

# **ECONOMICAL DYEING OF P/C BLENDS WITH MULTIFUNCTIONAL PROPERTY**

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*This paper deals with different energy conservation processes and multifunctional Auxiliaries. To meet the objectiveness, the dyeing of P/C blends is done by using high boiling swelling agent, as compared with conventional processes. Hence use of different swelling agents, results in the generation of COD and BOD low values, anti soiling etc. Finally results in economic process, which can dye both portion of blend in a single stage with disperse dye.*

**Key words:** *Economic process, Swelling agent, P/C blend, Disperse dye.*

## **INTRODUCTION**

The Multifunctional Auxiliaries and Energy Conservation processes are the Prime concern of the Textile Chemical processing industry. Attempts to utilize CD in textile applications started in the late 1980s. This was brought about by the recognition that the inclusion complex formation capability of CD can be applied to the deodorant, aroma, antimicrobial finishes that have recently popular and in treating effluents. Since then research and development of CD applications have become active, and the possibilities of using CD in textile finishing are being explored recently in the textile industry. With the trend in the textile industry demanding high quality and new properties, the range of application of CD is expected in P/C blends dyeing. In this study, for the coloration of P/C blend fabrics, so-called disperse dyes are used, which are very poorly soluble in water (0.1-10 mg/L). Without using solubility-enhancing agents (surfactants), uniform dyeing is not possible. CD however can replace the surfactant, and their COD in the waste water is lower than that of the usual textile surfactants<sup>1</sup>.

With the scarcity as well as increasing prices of fuel, it has become one of the imperative duties of the present day researchers to cut-short the processes, without sacrificing the desirable properties of the product for economy in general and conservation of energy in particular. To meet the above objectiveness, in the dyeing of P/C blends use of high boiling swelling agent like PEG can be used. In conventional process P/C dyeing involves various steps, viz. PET dyeing, reduction clearing, washing, drying; followed by cotton dyeing, washing, drying. If unfixed dyes is not removed properly during soaping/washing treatment will lead to poor fastness properties of the dyed material. Thus, sever washing-off treatments, reduction clearing and intermediate dyeing steps are involved in two bath P/C dyeing, which leads to more consumption of time, man-power, energy and also declination in the productivity. In this study to conserve time and energy, it is desirable to develop an economical process which can dye both the portions of the blend without altering their viz – properties. Therefore in the present investigation, an attempt can be made to dye P/C blends in a single

bath with disperse dyes using high boiling swelling agent (PEG).

## **MATERIAL AND METHODS**

### **Materials**

#### *Fabric*

67:33 Polyester: Cotton Knitted Sample.

#### *Yarn*

67:33 and 50:50 Polyester: Cotton Blended Samples.

#### *Dye stuff*

Yellow C4G H/C  
N.Blue 3G 200%  
Scarlet BR

#### *Special Auxiliaries*

$\beta$ -Cyclodextrin  
Polyethylene glycol with m.w 400  
BTCA  
Sodium Hypophosphite  
And all other chemicals are in laboratory reagent grade

### **Methods**

#### *Scouring and Bleaching*

The samples were scoured and bleached by the Combined Process at 80°C for 45 min., with a solution containing 2 gpl Non-Ionic Detergent, 2 % Hydrogen Peroxide and 2 % sodium carbonate etc. Washed with Hot Water, Cold Water, Squeezed and Air Dried.

Chemical Treatments:

**Table - 1: Various Chemical Treatments Prior to Dyeing**

Methods	Treatment
U	Untreated
A	Samples Treated with PEG then steaming at 160° C for 2 min. Finally the samples were thoroughly washed with tap water and air dried.
B	Samples Treated with a mixture of PEG and Sodium hydroxide solution (95.5%/4.5% w/w) to wet pick-up of 100% expression then steaming at 160°C for 2 min. Finally the samples were thoroughly washed with tap water and air dried.
C	Samples Treated with a mixture of PEG and Sodium hydroxide solution (95.5%/4.5% w/w) to wet pick-up of 100% expression then steaming at 160°C for 2 min then the samples were thoroughly washed with tap water and air dried; treated with CD in different concentration (10, 15, 20, 30,35gpl) along with BTCA-0.6%, Catalyst-SHPI-0.6% etc then Curing at 170°C for 2 min. Finally the samples were thoroughly washed with cold water and hot water, air dried.

