Bleaching of Jute

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JUTE has the largest colour variation known amongst textile fibres. Its colour varies from pale-green to golden reddish brown. The colour of jute is attributed to the water used for "retting." Jute has a fine silky lustre and is brittle.

The impetus for processing of jute was first given during second world war when novel union fabrics of jute, wool and linen were introduced into the yarn-starved market. Even today, the quantity of jute processed is very small.

Jute is basically composed of small units of celluloses (1 mm to 5 mm in length) surrounded and cemented togetner by incrusting material composing lignin and hemi-celluloses. X-ray diagram indicates that jute has the least crystalline structure and the imperfect crystal structure is attributed to disorientation of molecular segregates. The incrusting materials, composed of lignin and hemi-celluloses, are not impurities in the fibre as on them depends the physical and chemical characteristics of jute fibre. While these incrusting materials have little strength of their own, they contribute to the strength of the fibre by cementing together the ultimate cellulosic bundles. Of the chemical components of jute, lignin is supposed to be chiefly responsible for the colouration of the fibre.

Bleaching of jute is more difficult on account of its greater complexity of structure. It is likely that jute will be adversely affected by any chemical treatment which tries to remove or even attack the incrusting material, thereby loosening the cellulose units from embedding incrustants. In bleaching of jute, chemicals and conditions should, therefore, be so chosen that good white with minimum effect on cellulose and hemicellulose is achieved. Hence, in bleaching of jute, a number of milder treatments with oxidising bleaching agent are preferred to one drastic treatment. During bleaching, oxidising agents partially remove lignin and modify the remainder.

Jute is not treated with strong alkali prior to bleaching because strong alkali dissolves hemi-celluloses from jute. However, a number of milder alkali boils accomplish the removal of saponified resin with pectins and cell-wall polysaccharides. But alkali-treated jute, even after bleaching, retains a permanent yellow tinge.

Mild bleaching helps to improve the colour of poorer grades of fibres. Medium bleached jute is a better ground for dyeing. Jute, severely bleached, provides white pure lignin-free pulp for rayon and pulp manufacture. For composite fabric of jute with wool and flax, medium bleaching is given as it assists the dyeing of level shades.

Jute has a very low wet strength and hence, extreme care is needed while handling the fabric in bleaching and dyeing of jute.

The naturally present offensive smell and waxes, and the resins and mineral oil emulsions added during spinning, are removed by use of Calsolene Oil HS during bleaching or by extracting jute with benzene prior to bleaching. These processes remove the odour and facilitate good bleaching with perfect penetration. The most important bleaching agents used for bleaching of jute are

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(1) Hypochlorites, (2) Hydrogen peroxide and (3) Sodium chlorite or Textone.

(1) *Hypochlorites :—*

Since jute is composed of lignin and hemi-celluloses as well as cellulose, and since lignin is very sensitive to both oxidation and chlorination, the pH and concentration of hypochlorite bleach should be so chosen that good bleaching without undue modification of jute is attained.

Acid hypochlorite has a typical chlorinating action on lignin and hemi-celluloses to form soluble chloro compounds. Though acid hypochlorite chlorinates lignin in preference and lightens the shades, its bleaching effect is never considered satisfactory as it imparts a permanent yellowish-brown tone to the material. Moreover, washing of acid from jute is extremely difficult.

Warm alkaline hypochlorite (pH 9-10 and temp. 40°C) has a specific oxidising action on lignin. It oxidises a part of lignin and modifies the remainder to give a reasonably good white with minimum loss in weight and tensile strength. The consumption of available chlorine is minimum for alkaline solution. The bleaching liquor should be made sufficiently alkaline with soda ash and sodium silicate as the soluble reaction products of acidic nature tend to bring about a rapid change in pH range from alkaline to acid side.

Bleaching of jute with hypochlorous acid seems to take place through a series of reactions involving chlorination, demethoxylation and oxidation of lignin. The reaction products are of smal'er molecular weight and are readily soluble in sodium sulphite. The rate of bleaching with hypochlorous acid seems to depend upon the presence of phenolic groups present in lignin.

A number of treatments with milder alkaline hypochlorite solution followed by soda ash scour with intermediate drying ensures uniform and level cream-white throughout the thickness of the fibre with minimum degradation of fibre structure.

(2) *Hydrogen peroxide :—*

Hydrogen peroxide is used to bleach jute to good white with high absorption, little loss in tensile strength and elasticity, without seriously attacking or removing lignin, hemi-celluloses and cellulose. By the action of hydrogen peroxide, jute becomes cream-white even when the lignin removal is only 4.5%. This contradicts the contention of Little and Ridge that complete removal of lignin alone ensures good whiteness. To explain this observation, Das, Mitra and Wareham assume that lignin in fibre is present in two isomeric forms due to the presence of ionisable enolic groups and the colour of jute may be dependent on the amount of such coloured ionisable isomeric forms of lignin. According to them, owing to H_2O_2 bleach, most of the lignin either becomes a colourless isomer or becomes colourless by engaging these ionisable groups in forming linkages with lignin, cellulose and hemi-celluloses.

