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RESEARCH AND STUDY OF SALT AND SALT FREE DYEING ON COTTON FABRIC

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Abstract - *The present study utilizes salt free dyeing on cotton which would not contribute to environmental pollution an undertaken to explore promising approach to reduce cost of dye process. The salt free dyeing used to dye cotton. In conventional Method of dyeing of cotton with reactive dyes, alkali PH is should maintain in the dye bath. This method requires more electrolytes for exhaustion and alkali for fixation. In this paper the fibre modification technique based on polyacrylamide was discussed. When the fabric is treated with polyacrylamide (chitosan), the primary hydroxyl groups of cellulose is (partially) modified into amide groups, which intern leads the cellulose to act like as wool fibre and hence reactive dyes can be dyed on cotton at neutral PH in the absence of electrolyte and alkali.*

Key Words*: *Salt Free Dyeing, Reactive Dye, PH, Polyacrylamide (Chitosan), Cellulose, Amide Groups

1. INTRODUCTION

Cotton fibres are widely applied in textile industry due to its excellent properties of hygroscopicity, air permeability, biodegradability, no static electricity, good comfort and this fibre has good strength and it is known to provide comfort, good moisture absorption and good wicking properties etc.

The popularity of reactive dyes for dyeing of cotton, environmental problems associated with their use have received attention. Since cotton has only moderate affinity for most reactive dyes, large quantities of electrolytes such as NaCl or Na2So4 (40-100 gpl) are normally required for exhaustion.

The fibre reactive dyes are known as the best for cotton for its wide range of application and better fastness properties. However, all the reactive dyeing systems require huge amount of electrolyte and alkali to exhaust and fix the dye respectively. Reactive dyeing thus pollutes the environment by discharging highly colored reactive dye bath and higher electrolyte concentration.

The pre-treatment of cotton fabric with polyacrylamide demonstrates the introduction of functional amino groups which increase the substantively and also the reactivity of cotton. The cationic charged amino groups may be involved in the adsorption of anionic chromophore of reactive dyes. The improved dye ability is postulated due to the presence of amide groups (-CONH2) available from the polyacrylamide which also tents to improve the reactivity of cellulosic substrate.

The process involve in pad-dry process at 80*c. The attachment of the dye molecules onto the partially-modified cellulosic substrate is by covalent bonding since no dyes strips out from the dyed sample. The fastness values of all such dyed samples are quite satisfactory and comparable with those of conventional dyed samples.

Thus the aim of this project is to dye the cellulosic fabric without salt and instead using poly acrylamide and other reactive agents, thus analyzing the technical and economic reports of the material.

1.1 POLYACRYL AMIDE

Polyacrylamide is a polymer formed from acrylamide subunits. It can be synthesized as a simple linear-chain structure or cross-linked, typically using N, N'-methylenebisacrylamide. In the cross-linked form, the possibility of the monomer being present is reduced even further.

Formula: $(C_3H_5NO)_n$

Classification: Polymer

PROPERTIES OF POLYACRYLAMIDE:

- Linear polyamine
- Reactive Amino Groups
- Reactive Hydroxyl Groups are available
- Water soluble and positively charge at acidic PH.
- Solution properties of chitosan in free Amine (-NH2) form soluble in acidic solution.
- Insoluble at pH's > 6.5 Insoluble in H2SO4
- Limited solubility in H3PO4
- Insoluble in many organic solvents
- Soluble at pH < 6.5
- Form viscous solutions
- Solution shear thinning, forms gels with polyanions
- Will remain soluble in some alcohol-water mixture.