**Dyeing**

All the dyeing was performed using HTHP Dyeing technique. The pH of the liquor was maintained at 5.5 using acetic acid. Well wetted fabric was entered in to the vessel with the disperse dyes-x%, dispersing agent-0.5% etc at room temperature and then the temperature is gradually raised to 130°C and work for 30-40 min. Finally, all the dyed samples were thoroughly rinsed, soaped with 3 gpl Lissapol N (Non-ionic detergent) at boil for 10 min, washed and air dried.

**TESTING AND ANALYSIS**

**Determination of Degradation of PET**

Carboxylic content of treated samples (A, B & C) was analyzed according to a reported method<sup>2</sup>. This tests is useful to determine the degradation effect of PET causes by alkaline and steaming, However the staining test

can also be carried out with Basic dyes (Basic Blue 9 for 0.5%(o.w.f); Temp. 85°C, Time, 60 min; MLR 1:100) to find qualitatively through colour strength determination by CCM.

**Dye Exhaustion Percentage**

The dye uptake was evaluated by visible spectroscopy from calibration curve of concentration versus absorption of the individual dye at its wavelength of maximum absorption using shimadzu spectrophotometer. Dye exhaustion percent expressed as E%, it was calculated as a difference between the dye concentration before and after dyeing. i.e. equation (1).

$$E \% = (C_b - C_a / C_b) \times 100 \dots\dots\dots \text{Equation (1)}$$

Where, E-Exhaustion percentage

C<sub>b</sub>-The Dye concentration before dyeing

C<sub>a</sub>- The Dye concentration after dyeing

$$K/S = (1-R)^2 / 2R \dots\dots\dots \text{Equation (2)}$$

Where-Light absorption co-efficient

S-Light scattering co-efficient

R- Reflectance of the dyed samples

**Evaluation of K/S Value**

Colour strength (K/S Value) of the dyed sample was measured on Data Spectra flash SF 600 Spectrophotometer. These values are computer calculated from reflectance data according to kubelka-munk equation<sup>3</sup>.

**Fastness Properties**

The fastness properties of all treated and untreated dyed samples to washing, Rubbing and sublimation were assessed according to BIS Test methods. The change in shade was visualized using grey scale and graded from 1 to 5, 1 indicates poor and 5 indicates excellent fastness properties (Light fastness were graded from 1 to 8, 1 indicates poor and 8 indicates excellent fastness to light)<sup>4</sup>.

**Surface Studies**

The surface of untreated and untreated samples were studied using SEM analysis, the samples was mounted on a standard specimen stub and examined in a Jeol jxa-84 oh Electron probe micro analyzer, Japan operating at 19 KV. A Thin Coating ( app. 10 nm ) of gold was deposited on to the sample and attached to the stub, prior to examination in the SEM, to enhance conductivity and secondary electron emission characteristics of the over growth.

**Determination of Moisture Regain**

The alternative current (a.c.) electrical properties is very much

useful to determine the moisture regain of both treated and untreated samples, which have been studied using a programmable automatic RCI bridge (PH 6304 Philips), analyzing their dependence on temperature and frequency. The a.c conductivity and electrical resistance have been measured in the frequency range (5-20 KHz) over the temperature (24-100°C). Samples were in the form of tablets and silver rods was used as electrodes. Sample temperature was measured using a pre-calibrated chromelalumel thermocouple type K placed near the sample. All measurements were carried out in specially designed cell.

