since ages to paint the fabric surface and therefore, have the potential to be used as a dye. However, limited experimental data is available on the structure of the acrylic colours so as to determine its affinity for the cotton fabric. Also, not many studies are available on the dyeing of cotton with acrylic colours. Based on the analysis of the research mentioned in the above brief summary, the research on acrylic colours is appealing for two reasons:

1) Scope on experimentation with acrylic colours as a dye source as they are being used as a painting medium till now.
2) Reduction in the effluent load as the acrylic colours might reduce the chemical and biological oxygen demand.

B. Significance Of Study

Textile industry wastewater released after using direct dyes during the Tie and Dye process, is characterized by highly visible colour, and salt. Discharge of such toxic-colored effluents permeates into surface water bodies/ ground pose adverse effects to ecology and human beings due to mutagenic and carcinogenic effects of dyes. Furthermore, in the current method of using direct dyes while doing Tie and Dye, artisans come in direct contact with harmful chemicals through touch and inhalation. Therefore, it is imperative to research on making Tie and Dye more environment friendly and find an alternative to the use of direct dyes. Thus, need was felt to undertake research on making Tie and dye a sustainable process. A positive outcome of this study will not only enable the artisans to develop different colours according to the requirement of the new generation designers but also make the traditional method more eco-friendly.

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C. Research Questions

Based on the literature and research gap, the following questions have been framed for conducting the research.

- Can acrylic colours be used as a dye in Tie and Dye process in addition to its present use as a painting medium?

D. Research Objectives

The key objectives of the research are summarised below:

1) To characterize the acrylic colours and study their physical, structural and thermal properties. 2. To optimize the parameters for dyeing of cotton with acrylic colours.

2) To determine COD and BOD of wastewater generated by dyeing using acrylic colours and compare with the COD and BOD of wastewater generated by dyeing using direct dyes.

Despite the several strengths of this research as discussed above, there are also a few limitations of this study:

a) The study is limited to cotton fabric only.

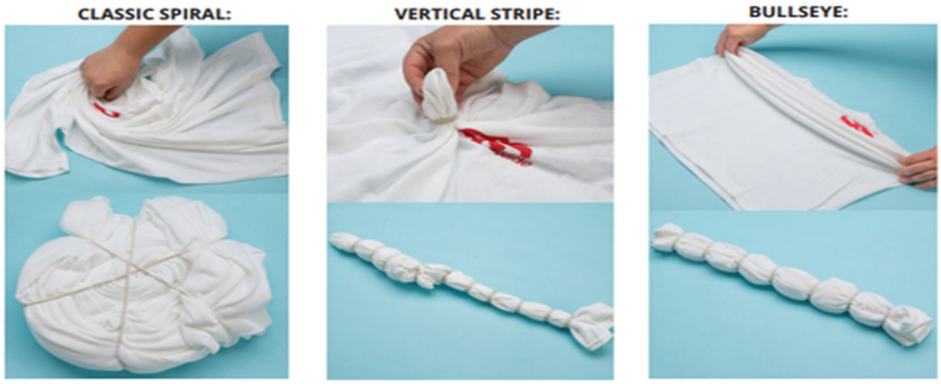
b) 2 Only three primary acrylic colours Crimson Red, Ultramarine Blue, and Lemon Yellow, have been used in the study.

II. REVIEW OF LITERATURE

Literature related to this study. It begins with the historical perspective of Tie and Dye followed by the study of the process and the obstacles it poses to the environment due to the use of direct dyes. In the accompanying section, the significance of substituting the direct dyes is illustrated. The researcher visited many websites, libraries, dyeing and printing factories to understand the impact of direct dyes on the environment and the methods used to substitute the consequences of the same on the ecology. However, it was observed that there is very limited literature on Tie and Dye with acrylic colours, as a way to replace the direct dyes. The few studies that have been reported are quoted in the chapter. Finally, the studies conducted on Tie and Dye, both nationally and internationally have been reviewed.