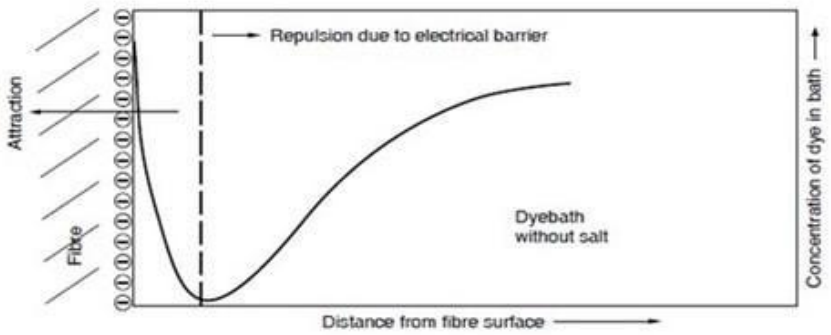
1.2 ROLE OF SALT IN REACTIVE DYEING

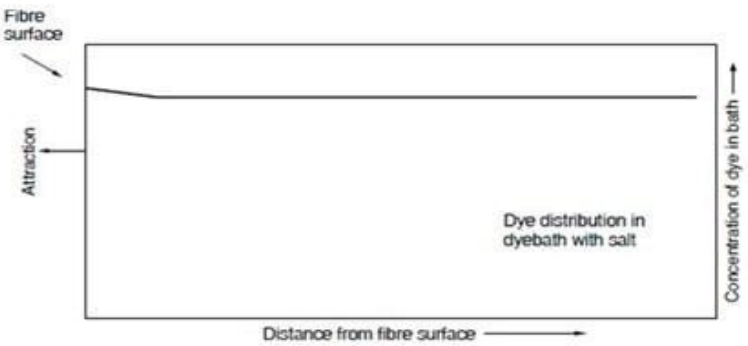
Inorganic salts have two main functions in exhaustion dyeing with reactive dyestuffs:

- Improving the affinity of the dyestuff
- Acceleration of the dyestuff's association and lowering of its solubility.

Generally reactive dyes contains sulphonic acid (-SO3H) group which is insoluble in water. During the manufacturing of the reactive dyes these sulphonic acid groups are converted into the sodium salt of sulphonic acid (-SO3Na) which is soluble in water.

Reactive dye – SO3H + Na^+ → Reactive dye SO3Na





Reactive dye – SO3Na + Water -- → Reactive dye – $SO3^-$ + Na^+

(Dye anion) (Sodium cation)