### X-Ray Diffraction

Both treated and untreated samples were investigated by X-Ray diffraction technique using Siemens D-5000(Computer controller) X-ray diffract meter, with Cu target ( $\lambda=1.542 \text{ \AA}$ ) and Ni filter. A continuous scan mode was used to scan  $5^\circ <20> 65$  in 0.05 step. The samples were in powder form.

### Wettability

A Simple test of Wettability of fabric is to cut small square specimens, ex. 1" x 1", and to drop them on to the surface of a beaker of distilled water. The time taken for the specimens to make sink below the surface is observed, the shorter the time the greater the wettability<sup>5</sup>.

### Soil Release Testing

The tumbler test is used with the help of artificial soil (Appendix 1) to find out Soil Release property of both treated and untreated samples<sup>6</sup>. The fabric samples were soiled by using ISI procedure involving repeated (thrice) dipping of fabric in standard soil, padding and drying. Standard soil contained coconut oil, fatty acid, white oil, carbon black in tetrachloroethylene solvent. Soiled samples were soaped at 95°C for 10 min in nonionic detergent (4 gpl) followed

by washing with distilled water. The soiled as well as washed samples were visually compared to assess the extent of soil removal and graded<sup>7</sup>.

### Pilling Tendency

ASTM has recommended different test Methods for determining pilling resistance and other surface effects such as fuzzing. Accelerator test methods were used for pilling tendency testing and it covers the method for using the impeller tumble abrasion testing machine to evaluate the pilling propensity of knitted fabric<sup>8</sup>. The Grading of pilling are given in Appendix 2.

## RESULTS AND DISCUSSION

Polyethylene Glycols are widely used in textile in processing as additives for improving fixation of disperse dyes to specific fibre type. For example, cellulosic and cellulosic fibre blends exhibit improved dye ability when concentrations of up to 10% PEG(av. M.w of 100-600) were used in the dye bath<sup>9</sup>. Similar improvements were observed when PEG was used as dye bath additives in the dyeing of P/C fabrics with disperse dye<sup>10</sup>.

Cyclodextrins can be considered as a new class of Textile auxiliary's substances for the textile Chemical processing industry; Very important is that their COD in the waste water is lower than that of the usual textile auxiliaries. While the COD is 2020 mg/g for NP-10 (a polyester); 1930 mg/g for Uniperol O (a fatty alcohol polyglycol ether; BASF), for  $\beta$ -CD

this value is only 1060 mg/g<sup>11</sup>. For coloration of PET fibres, so-called disperse dyes are used, which are very poorly soluble in water(0.1-10 mg/L) Without using solubility-enhancing agents(surfactants), uniform dyeing is not possible. CD, however, can replace the surfactant<sup>12</sup>. A New finish was developed for easy removal of sweat degradation products from the textile by preventing their penetration into the fibre. A Cotton textile was impregnated with a composition containing dimethylolethylene urea, catalyst and  $\beta$ -CD (5-50 gpl) and fixed. The textile was treated with in a bath containing 10 gpl butyric acid and as the concentration of  $\beta$ -CD increased in the finish bath, the concentration of butyric acid in the fabric increased<sup>13</sup>.

This project's intention was to make the use of the positive aspects of the mentioned methods for modifying the surface of the fabrics and we choose to apply a hybrid approach. The influence of the type of treatments, carboxylic content, dye uptake, Surface topography, fastness properties, electrical properties and the structural properties of the treated and untreated samples are discussed in Table - 2.

It is seen from Table - 2, that the carboxylic content in the case of treated sample is higher than the un-treated ones; and that the mode of increasing is depending upon the type of treatment. The hydrolysis of polyester takes place not only at their free ends, but also in other

Table - 2: Carboxylic Content & Colour Strength of Various treated Samples of Carbonized P/C Fabrics Dyed With Basic Dyes.

Carbonized P/C Sample	Carboxylic content m.eq.100 gr.fabric	Colour Strength (K/S)
Untreated	31.2	0.23
A	48.4	0.29
B	290.6	2.54
C	180	2.2

Graph - 1: Carboxylic Content & Colour Strength of Various treated Samples of Carbonized P/C Fabrics Dyed With Basic Dyes.

