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Cold Process Dyeing by Soft Flow Method

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***Abstract*: The soft flow method of cold process dyeing is the subject of this research. Reactive dyes are a form of dye that is often used to colour cotton, viscose, and other cellulosic fibres. Reactive dyeing, on the other hand, necessitates a large amount of salt, water, and electricity. In addition, the procedure is slow, resulting in low fixation rates (approximately 75 percent). This necessitates several rinses to clear the unfixed ink, which consumes more water and energy (as rinse water is often heated). Reactive dyeing wastewater is difficult to process because it contains high amounts of salt and dye. Cold pad batch dyeing is a less resource-intensive alternative to reactive dyeing. Advantage of cold process method is reduced water consumption, energy consumption, high percentage of dye fixation, no salts were added, Better suited to stretch fabrics and knits because it is easier to manage tension control in a small machine and fabrics are stronger than bio polished equivalent. The disadvantage is that it takes a long time, and the procedure is only practical if high-quality equipment is used. It also necessitates an intermediate drying process after bleaching. We measured wash fastness, light fastness, and colour matching in this analysis and presented the findings.**

***Keywords*: Reactive dyes, cold process dyeing, advantages, disadvantages, colour matching, wash fastness and light fastness.**

1. Introduction

The reel is absolutely discarded in the Jet dyeing machine. A closed tubular structure occurs where the fabric is mounted. A jet of dye liquor is supplied by a venture to carry the cloth through the tunnel. Turbulence is generated by the plane. This aids dye penetration while also stopping the cloth from contacting the tube's walls. This is only enough to allow for a seamless transition from back to front. A powered winch reel and a jet nozzle are often used in aqueous jet dyeing machines. Jet dyeing machines are divided into three categories: There are three types of dyeing machines: overflow dyeing, soft-flow dyeing, and airflow dyeing. Low water intake, time taking, and fabrics treated with care and gentleness are all advantages of jet dyeing machines. Water is used in the soft flow dyeing system to keep the cloth moving. The cloth rope is kept rotating during the entire manufacturing period, which distinguishes this equipment from traditional jets that use a hydraulic mechanism (right from loading to unloading). The liquor or cloth circulation is not interrupted during the drain and fills phases. Fresh water enters the vessel through a heat exchanger and is routed to a special interchange zone. At the same time, the polluted liquor is able to drain without coming into contact with the cloth or, for that matter, the fresh bath in the machine. This research is on using the soft flow system for cold process dyeing. Reactive dyes are a form of dye that is often used to colour cotton, viscose, and other cellulosic fibres. Reactive dyeing, on the other hand, necessitates a large amount of salt, water, and electricity. In addition, the procedure is slow, resulting in low fixation rates (approximately 75 percent). This necessitates several rinses to clear the unfixed ink, which consumes more water and energy (as rinse water is often heated). Reactive dyeing wastewater is difficult to process because it contains high amounts of salt and dye. Cold pad batch dyeing is a less resource-intensive alternative to reactive dyeing. There is no need to use heat during the CPB operation, and there is no need for salt or humectants. However, since the rate of fixation is affected by the ambient temperature, it is a safe idea to carry out dye fixation in a heat-controlled room in countries where the summer and winter temperatures vary significantly. To avoid hydrolysis and achieve reasonable levels of dye fixation, the contents of the dye pad trough must be prepared just before dyeing begins. This is why the dye and alkali solutions are normally injected individually into the dye trough and combined just before dyeing – and a chiller is often used to keep the dye liquors cold. To achieve uniform dye application and avoid side-to-side variance, high-quality adjustable rollers/mangles are needed (resulting in fabric rejections). The fabrics can be washed after dyeing, ideally on a high-efficiency counter-flow washing machine. It's crucial to get cold pad-batch dyeing right the first time because it's impossible to fix off-shade batches. However, since the dye liquor (without the alkali) is normally prepared ahead of time, there should be enough time for laboratory tests and modifications. Cotton, wool, linen, and viscose are among the fibres that can be dyed with CPB since they have a cellulosic structure. CPB does not work with silk or synthetic fibres. The procedure can be used on both woven and knitted fabrics (the latter need careful preparation). Smooth fabrics can be obtained without enzyme biopolishing due to the lack of abrasive manufacturing, resulting in stronger fabrics. The advantages of the cold process system include decreased water and energy intake, a high percentage of dye fixation, and the absence of salts. Stretch fabrics and knits are more suited to this system because stress management is smoother in a small machine and the fabrics are finer than the bio polished counterpart. The disadvantage is that it takes a long time, and the procedure is only practical if high-quality equipment is used. It also necessitates an intermediate drying process after bleaching.