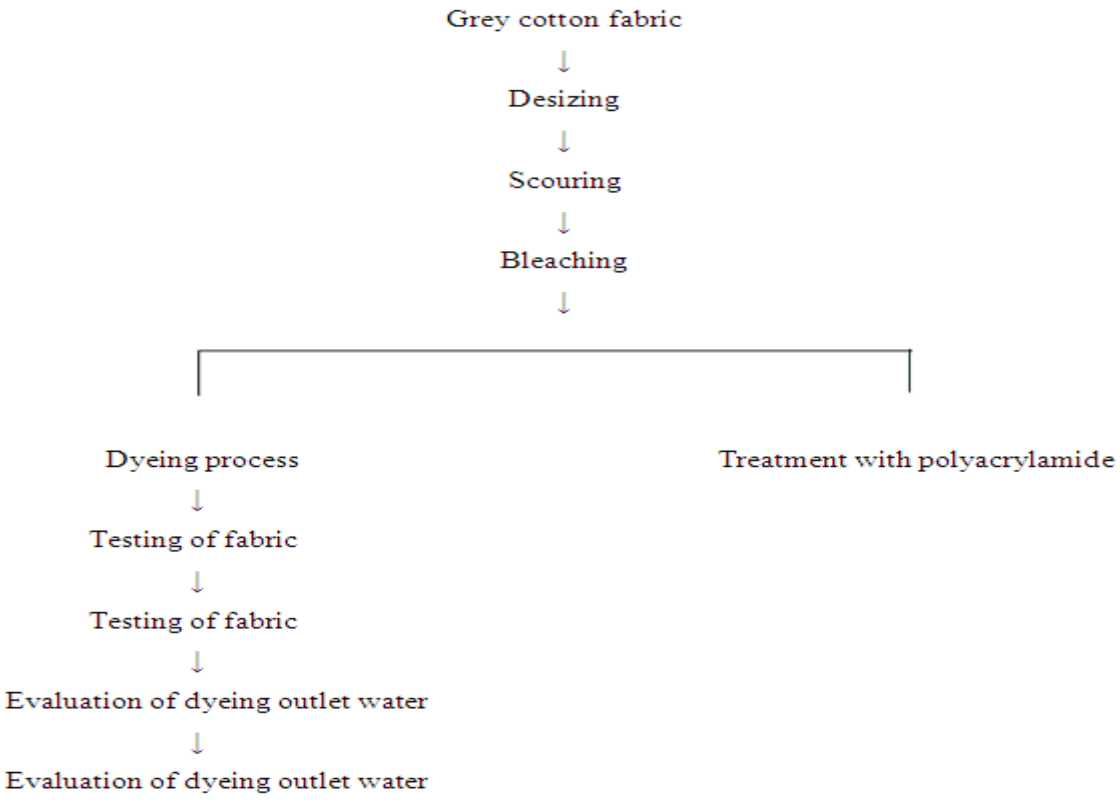
2. OBJECTIVES

- To elimination of salt as an electrolyte.
- To reduce the hydrolysis of dye molecules.
- To achieve maximum dye fixation.
- To improve the highest dye up-take
- To reduce low volume of water requirement during washing process
- To control low level of TDS value
- To reduce the environmental pollution.

2.1 RAW MATERIALS

- Cotton fabric(30s,155 GSM)
- PAA(polyacrylamide)
- Dyes
- H2O2,NACL,NAOH,NA2CO3
- Lubricants

3. METHODOLOGY



3.1 DESIZING

Recipe:

- Enzyme - 2.0%
- Wetting agent - 1.0%
- Sodium chloride - 1.0%
- Temperature - 50-60°c
- PH -6 - 7
- Duration -1-2 Hours

Procedure:

The given sample is weighed by using electronic balance

↓

Prepare the desizing bath set with 2.0% enzyme, 1.0% wetting agent and salt by using 1:20 material to liquor ratio.

↓

The temperature of the bath is to be raised to 50°c then enter the well wetted and squeezed material into the bath and worked for 2 hours

↓

Then the material is taken out from the bath and washed thoroughly using hot water and cold water

↓

Finally the material is squeezed and dried.

3.2 SCOURING

Scouring Process Scouring is the process where all natural and added impurities such as oil, wax, fat etc., are removed to make the fabric hydrophilic and clean the textile materials. The main purpose of scouring cotton fabrics is to remove natural as well as added impurities of essentially hydrophobic character as completely as possible and leave the fabric in a highly absorptive condition without any damage. The other objects of scouring are removed the non-cellulosic substances in case of cotton, make the fabric ready for dyeing, printing or finishing, and produce a clean material by adding scouring agents to remove impurities such as oils, waxes, gum, husks as nearly as possible.

1. Batch process
2. Semi continuous process
3. Modern process

3.3 BLEACHING

In the combined scouring-bleaching of cotton, the scouring process is accelerated in the presence of H2 O2 and less time is generally required to achieve good absorbency of the material. The advantages of this process are increased production with reduction of labour cost and reduced treatment time; the loss in wt. and strength of material is less.

H2 O2 is a powerful oxidizing agent that rapidly destroys the natural colouring matters present in cotton without undue oxidative damage to the fibres. Full use of the stabilizing properties of natural cotton impurities minimizes peroxide consumption during bleaching.

High alkalinity at elevated temperatures produces efficient scouring action.

Bleaching and leveling residual waxes are also affected in this process. Hence a combined scouring bleaching process for cotton using peroxide in winch and package has gained commercial success.

3.4 DYEING PROCESS

Dyeing is the technique of adding color to textile products like fibers, yarns, and fabrics. Dyeing is typically executed in a special solution containing dyes and specific chemical material. After dyeing, dye molecules have uncut chemical bond with fiber molecules. The temperature and time controlling are two key elements in dyeing. These are 3 application procedures available:

Discontinuous method

- Conventional method
- Exhaust or constant temperature method
- High temperature method
- Hot critical method.

Continuous method

- Pad-steam method
- Pad dry method
- Pad thermo fix method.