A. Tie and Dye

The term ―Tie and Dye‖ is used to describe a number of resist dyeing techniques and the resulting dyed products of these processes. It is one of the traditional methods of dyeing textiles. The basic concept behind Tie and Dye is to provide colour to the fabric and to make them attractive. The technique of ―Tie and Dye‖ became popular again in the United States during the 1960's, when Hippies, were protesting in the Vietnam War and promoting peace and love. The clothes were vibrant in colors and had psychedelic designs The word ―bandhni‖ comes from the Sanskrit words ―bandha‖ and ―bandhana‖, which means ―tying‖. The Gujarati term ―bandhavun‖, to tie was derived from them. In Rajasthan the prevalent expression is bandhni or also bandhana. The people engaged here in producing designs on fabrics using the Tie-Dyeing technique are known as bandhej Earliest evidence of Bandhani dates back to Indus Valley Civilization where dyeing was done as early as 4000 B.C. The earliest example of the most pervasive type of Bandhani dots can be seen in the 6th century paintings depicting the life of Buddha found on the wall of Cave 1 at Ajanta [Wada, 2002]. The resist-dyeing process was used to create attractive coloured designs on fabrics by knotting, binding, folding or sewing on certain parts of the cloth in such a way that the dye cannot penetrate into these areas when the cloth is dyed. It is a hand process by which intricate and attractive patterns can be produced



https://thedesigncart.com/blogs/news/diy-tie-and-dye?srsltid=AfmBOorCz5OWrh_fOgOhiNZ68dmevBh8Lc8bNv3sIBvFr-VIg1qXiJoV

The majorities of currently produced Tie-Dye uses standard designs and are mass produced for wholesale distribution. In the 21st century, a revived interest in more 'sophisticated' Tie Dye techniques emerged in the fashion and hobby industry which was characterized by simple motifs and monochromatic color schemes on fabrics, other than cotton

B. Historical Perspective of Tie and Dye

Indian Bandhani, a traditional form of Tie and Dye, began about 5000 yrs ago. Also known as Bandhej, it is the oldest Tie and Dye tradition still in practice. The craft is still thriving with Gujarat and Rajasthan as chief production centres [Jain and Tiwari, 2012]. It is not exactly known when ―Bandhnii cloths were first made in India or anywhere in the world for that matter, but it can be estimated that the technique was practiced as early as in the 2000 BC in the ancient city of Mohenjodaro, since the complex process of mordant dyeing was certainly known then. The painting on the walls of Ajanta caves



Sophisticated ornaments seen on the dancer, Maha-janaka Jataka,on Cave 1 Ajanta Cave Paintings

The miniature paintings of 16th century have also provided visual evidence of the ladies cladded in fine muslin odhanis with dotted chunari or striped leheriya designs. In the 18th and early 19th century, the Tie-Dyed silk handkerchiefs (bandannas) of Kasimbazar Bengal were a major export commodity [Veronica and Rosemary,1991]. The Khatri community migrated from the Punjab region in the 12th century, bringing their tradition of Tie and Dye that has evolved to be native to Gujarat. Tied and dyed rumal were found in the Kutch region of Gujarat, early 20th century.

III. TRADITIONAL METHODS OF TYEING THE FABRIC

The process of Tie Dye in India is basically the same today as it has been since antiquity, although the introduction of chemical dyes for dyeing and bleaching in the 19th century brought an important exception. First and foremost, the cloth is bleached or, as in Jamnagar, dyed blue with a mixture of indigo and water. Then, according to the complexity of the pattern to be dyed, a variety of ways are used to mark the designs on to the cloth. To achieve symmetry. Formerly, in Gujarat, a board on which design was drawn out in nails was used to mark the cloth. The fabric was dampened by steaming and pressed lightly over the nails so that the pattern could be distinguished in raised bumps. The tier, who bound each tiny bump, using one continuous thread for all, then caught these up. Some tiers used a metal, or an ivory tube through which the cotton thread was fed, which facilitated winding it around the fabric. Nowadays, the designer draws or block prints the design onto the cloth using a fugitive dye such as geru, or in some cases, with soot obtained from kerosene lamps. The tier then pinches a series of dots along the lines, often using a specially cultivated long fingernail on the left hand, or a metal substitute to assist in the process. Sometimes paste is dabbed onto the bound knots to ensure greater resistance to the dye. and to save time, the cloth, unless it is very coarse cotton or wool, is folded into two, or as many as eight folds if it is fine silk or muslin.