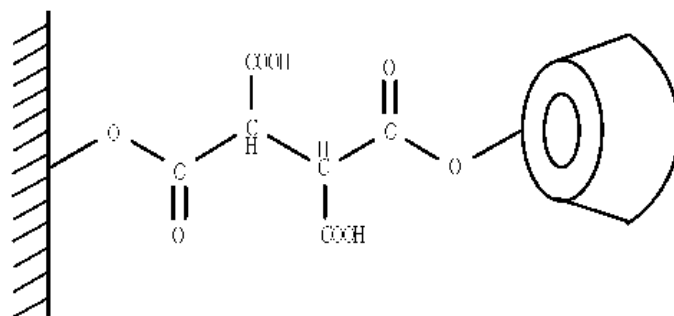
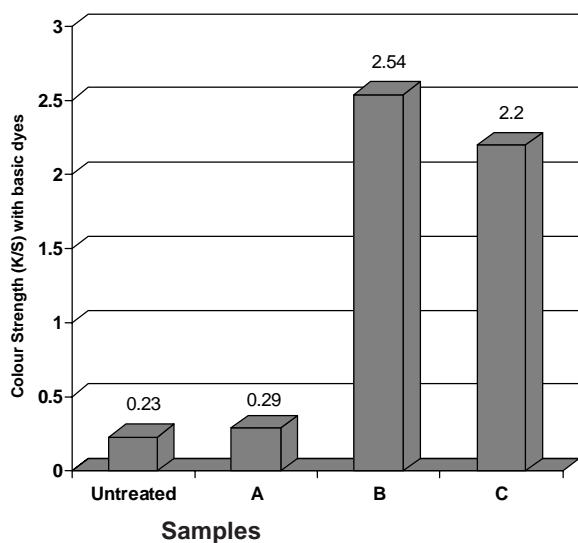


Fig. 1. Grafting of  $\beta$ -CD on to OH group via BTCA

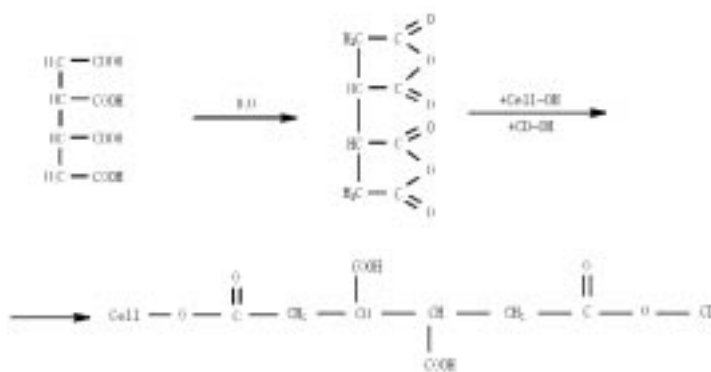


Fig. 2. The proposed Grafting reaction of  $\beta$ -CD on to OH group via BTCA

positions, thereby the increase in carboxylic content was continued and reached 290.6 m.eq./100 gr.treated samples. The colour strength of samples dyed with basic dye is thus indication of hydrolysis and it can provide an assessment of the degree of hydrolysis. It was found that K/S increased as the concentration of carboxylic groups increased, even though the concentration of the basic dye in dyeing bath was held constant. On the other hand it was found that the values of carboxylic contents have decreased and it might be possible that the action of PEG is more chemical in nature. The new formed free carboxylic end groups react with hydroxyl groups in PEG and CD thereby decreasing its content and forming the block copolymer of PET and PEG

### Conversion of Carboxylic groups to Carboxylate Anion

When fabrics were treated with BTCA & CD, esterification between BTCA, CD and hydroxyl group of cellulose and PEG occurred at elevated temperature. After washing the un-reacted acid, the carbonyls retained in the fabrics and existed in three forms, namely Ester, Carboxylic acids and Carboxylate anions.