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A. Principle of soft flow dyeing machine

Batch dyeing, continuous dyeing, and semi-continuous dyeing are all options for dyeing textiles. The most popular technique for dyeing textile materials is batch processes. Batch dyeing machines can be divided into three categories:

- In which fabric is circulated
- In which dye bath is circulated
- In which both the bath and material is circulated.

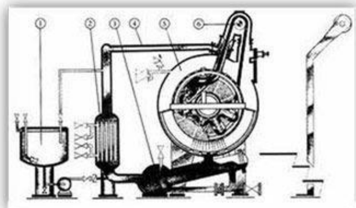


Fig. 1. Soft flow dyeing machine

B. Types of soft flow dyeing machine

1) Multi nozzle soft flows dyeing machine

It has a very low liquor ration around 1:1 and reaches high temperature up to $140^{\circ}C$. It has a ability of dyeing 30 to 450 g/mt.sq of woven and knitted fabrics. There is no pilling effect on it. It has wide capacity.

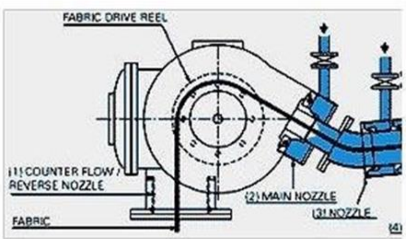


Fig. 2. Multi nozzle soft flows dyeing machine

2) High temperature high pressure soft flows dyeing machine

Stainless steel makes up the lightweight body. It has a high-efficiency heat exchanger that allows for rapid heating and cooling. The working temperature is up to 320°F, and the working pressure is 3.2 bar. Both manually and automatically, we can monitor the operation.

Fig. 3. High temperature high pressure soft flows dyeing machine

2. Material and Methodology

1) Raw materials

- 3 colour dye with different compositions
- Cotton 34's yarn
- 2 different dia knitted fabrics
- Sample soft flow machine

2) Recipe

- Wetting oil
- Salt(Nacl))
- Soda(Na_2Co_3)
- Caustic(NaOH))
- Acid(HCL)
- Soaping agent
- Fixing
- Softener

3. Methodology

1) Hot process method

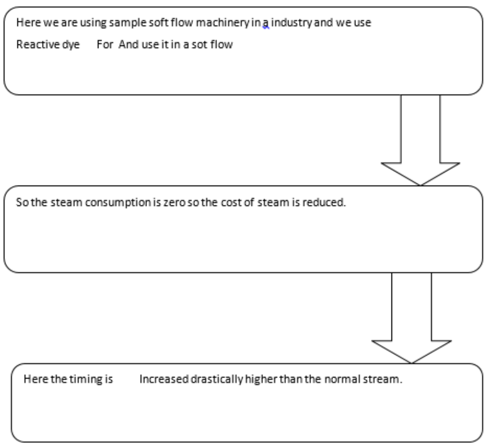
- First the fabric and the water is added, water keeps the fabric in circulation. The cloth rope is kept flowing during the manufacturing period thanks to the hydraulic mechanism (right from loading to unloading).
- Then the wetting agent is added, wetting agents (oil) is being run in the dye bath for 30 mins.
- The wetting oil is drained then the water from the storage is added into the soft-flow machine all this process is done automatically by the system.
- Then we are adding dye to the bath and then the salt is added let it is running the program for 30 mins.
- After that we are adding soda ash (Na_2Co_3) it is being run for 30mins.
- After that we are running the dye bath in stream for 1.30 hours.
- After that the dye bath is drained out
- Wash it 1 times and after that we are adding acidic to the water and it is being run it for 30 minutes and then we wash the acidic bath.
- Then we are adding the soaping agent and the soap is being washed for 2 times
- Then we are adding fixing agent and it is being run for 30 minutes, then we are washing it 2-3 times until the bleeding stop and at last we are using softener for the fabric to get softer and the softener is removed by 2 washes, then the water is drained.
- The processes takes for about 10 hours.

2) Cold processes method

- The cloth and water are applied first, with the water being used to hold the fabric moving. The cloth rope is kept flowing during the manufacturing period thanks to the hydraulic mechanism (right from loading to unloading).
- Then the wetting agent is added, wetting agents (oil) is being run in the dye bath for 1.30 hours.
- The wetting oil is drained then the water from the storage is added into the soft-flow machine all this process is done automatically by the system.
- Then we are adding dye to the bath and then after 30 minutes the salt is added let it is running the program for 1.30 hours.