Hydrogen peroxide above 5 volume concentration attacks α cellulose content of jute. Up to 1 volume concentration of H_2O_2, α cellulose is unaffected. Above this concentration, α cellulose is not only oxidised progressively as seen by continuous rise in copper number but is also degraded to smaller chain length as shown by increased fluidity value. When jute is treated with alkaline hydrogen peroxide at 80°C, about 4% of hemi-celluloses is removed irrespective of the concentration of H_2O_2. It is, therefore, suggested that a portion of hemi-cellulose is uncombined or loosely held and

is presumably located in the most disorganised part of the fibre. Peroxide bleaching increases the dry strength of jute fibre owing to the closer setting of fibre on fibre consequent to swelling and non-pronounced removal of incrustants.

Laporte Ltd. and Weber suggest a sequence bleaching of hypochlorite and hydrogen peroxide. Hypochlorite treatment given for a short time has little effect on lignin but the action of hydrogen peroxide is believed to be accelerated due to the absorption of certain amount of chlorine by the fibre.

(3) *Textone or sodium chlorite :—*

This bleaching agent has equivalent chlorine content of 135-137% and is alkaline in aqueous solution. Its action is profound at pH 4-5.5 and at 80°C to give a pale cream-white within an hour. It has no deleterious action on cellulose and as it is employed in slightly acidic solution, neither scouring nor antichloring is necessary.

Textone also bleaches flax, rayons and wool in acidic medium to give excellent whiteness with least or no degradation of strength and weight.

Hence, for union fabrics of jute, with flax, linen, wool and rayons, sodium chlorite is an ideal bleaching agent and is recently very popular.

Bleaching of jute in union fabrics :—

(a) *Jute and linen :* Linen is bleached with acid hypochlorite and jute by slightly alkaline hypochlorite under controlled pH. Hence, for this union fabric, a sequence bleach of neutral hypochlorite and peroxide is recommended to give a good pale cream-white with minimum degradation of cellulose.

(b) *Jute and cotton :* This fabric is scoured with soda ash and bleached repeatedly with hydrogen peroxide.

(c) *Jute and rayons :* (1) *Acetate rayon and jute :* The fabric is wetted out in Calsolene Oil HS at 50-70°C and bleached with hypochlorite in open width.

(2) *Regenerated rayon and jute :* The fabric is scoured with 5% soda ash at 70°C for half an hour to have least loss in weight and weakening of the fibre and is bleached with alkaline hypochlorite (3 g/l chlorine content). This concentration of hypochlorite is usually strong for viscose but in presence of jute, the greater oxidising power of hypochlorite is rapidly consumed by non-cellulosic constituents of jute fibre. This protects the rayon.

Alternatively, the fabric is scoured with soda ash and bleached with alkaline hydrogen peroxide. The residual bleach liquor is used for scouring the next lot.

(d) *Jute and wool :* The fabric is scoured with Lissapols and soap at 45°C for 2 hours and next bleached with alkaline hydrogen peroxide to obtain cream-white.

Yellowing of bleached jute and its prevention :—

The bleaching of jute is only a temporary efficacy, for bleached jute gradually discolours again on exposure to light. The cause of discolouration, it is presumed, is bound with the phenolic groups of lignin present in the fibre, which under the action of light, tend to polymerise to form coloured quinones. The polymerisation products may be furfural polymers or furfural-phenol condensation products. The aqueous extract of exposed material is acidic in nature and consists of aldehydes of low molecular weight derived from cellulose by fission of main chains.

It is now established that lignin and a part of hemi-cellulose are responsible

for yellowing of jute. In absence of moisture, it is claimed, this photochemical action of light on jute is minimum.

To obtain permanent bleaching, free phenolic groups of lignin in jute are acetylated, methylated or benzoylated.

Methylation, done with etherial diazomethane only minimises the discolouration but does not completely prevent it. Benzoylation with benzoyl chloride in pyridine and acetylation with acetic anhydride in presence of xylene and sulphanilic acid give complete protection against yellowing. The bleaching of acetylated sample on irradiation is attributed to acetyl peroxide, a bleaching agent formed by labile acetyl groups. Acetylation, as an aid to colour inhibition, appears, therefore, to have two functions of preventig *o*-quinone formation and causing the production of acetyl peroxide, a bleaching agent, during irradiation.

Conclusion :—

Bleached, dyed and printed jute is used for rugs, carpets and tapestry owing to its softness, lustre and brightness. Severely bleached jute and butts form a valuable pure raw material for paper and rayon manufacture. Now-a-days, fancy and novel union fabrics of jute with wool, cotton and linen are becoming very popular in the market. Besides ropes, stockings and gunny bags, bleached jute is used for preparing cloth called hessain—used for tarpaulins and other superior packing material.

Jute is the least expensive fibre of all the textile fibres to grow, to prepare and to put in market to fetch high prices. It is gradually replacing costly linen in union fabrics. The uses of this least expensive golden fibre are daily increasing.

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