The formation of such block copolymer is well established<sup>14</sup>. Nevertheless, a Distinct feature of CD is its ability to form inclusion compounds, where inclusion

formation is mainly affected by the geometric shape of the molecular rather than chemical interactions. The hydrophobic portion of the guest molecule is positioned such that maximum contact with the non-polar cavity is possible while the hydrophilic portion is located on the outer surface of the inclusion complex such that it is near the proximity of the hydroxyl groups of the host.


### Qualitative Determination of $\beta$ -CD Molecules on the Textile Substrates

$\beta$ -CD Molecules on textile substrate was determined by phenol Red and Phenolphthalein. Phenol red forms coloured complex with  $\beta$ -CD, So, phenol red changes colour from red to yellow when CD is present on the substrate.

[Block A] [Block B] [Block A] [Block B] and Grafting with CD

Where, Block A- PET  
Block A- PEG

Fig. 3. Presents the Change in the Colour of Phenol Red to Yellow.

c ( $\beta$ -CD)			
0 (g/l)	30 (g/l)	Washed in cold water	Washed at 60°C
			

Change of phenol red colour from red (for untreated) to yellow for treated in solution containing 30 gpl of  $\beta$ -CD, 6 gpl of BTCA, 6 gpl of SHPI; Thermofixed and rinsed in cold water and washed at 60°C for 30 min.

Fig. 4. Presents the change in the colour of phenolphthalein from carmine red for untreated textile substrate to colourless.

c ( $\beta$ -CD)			
0 (g/l)	30 (g/l)	Washed in cold water	Washed at 60°C

Change of phenolphthalein colour from carmine red (for untreated) to colourless for the fabrics treated in solution containing 30 gpl of  $\beta$ -CD, 6 gpl of BTCA, 6 gpl of SHPI; Thermofixed and rinsed in cold water and washed at 60°C for 30 min.

### Dyeing Properties

The probable reason for these observations may be explained as follows: The two components viz. cotton and polyester, present in the blend possess different characteristics individually. Cotton fibre constitute of a continuous network of cellulose chain which come together at certain places to form an ordered arrangements called crystallite or miscelle. The size of the spaces between the micelles in the water swollen fibre covers the maximum size of molecule which can penetrate into the closely packed structure of the micelles. The pore size available in cellulosic molecule is much higher compared to disperse dyes which

are usually small molecular weight compounds. Thus to and free movement of dye particle occurs without any sort of disruption from the dye liquor to the fibre and vice versa. Due to this virtually no dyeing results. However, the pore size in the fibre structure probably reduces in the presence of PEG, thereby allowing

dyeing to occur. On the other hand, the compact structure of polyester allows minimum pore size available for the penetration of dye molecule. It is well established that for polyester, penetration of disperse dyes is more prominent at higher

Table - 2 : Effect of CD's conc. on Dye exhaustion (E %) and Colour strength (K/S) of treated and untreated P/C Blends dyed with Disperse dyes

CD Conc. (gpl).	C	
	E%	K/S
0	24	2.4
10	37.8	4.2
15	44.2	4.8
20	48.2	5.0
30	52.5	5.2
35	52.1	5.2

Graph 2. Effect of CD's conc. on Dye exhaustion (E %) and Colour strength (K/S) of treated and untreated P/C Blends dyed with Disperse dyes.