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There are various methods of tyeing, like lehariya, pleating, rouching, crumpling according to the motifs and patterns desired. The area of the fabric to be dyed is outlined using fugitive colors. Then a clear thin sheet of plastic, which has been pierced with pinholes, is kept over this area of the fabric and using fugitive colours, an imprint of the desired pattern is transferred onto the fabric. The craftsperson then pulls on a small area of the fabric where each is placed and winds thread tightly around the protruding cloth to form a knot or bhindi

A. Process of Dyeing

The dyeing process, usually done by men, starts after tyeing. The first colour to be dyed was a light one, usually yellow. The cloth was immersed in the dye-bath for 5 - 7 minutes, then rinsed and allowed to dry

The cloth is then returned to the tier for further ties to be made for those dots that are to remain yellow. The dots can be applied in individual colours at this stage also, which are then concealed by tying. The cloth is then re-dyed in deeper shades, typically green or red. The borders of odhanis and saris are usually dyed by stitch-resist, where the limits of the borders are stitched and the thread is drawn up to gather the borders. The field is tightly bound, formerly with thick grass but today with plastic sheets, and the borders are then dipped into the dye bath.



https://ourownpace.co/blogs/journal/indian-artisanal-fabrics-techniques-tie-dye?srsltid=AfmBOoqA0Q9RlT9wZx9rP1ztj55UO5asqs8I7il5xDa_O9MrCd1KtnEM

B. Status of Tie and Dye in Indian context

India has a diverse and rich textile tradition, which is known for its beauty and durability. The traditional textiles especially Tie and Dye are highly appreciated all over the world and considered as prestigious possession by one and all. The time has come for this art to be promoted all over India rather than to restrict this art to some parts of Gujarat and Rajasthan [Jain, 2012].

1) Bandhani

The Tie and Dye method is also called "bandhani" in India which senses out its meaning of "bandhan". The various states in India like Rajasthan, Gujarat has various methodologies for the Tie and Dye. The process consists of taking a pure fabric (non- synthetic) and ties it out in various forms with various shapes and then arranges it for dyeing. The choice of dyes used viz. Direct, Reactive, Acid, Natural, depends on the kind of fabric being dyed.

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https://cdn.shopify.com/s/files/1/0639/2741/9138/files/Bandhani_Green_2048x_44096a84-fcb1-455f-8d44-a5131a7b4701.jpg?v=1666590886

Gujarat Since very early times, Gujarat has been one of India‘s major textile producers. It is not clear when Tie-Dyed textiles were first made in Gujarat, but the earliest surviving pieces are probably small fragments of silk used by Jain monks from the medieval period onwards, to infuse manuscripts and to protect the paintings thereon.

2) Bagru and Sikar

Rajasthan In Western Rajasthan around Barmer and Jaisalmer, some of the simplest Tie-Dye designs are produced. The same technique of making patterns from a series of dots or squares as that made in Gujarat, were also used in east Rajasthan such as Jaipur, Kota, Ajmer and Alwar. In Sawai Madhopur, striking abstract Tie- Dye designs on coarse dark brown cotton are still worn by local Mina tribeswomen. Despite the popularity of Tie Dye across different states of Rajasthan, Jaipur still retains its charm as an important centre, both for Chunari and Lahariya cloths [Pal, 1934]. Tie- and Dye is also done in Bagru and Sikar, which produce boldly patterned cotton Odhanis in rich earth tones for the Jat women of Shekhawati.



https://itokri.com/collections/bagru-print-fabrics?srsltid=AfmBOorNLnUaB7p2JCSZ1D0uVFC-9BhdbXmH1-qymSX3SI9WFFuQccpN

3) Lahariya

(or leheriya) is a traditional style of Tie and Dye practiced in Rajasthan, India that results in brightly colored cloth with distinctive patterns.