- After that we are adding soda ash (Na2Co3) it is being run for 1.30hr.
- After that add caustic (NaOH) is added to the dye bath and the program is running it for 5.30hrs then the dye bath is drained out
- Wash it 2 times and after that we are adding acidic to the water and it is being run it for 45 minutes and then we wash the acidic bath.
- Then we are adding the soaping agent and the soap is being washed for 2 times
- Then we are adding fixing agent and it is being run for 30 minutes, then we are washing it 4-6times until the bleeding stop and at last we are using softener for the fabric to get softer and the softener is removed by 2 washes, then the water is drained.
- The processes take for about 15 hours.

3) Flowchart



4) Samples in different contribution

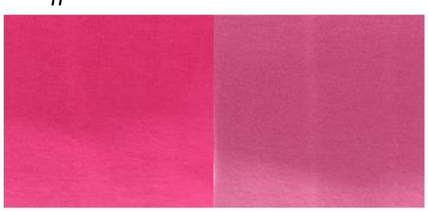


Fig. 4. Red F3B-0.500&3%

Fig. 5. T.Blue.G 266-0.500&3%

Fig. 6. Yellow. R R-0.500&3%

Fig. 7. Blue. RR-0.500&3%

4. Experimental Test to be taken

1) Colour fastness

Color fastness is a term used in textile dyeing to describe the resistance of a material's colour to fading or moving. Color fastness is a dye property that is equal to the binding force between the photochromic dye and the fibre. Processing processes, as well as the chemicals and axillaries used, can influence colour fastness. The word is most often associated with clothing. Before using bleach or other washing materials, garments should be checked for colour fastness. The three types of colour fastness that are standardised are light fastness, wash fastness, and rub fastness are all qualities to look for in a product. Textile dye light fastness is rated from one to eight, and wash fastness is rated from one to five, with a higher number meaning greater fastness.

Colour fastness is usually assessed separately with respect to:

- Color fading, or changes in the colour of the specimen being tested;
- Bleeding of colour from undyed material that comes into contact with the specimen during the examination.

2) Major test standards for color fastness

There are a variety of common research methods for determining the colour fastness of fabrics.

The key standard setters for textile colour fastness are,

- The Society of Dyers and Colourists (SDC).
- The American Association of Textile Chemists and Colorists (AATCC).
- The International Organisation for Standardisation (ISO).
- The International Wool Textile Organisation (IWTO).

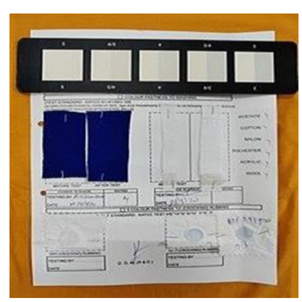


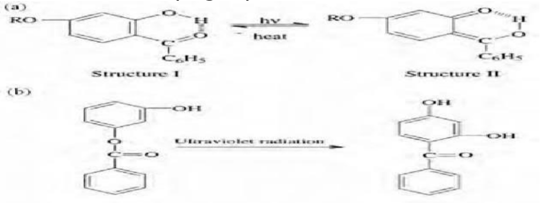
Fig. 8. Color fast tester

3) Light fastness

When a colourant, such as a dye or ink, is exposed to light, its light fastness defines how resistant it is to fading. Dyes and pigments are used to colour fibres, plastics, and other materials, as well as to make paints and printing inks. The effect of UV radiation on the chemical composition of the molecules that give the subject its colour causes colour bleaching. The chromophore is the component of a molecule that gives it its colour. Photo deterioration occurs as light strikes a painted surface and alters or breaks the, the pigments chemical bonds allowing the colours to bleach or shift. Lightfast materials are those that are resistant to this effect. The sun's electromagnetic spectrum includes wavelengths ranging from gamma to radio waves. UVA radiation that is not absorbed by ambient ozone has a photon energy that exceeds the dissociation energy of the carbon-carbon single bond, causing the bond to cleave and the colour to fade. Organic and inorganic colourants are thought to be more lightfast than each other. Black colourants are also thought to be the most lightfast. The light fastness of a sample is determined by exposing it to a light source for a certain amount of time and then comparing it to an unexposed sample Light fastness testing is a form of colour fastness testing in which the test materials are exposed to extreme artificial light to determine the effect on the object. The most difficult phenomenon relating to colour fastness in fabrics is photo fading of textile dyes, and thorough study is needed to ascertain the evidence. A key property of dyed textiles is light fastness. The given properties required for light fastness

- The incident radiation's wavelength,
- Dye and fibres form compactness
- Dye–fibre framework
- The degree of dye accumulation and the size of the dye particles,
- Humidity that works (combination of air, surface temperature and relative humidity are the important factors for determination of moisture content on the surface of fibre),
- Catalytic activity caused by dye,
- Temperature,
- The presence of oxygenic (photo-oxidation) or ultraviolet radiation (photo-reduction),
- The amount of colourant on the fibre (dark or medium shades),
- Impurities such as carriers, dispersing agents, dye-fixing agents, metals, and various dilutants are present.
- Exposure time,
- The amount of light that reaches the exposed surface area,
- Dye and fibre photoconductivity, • dye composition contains a substituent • Aromatic compound stability.