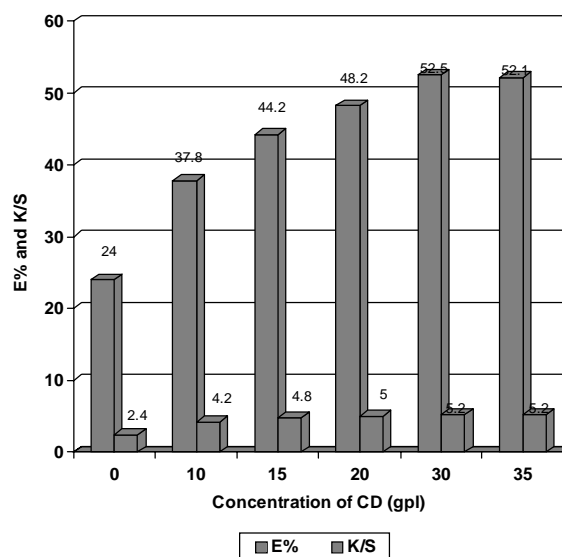
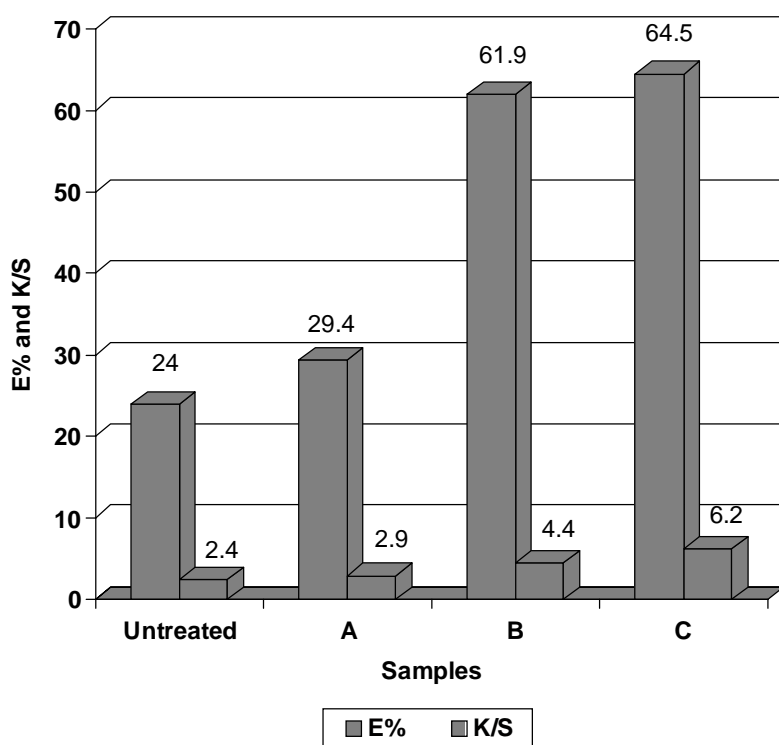


Table - 3 : Effect of Treatments on Dye exhaustion (E %) and Colour strength (K/S) of treated and untreated P/C Blends dyed with Disperse dyes

Untreated		A		B		C*	
E%	K/S	E%	K/S	E%	K/S	E%	K/S
24	2.4	29.4	2.9	61.9	4.4	64.5	6.2

\*30 gpl of CD Treatment

**Graph 3. Effect of Treatments on Dye exhaustion (E %) and Colour strength (K/S) of treated and untreated P/C Blends dyed with Disperse dyes.**



temperature due to more availability of free volume<sup>6</sup>. In the present study, the presence of PEG hinders the usual penetration of the dye molecules.

The dye exhaustion and colour strength increases by increasing the Conc., of CD up to 30 gpl then the effect gets no change due to saturation. The type of treatment also determines the dye exhaustion and colour strength that means the alkaline and PEG treatment alter the characteristics of fibre. The swelling of PET fabric is favored at steaming temperature, thus facilitating the diffusion of saturated steam inside the fabric thereby speeding the removing of oligomers, opening up and modifying the fabric structure, as well as enhancing the segmental mobility, this speeds the diffusion

of the dye in to the fabric and increases its dye uptake.

In case of P/C blend, the presence of PEG, the K/S Value is more for cotton component and less for polyester component, & it is possible that the pore size available in the cotton fibre structure reduces in the presence of PEG thereby making the cotton fibre as dyeable with disperse dyes.

The effect of such treatments on various properties like fastness, Pilling etc. has to be discussed in Part-2.