Punjab The boldly patterned bandhani of present-day Punjab is closely related to the adjacent dessert belt of western Rajasthan and Kutch. Tie-Dyed textiles from Kutch are imported into Punjab, Muslim dyers, immigrated to undivided Punjab from Gujarat also developed the skill to make Gujarati-style bandhni. It is dyed similar to that of Punjabi Phulkari embroidery.



https://fabricdekho.com/products/purple-colour-lehariya-print-georgette-fabric?srsltid=AfmBOopbzICCcGhhaNzfAiU3wExIQ4CG4Ib5cCKWWayXYiDq-ZmvQOQW

4) Madhya Pradesh -chanderi

Madhya Pradesh, known as the heart of India, is a hub of major art and crafts of the country. It is known for various printing techniques, batik printing and techniques of Tying and Dyeing known as Bandhini. It is also known for its rich weaves of Chanderi and Maheshwari. Shivpuri in Madhya Pradesh is said to produce exceptionally beautiful Bandhani in dark blue cotton with figurative patterns in white, which are made for the local farming community, but is extremely rare or quite unknown in the rest of India.



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IV. ACRYLIC COLOURS

Acrylic colour is a fast-drying paint made of pigment suspended in acrylic polymer emulsion and is relatively more environment friendly [Izzo et. al., 2014] . Acrylic paints are 50 water-soluble, but become water-resistant when dry. They are traditionally used in paintings and craft. Water-based acrylic paint is composed of pigment particles dispersed in an acrylic polymer emulsion. There are three main components in any acrylic paint namely, pigment, binder and vehicle. Pigments are granular solids which give paint its color. They have little or no affinity for the surface to which they are applied. Vehicle refers to the part of the paint that carries the pigment and binder. Water is the vehicle for water-based acrylic and when combined with the binder, it creates a polymer emulsion. Once the water leaves the system via evaporation or absorption, the paint dries, creating a stable clear polymer film full of trapped colored pigment particles. Binder is the substance that keeps pigment in place after the paint dries. Acrylic paint has acrylic polymer as its binder, and this forms a film after the water has evaporated



https://blogger.googleusercontent.com/img/b/R29vZ2xl/AVvXsEhtESBmD7TemzcsC0FH0c_4HQU7WCFfXbmL8EFASZkTVYbQ1DH0NsKz1zar0apNy5YvZIPjHEnQK0HdbwPU0GGn-EvOFeuvTwA6VOpz3BRUoV2iGppCdc2hLaoYq-Gwp7qqxyI1JA7FAsLK2_oTrAMNhwBkwquQcuxsAFCI1CPwjFbXcmieMDnOos7JgVw/s1075/20250602_1349_Acrylic%20Tie-Dye%20Guide_simple_compose_01jwray2nte6t9gm885jvwvx1z.jpg

A. History of Acrylic Colours

Otto Röhm invented acrylic resin, which was quickly transformed into acrylic paint. As early as 1934, the first usable acrylic resin dispersion was developed by German chemical company BASF, which was patented by Rohm and Haas. The synthetic paint was first used in the 1940s, combining some of the properties of oil and watercolour [Phaidon Press, 2001]. Water-based acrylic paints were subsequently sold as latex house paints

Studies related to the acrylic colours Acrylic colours has always been used a sa painting medium, therefore, in this study it was explored to use the acrylic colours as dye medium. This section reprts the studies undertaken with acrylic colours. Direct dye of Seba brand was used for dyeing of cotton fabric and the results were compared with acrylic dyes. Evaluation of the sample showed that the feel of the sample in direct dyes was rated very good in all the cases whereas the sample with fabric colors was also rated very good.It was concluded with slight modification in our traditional techniques, new method of Tie & Dyeing could be introduced for fashion conscious people. She concluded that fabric colors were better choice than direct dyes.