4) Common method of light fastness test



- ISO 105 test method (ISO 105 B01, ISO 105 B02, ISO 105 B04, ISO 105 B06, etc.)
- AATCC 16 – Test Method by Light Source Type

Improving light fastness of reactive dyed cotton fabric with antioxidant and UV absorbers.

5) Dye selection

Different dyes have different fading properties, and the theory of photo fading is also different. The appearance of one pigment will also make another dye more susceptible to fading. When dyeing dark varieties like black, we should select dyes that would not sensitise each other or even increase light stability. This is especially important when dyeing dark varieties like black. If one of the three primary colours fades so easily, the dyed textile or cloth will soon turn a different colour, and the fading dye residue will impair the light stability of the other two dyes. Monitor the dyeing process as closely as possible, ensuring that the dye thoroughly combines with the fibre and that no trace of hydrolyzed dye or unfixed dye remains on the fibre. This is a crucial step in achieving a consistent colour fastness to light. It's impossible to replicate the colorlight fastness test because light and temperature are too dynamic in real life. The operators must learn the test process skilfully and with the aid of a stable Weather metre in order to achieve outcomes that are similar to facts (Light fastness tester).

6) Test standards for light fastness

Light fastness is affected by the intensity of the sun's radiation, so it varies depending on geographic area, season, and exposure position. The table below shows possible relationships between light fastness ratings on various scales and time in direct sunlight, as well as standard viewing conditions: away from a fan, in the dappled sunshine, and UV-protected glass is properly framed.

B. Standards for light fastness

1) Colour matching

Tone mixing is not the same as colour styling. Color matching usually entails copying a colour from a known norm or objective. The translation of a pigment into a certain medium is known as colour styling. An image and a painting are identical in that a photograph (in most cases) offers an exact reproduction of a subject, while a painting is an approximation of a subject. Designers sometimes make the mistake of asking the vendor for an exact match after selecting a colour for a project. Frequently, the designer must match the colour of a painted objective or cloth and reinterpret it into a moulded plastic product (or the other way around). If the artist allows the maker to interpret the paint and offer a few different colour styling options, a lot of time will be saved in going back and forth to find the right fit, which may or may not be possible. Color styling is often commonly used in the development and interpretation of colour pattern palettes. By encouraging the colour matcher to use their imagination rather than an exact match, they may account for regional colour variations as well as the abundance of raw materials in those areas.

2) Computer aided colour matching

Color matching in clothing is often linked to dyeing textiles with specific quantities of dyestuffs to fulfil the designer's vision for the final garment's colour. When today's supply chains become more global and customers become more demanding in terms of colour consistency, matching the colour of all garment components becomes increasingly necessary. This is particularly true today, given that not only are the zip and buttons made of a different material than the garment, but the collars, sleeves, and key material are often sourced from different parts of the world. As a result, it's critical to be sure that when the supplies arrive in the sew and cut shop, they all meet a predetermined requirement at an early point in the procurement phase. The designer's concept is something fresh, creative, and unusual, born of creativity and aimed at gaining the end-approval user's. "Just another copy" is how the artist describes his colour scheme of what has already been achieved countless times ago for those in the supply chain who must ensure that the colour idea makes it onto the cloth. When they attempt to pair a colour with new ingredients or merely use an index of previously approved matches to run searches and make small adaptations to an initial formula, they may see an opportunity for lower manufacturing costs.

Fig. 9. Color matching testner

5. Conclusion

The difference between the cold and hot processes is the time duration and the steam. For hot process all the program is run in steam and due to it the cost is increased, but in cold process there is no steam is used so the cost of the process is drastically decreased. The hot process takes 10 hours of time whereas the cold processes take nearly 15 hours. Reduced water and energy consumption, a high proportion of dye fixation, and the lack of salts are all advantages of the cold process technique. Since tension relief is easier in a small machine and the materials are nicer than the bio polished equivalent, stretch fabrics and knits are more suited to this method. The downside is that it takes a long time and that it can only be done with high-quality machines. After bleaching, it also necessitates an intermediate drying method. UVA radiation with photon energy greater than the carbon-carbon single bond's dissociation energy induces the bond to cleave and the colour to disappear as it is not absorbed by atmospheric ozone. Organic and inorganic colorants are believed to be fast lighted in different ways. Clothing colour matching is often associated with dyeing textiles with specific amounts of dyestuffs to achieve the designer's vision for the final garment's colour. Color synchronisation of all garment materials becomes increasingly important Consumers demand higher colour consistency as today's supply chains become more multinational.

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