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## "INNOVATION"

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## UNITS' ACTIVITIES

### ● DELHI UNIT

#### Family Picnic

TA(I)-Delhi organized a Family Picnic of the members on 4th February 2007 at the lawns of Mr. Mahaveer Samiti Kendra adjoining Delhi University south campus. The activity started from morning till 4'O clock afternoon. Games for the children, music programme, tambola, musical chair, prize



TA(I) - Delhi Unit.



Family Picnic TA(I) - Delhi Unit.

distribution etc. were fully enjoyed. Snacks, food items were in abundance.

Nearly 150 family members including children enjoyed the get together. The President Mr. J. P. Saria speaking on the occasion observed that this event was a reunion of the members leading to a stronger ties with the association. ■

## ADVERTISERS' INDEX

CHT (India) Pvt. Ltd. .... A-7	M. K. Spindle Mfg. Pvt. Ltd. .... 262
Croda Chemicals (I) Pvt. Ltd. .... A-11	M. K. Brothers Mfrs. Pvt. Ltd. .... A-10
Dornier Machinery India Pvt. Ltd. .... A-5	Nova Transfers Pvt. Ltd. .... A-16
Hitkari Fibres Ltd. .... 276	Paramount Instruments Pvt. Ltd. .... Second Cover
Inarco Limited ..... A-2	Reliance Industries Ltd. .... Front Cover
Itema India Ltd. .... A-3, 254	Rieter India Pvt. Ltd. .... 253
Jupiter Engineering Company ..... A-6	Super Tex Industries ..... A-13
Kothari Textile Industries ..... A-12	Unitech Texmech Pvt. Ltd. .... Fourth Cover
K. U. Sodalamuthu & Co. Pvt. Ltd. .... A-15	Unity Textile Engineers Pvt. Ltd. .... A-1, A-14
Lakshmi Machine Works Ltd. .... Third Cover	Veejay Lakshmi Engineering Works Ltd. .... A-8, A-9
Lee Marketing (India) ..... A-4	World Traders Mfg. Pvt. Ltd ..... 283

# Texquest 2007



Prof. (Dr.) M. D. Teli, Head of the Dept. of Fibres and Textile Processing Technology delivering welcome speech at Texquest 2007.

Texquest 2007 was a National level paper presentation competition was held on March 10th 2007, at U.I.C.T., Mumbai. It was organized by the Students' Council of Department of Fibres and Textile Processing Technology of U.I.C.T., Mumbai.



Prof. (Dr.) M. D. Teli welcoming Mr. Ulhas Nimkar in Texquest 2007.

Near about 70 papers were received from various renowned textile institutions all over India, out of which 13 best papers were selected for presentation at Texquest 2007. The welcome speech was delivered by the honourable Head of the Department of Fibres and Textile Processing Technology of U.I.C.T., Prof. (Dr.) M. D. Teli. Texquest 2007 was inaugurated by the Panel of Honourable Judges

- Mr. Ulhas Nimkar, Texanlab
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This year the Texquest 2007 was sponsored by Amtex Dye-Chem Industries, Ahmedabad and

Supertex Sarex, Mumbai. The event was attended and appreciated by the family members of various reputed textile institutions. Industrial executives and students of various textile and fashion institutions from all over India. The first prize of amount Rs. 11,000

and Crystal trophy was bagged by Mr. S. A. Hipparagi and Mr. N. Giridhar Srinivas, Govt. SKSJT Institute, Bangalore. The second prize of amount Rs. 7,000 and Crystal trophy was bagged by Mr. Kanwaljeet Singh, IIT, Delhi. The third prize of amount Rs. 5,000 and Crystal trophy was bagged by Ms. Nida Vanoo and Ms. Bhumiika Dhandhukiya from S.N.D.T., Matunga, Mumbai. The Texquest 2007 was concluded by vote of thanks was

delivered by Chief Student Co-ordination Mr. G.V.N. Shirish Kumar, M.Tech, 1st Year, Dept. of Fibres and Textile Processing Technology, U.I.C.T., Mumbai. ■



Honourable Judges inaugurating Texquest 2007.