B. Research Design

The research design employed, used a combination of experimental and Interpretative techniques, with a pragmatic approach, to establish that Tie & Dyeing of cotton fabric with acrylic colours was possible as an eco friendly alternative.

1) Material

Cotton fabric of 76 GSM, with average ends per inch of 113 (warp) and average picks per inch of 102 (weft) was used. Direct dyes of brand, Surya art, were procured

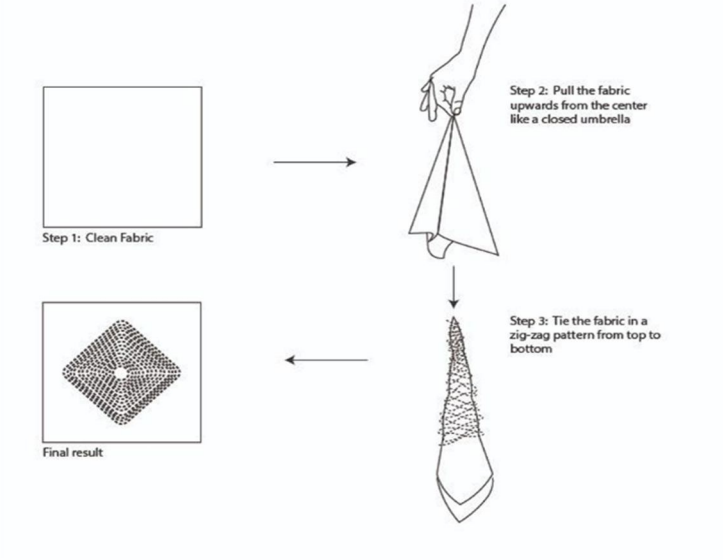
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2) Preparation of Cotton Fabric

The cotton fabric was soaked in soap water in order to remove starch and various finishing ingredients present in the fabric and to improve its absorbency. The cotton fabric was scoured using 0.2% soap solution at 250C for 30 minutes. The material was then taken out and rinsed thoroughly with cold water to remove all the traces of soap. The fabric was then dried in shade and ironed.

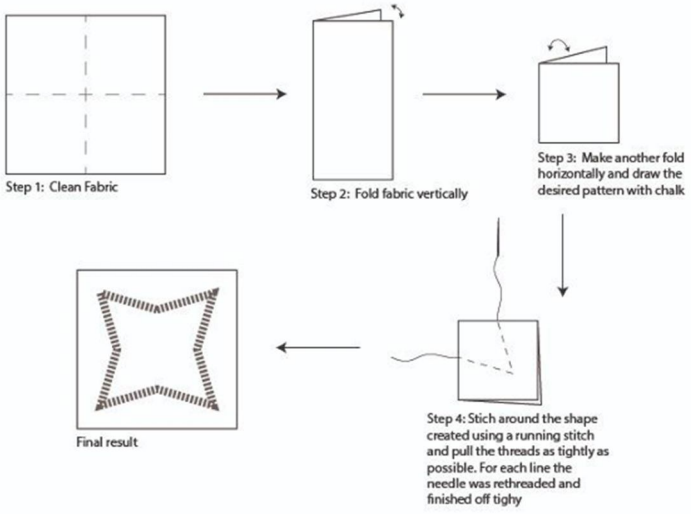
3) Tyeing of the Fabric

The scoured cotton fabric was tied with 8 ply cotton thread by using the following three techniques-



4) Sewing

The fabric was firstly folded in half and then pattern was drawn with a pencil or chalk. After that it was stitched around the shapes by using running stitches and then the threads were pulled up as tightly as possible before fastening off (Figure 3.3). For each line, the needle was rethreaded and finished off tightly.