Semi continuous method

- Pad roll method
- Pad jig method
- Pad batch method

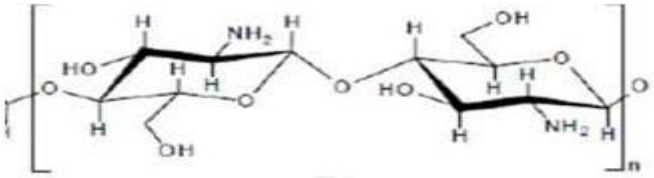
3.5 CONVENTIONAL METHOD OF DYEING (PRE-TREASTMENT)

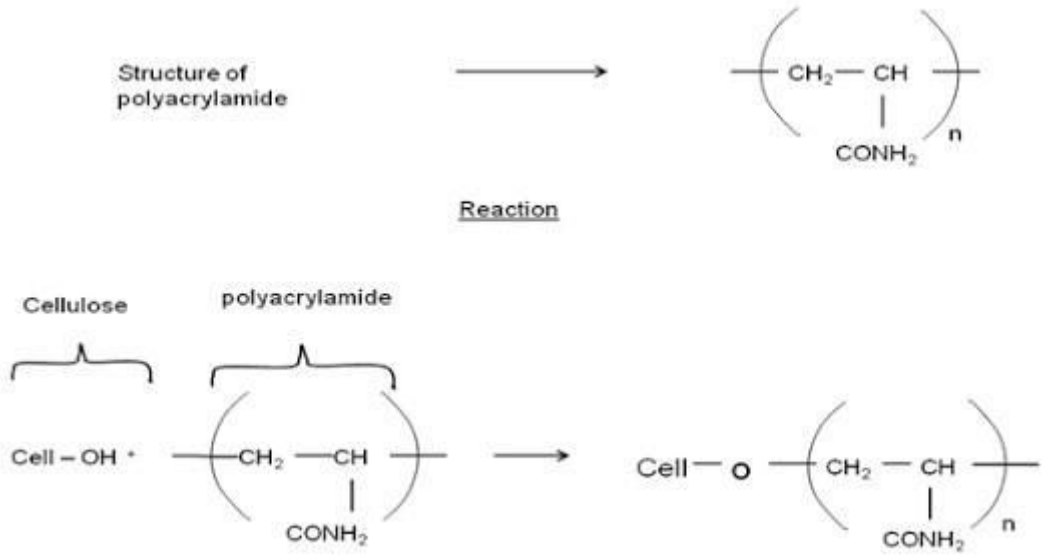
CHEMICALS CALCULATED FOR 1000KG OF FABRIC

PRETREATMENT OF COTTON FABRIC

S.NO	CHEMICALS	%(KG)	RUN TIME	TEMP(CELCIUS)
1	PLF	3.6	10MINS	60*C
2	AC CONE	9	10MINS	60*C
3	CAUSTIC SODA	9	10MINS	60*C
4	HPS	1.35	10MINS	60*C
5	H2O2	9	40MINS	90*C
6	ACETIC ACID	6.3	20MINS	55*C

3.6 REACTION OF POLYACRYLAMIDE THROUGH CELLULOSE





3.7 CONVENTIONAL DYEING OF COTTON FABRIC (WITH SALT) ---- (WITHOUT SALT) ---- (POLYACRYLAMIDE)

NOTE :- (VALUES CALCULATED FOR 1000KG OF FABRIC) DYE SHADE: - OLIVE (4%)