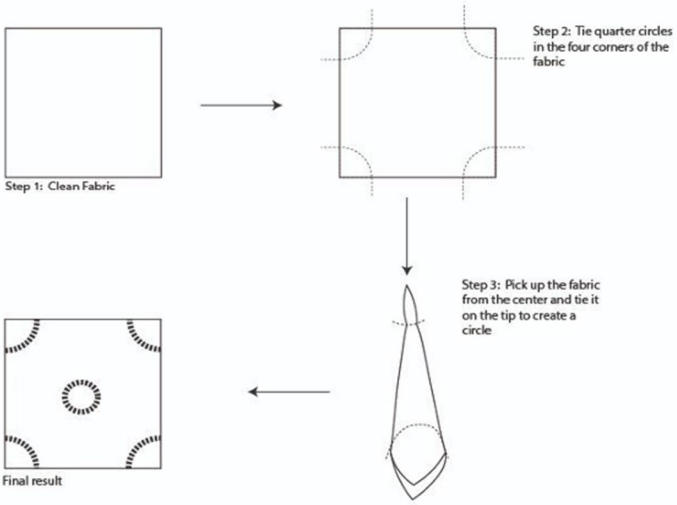


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5) Circle

This technique gives circle effect on fabric. A centre point is taken and then the fabric is tied in circular form (Figure 3.4) and dipped into the dye solution.



C. Dyeing with Acrylic Colours

A clean cotton fabric was taken and cut in appropriate size. The samples were then tied using the criss cross, sewing or circle technique. Then, one tied fabric was immersed in each primary colour solution of the acrylic colour respectively. Acrylic colour Dye concentration 1% owf, MLR 1:10; for 60 minutes at 55 °C. The samples were thereafter dried in shade. After drying the threads were cut.

Characterization of acrylic colours The acrylic colours were characterized for their physical, structural and thermal properties. The detail of every method has been discussed in the following sections.

1) Pre-treatment of cotton fabric

Pre-bleached cotton fabric was used for the study. However, to remove unwanted impurities and dirt etc from the fabrics before dying, the fabric was treated with 1 gpl non ionic detergent at 900.C for 15 minutes. The fabric was then washed thoroughly with water and dried.

2) Wash fastness

Colour Fastness of the dyed samples to washing (change in colour of samples and staining on multifibre). Colour fastness to wash is very important for assessing the feasibility of dyeing using acrylic colour. To evaluate wash fastness accelerated test methods were used. The degree of fading and staining of dyed goods from washing was evaluated at a temperature range of 450C to 500C and colour fastness to washing with different fibres (acetate, cotton, polyester, acrylic, wool, nylon) to test staining by the dyed fabric.

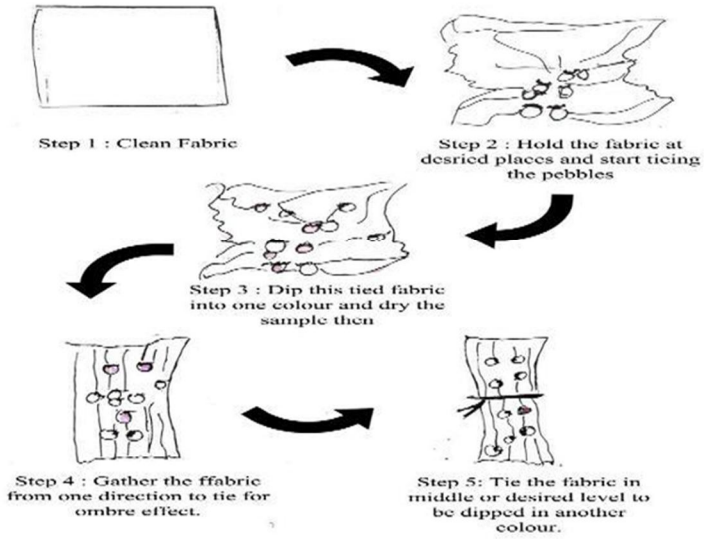
3) Dyeing of cotton fabric with acrylic colours

Firstly, fabric was prepared as per measurement and the weight of the fabric was noted. Then distilled water was taken in the shaker dye bath vessel on the basis of required material to liquid ratio (MLR) of 1:30. Then acrylic fabric colour with concentration 1% owf was added to the shaker dye bath vessel. The shaker dye bath was set to a temperature of 50°C. When the temperature of the dye bath reaches 50° C the fabric was dipped in the shaker batch for a time period of 60 minutes while maintaining the temperature (Figure 3.8). After the given time period, the fabric swatch was removed from the dye bath and left to dry on a clean surface so that no colour patches are formed.

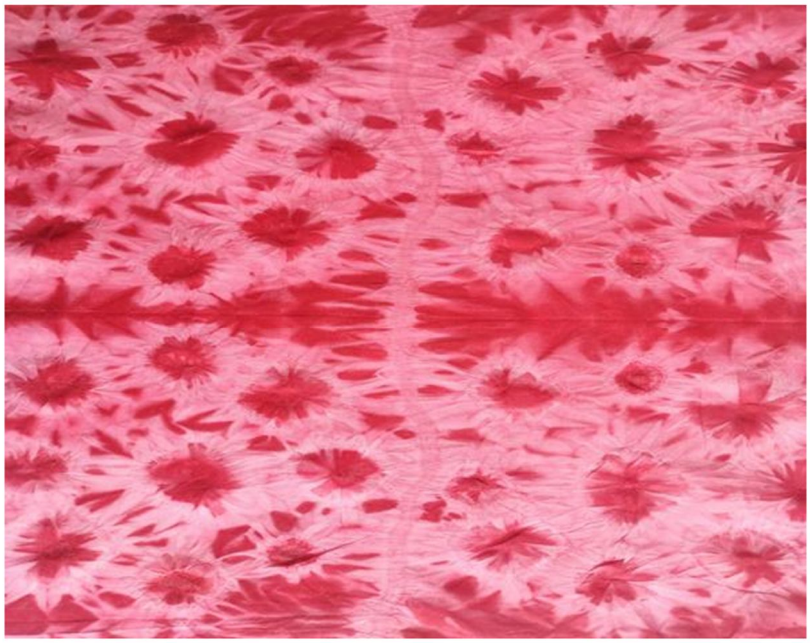
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4) Development of Tie and Dyed samples using acrylic colours

Tie and Dye samples were developed using acrylic colours on cotton fabric pebbles pattern techniques:



Pebbles Pattern with Ombre dye in red Colour The Fabric was prewashed and then placed on the surface. Pebbles were tied on the fabric at regular intervals or the desired gaps with an 8-ply cotton thread. The tied fabric was placed in the dye solution of one colour. The fabric was then gathered and tied in the middle for ombre effect. The sample was then dye with the second colour. Thereafter, the sample was dried in shade to restrain from colour becoming light due to sunlight. When the sample dried up, the threads tied