S.NO	CHEMICALS	QUANTITY USED(KG)	WITH SALT	WITHOUTSALT	POLYACRYLAMIDE	RUN TIME	TEMP (*C)
1	MSP	2.750	2.750	2.600	2.750	5mins	65*C
2	RDL	2.750	2.750	2.750	2.750	5mins	65*C
3	CATALYST (SALT)			NIL	PAA (GEL)		65*C
4	YELLOW- CW	21.40	21.40	21.40	21.40	10mins	65*C
5	BLUE-CE	11.60	11.60	11.60	11.60	10mins	65*C
6	RED-CE	4.830	4.830	4.830	4.830	10mins	65*C
7	SODA-I SODA-II	30 80+10	30 80+10	30 80+10	20 70+10	20mins	65*C
8	COLD WASH					20mins	RT
9	WARM WASH					20mins	55*C
10	ACETIC	11.00	11.00	11.00	9.00	10mins	55*C
11	WARM WASH					20mins	95*C
12	FINAL ACERIC	0.900	0.900	0.900	0.500	OUT	RT
13	SGX(CONE)	2.730	2.730	2.730	1.800	OUT	RT

4. TESTING METHODS

- WASH FASTNESS (AATCC TM61)
- COLOUR FASTNESS
- RUBBING FASTNESS (AATCC TM8)
- LIGHT FASTNESS (AATCC TM16.1/16.2)
- TDS CALCULATION & PH EVALUATION (AATCCTM81)

These standards are calculated with respect to AATCC / ASTM / ISO standards

4.1 WASH FASTNESS TESTER PROCEDURE:

1. Cut sample &multi fibre at 100 × 400 mm.

2. ECE detergent & Sodium per borate is taken with the sample.

The solution is taken by the following formula: (Sample fabric + Multi fibre weight) × 50 ml (1:50 liquor ratio)

3. The sample is kept in 60oC for 30 min.in Wash fastness tester

4. Rinse the sample twice with cold water. Flat iron pressing but temperature should not be more than 150°C

DESCRIPTION	SALT SAMPLE	SALT FREE SAMPLE	POLYACRYLAMIDE SAMPLE
WASH FASTNESS GRADES	4-5(VERY GOOD)	3(FAIR)	3-4(GOOD)

4.2 COLOUR THE FASTNESS TO RUBBING (DRY & WET) TEST (CROCKMETER)

Sample: ¬ Dyed fabric – 15 cm X 5 cm ¬ White Test Cloth - 5 cm X 5 cm Rubbing test machine

PROCEDURE: 1. White test cloth is put on to the grating and stag by steel wire.

2. The sample is run twenty times manually for ten seconds and the rubbing fastness of the sample cloth and degree of staining is accessed.

3. For rubbing fastness (Wet), the rubbing cloth is placed in the water and socked and squeeze. The wet rubbing cloth is placed on to the grating and stag with stainless steel wire and run ten times manually then assesses the staining on to the rubbing cloth and the rubbing fastness of the sample cloth is accessed.

DESCRIPTION	**SALT SAMPLE**	**SALT FREE SAMPLE**	**POLYACRYLAMIDE SAMPLE**
RUBBING FASTNESS GRADE(DRY)	**4**	**4**	**4**
RUBBING FASTNESS GRADE(WET)	**4-5**	**3-4**	**4-5**

5. CONCLUSIONS

In my project, the Cotton fabrics were pretreated with polyacrylamide, then reactivity of reactive dyes on fibre increased. Then the fabric are dyed using reactive dyes without salt. The dyeing of cotton with reactive dyes using polyacrylamide pretreated fabric in the dye bath improves the dye ability of cellulosic fabrics with reactive dye, when dyeing the modified substrates. The reactive dyes can be much more efficiently exhausted and fixed onto cellulosic fabrics under neutral conditions in the absence of salt.

Then Washing fastness, rubbing fastness, light fastness and perspiration fastness of pre-treated sample were better than that for the conventionally dyed sample. The pre-treated sample increases the dye uptake as well as deep colour yield delta-E value .The total dissolved solid (TDS) content of the dyed outlet water efficiently reduced than conventional dyeing process. The biological oxygen demand (BOD) and chemical oxygen demand (COD) of dyed outlet water also controlled and reduced than conventional method dyeing. By using this pre-treatment method, the following advantages were observed:

- Elimination of salt as an electrolyte,
- Maximum fixation of dye,
- Minimum hydrolysis of dye,
- Low volume of water requirement during the wash-off process,
- Significant savings in process costs,

And environmentally friendly.

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