Cotton Fabric, Acrylic Crimson Red Color Omber dye colour with pebbles pattern

V. CONCULSIONS

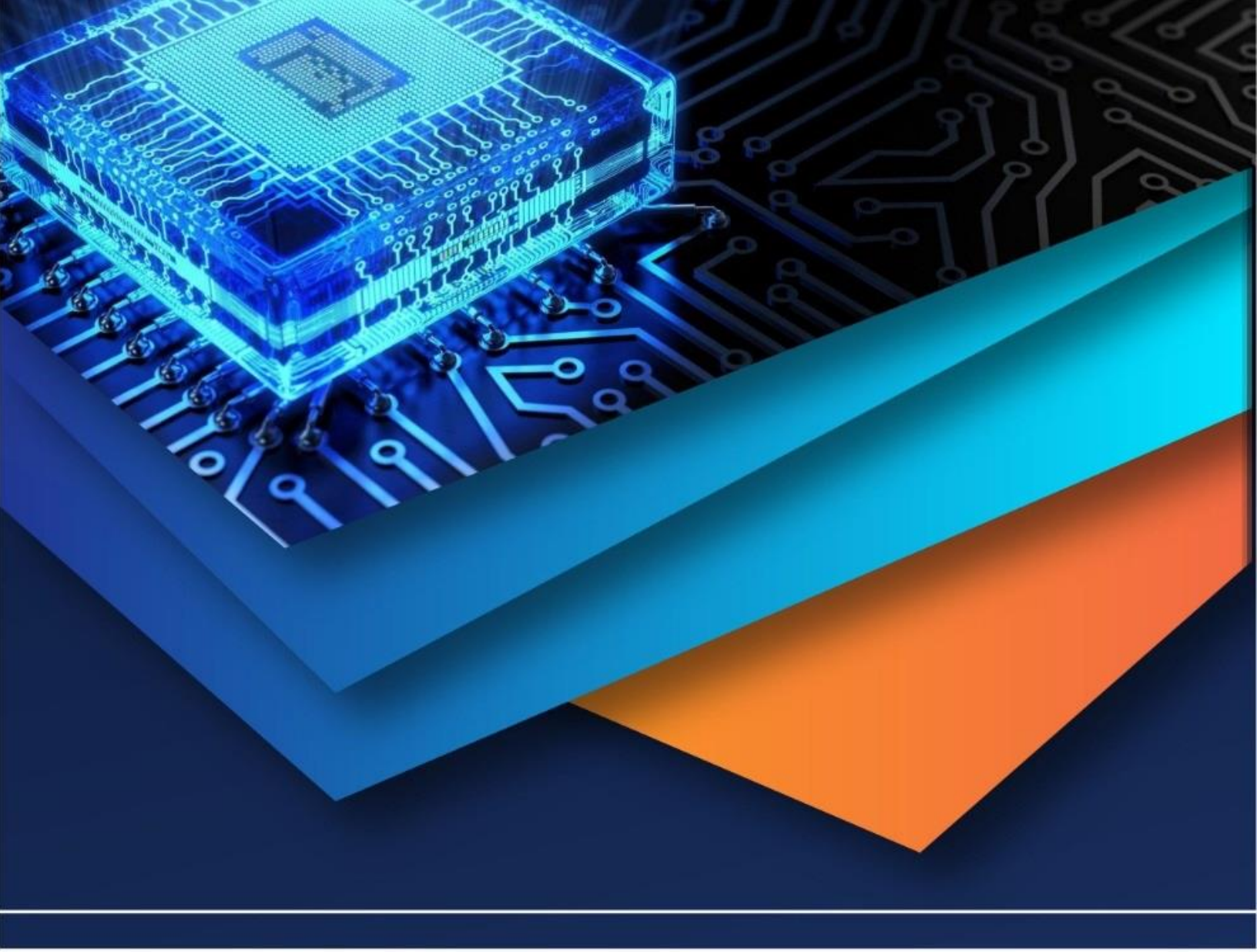
The preliminary objective of this research was to understand the feasibility of dyeing cotton fabric with acrylic colours. Promising results were obtained when fabric was dyed with acrylic colours and it was established that acrylic colours can be used for Tie and Dyeing cotton fabrics. Experiments were conducted on Acrylic colours for physical, structural and thermal properties. The physical characterization of moisture and ash content indicated that ~40 45% moisture content in these colours. The physical properties suggested that dyeing using acrylic colours is possible. The colours are expected to withstand the high temperatures of dyeing and yield the desired results on dyeing cotton and other pure fabrics.

Based on experiments conducted and analysis of the results, it can safely be concluded that dyeing is possible using acrylic colours. Dyeing using acrylic colours can be a good alternative for dyeing using direct dye as it requires less amount of water Having compared Tie and Dyeing with both Direct Dyes and Acrylic colours, and established that Tie and Dye with Acrylic colours is possible and gives good results, and that the same is eco-friendly and less polluting. This fact can play a significant role in transforming the Tie and Dyeing technique as well as making it more creative and an easy process.

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