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Short Communication

Dirty Linen?

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Introduction

Linen used to be the most widely used textile material for apparel clothing for ages during the primordial era. Additionally, owing to its strength, durability and long lasting property, the ancient Egyptians were considered to use it even as a currency. Thus, Linen was an intrinsic and intimate component of human life and it was valued so much that cleaning of household cloths in public place probably led to the popular colloquial term of washing dirty Linen (personal matters that could be embarrassing if made public). Linen which ruled the northern hemisphere garb for thousands of years lost its importance in the last few centuries as another natural fiber "Cotton" also initially marketed as white gold gained prominence during British colonization in Asia and the advent of industrialization. Availability of vast land mass for cultivation of cotton in Indian subcontinent, claimant tropical weather conditions, cheap labor, ease of downstream processing, etc boosted popularity of cotton and it became the most popular textile substrate around the globe within a short time. Linen, which enjoyed a lion's share among the natural farm-cultivated textile substrates until the 17th century, lost its mare and reduced to hardly 1 % of total textile fiber consumption by mid 19th century. However, last few decades have witnessed revival of Linen and usage of this long and thick fiber in apparel and home furnishing segment.

Linen is best grown in cold and moist climatic conditions, the claimant weather of Western Europe is considered to produce best quality of Linen. France, Belgium, Netherlands and other neighboring countries contribute to about 80% of global Linen fiber production of about 1,500,000 MT while remaining 20 % comes mostly from Egypt, Russia and China. Though, the Linen fiber cultivation is less in China, it has the highest Linen yarn spinning capacity amounting to almost 80 % of global production. The largest consumer of Linen made textile material worldwide is considered to be the USA, followed by Europe and India. However, their consumption pattern is different. In the US and Europe about 30% of Linen is used in clothing and 70% in home furnishing, while in India almost 70% is consumed in clothing and remaining for home furnishing. India is considered to be one of the fastest growing markets for Linen and blended textile material and bout 30,000 MT was consumed last year and is believed to be growing at CAGR of about 15% in last decade. Linen's ability to absorb sweat and keep the body cool makes it a perfect fabric for India's climate.

Further, with the growing awareness about sustainability and various aspects of a textile material in terms of its environment impact, water footprint, biodegradability, long evity, etc the focus is shifting to Linen as it is one of the most eco friendly natural fibers. Cotton and Linen are both natural fibers of cellulosic origin containing hydro glucose units but there are many differences between them in terms of physical, environmental and usage performance. Apart from the use of Linen fiber in textile application, its other parts are also used as varnish for wood preservation and theOmega-3 fatty acid extract from its seeds "Linseed oil" as a nutrient for animal health. Linen has many fold advantages over cotton and other natural fibers as it

a) Gains strength when wet and strongest among all natural fibers

b) Provides natural drape due to crispy appearance

c) Retains shape, does not shrink or stretch owing to non-elastic behavior

d) Becomes soft and supple after washing

e) Requires less quantity | thread count due to longer length and high fiber thickness

f) Appears pleasant due to inherent luster and texture

g) Wrinkles easily but become smoother through handling and use

h) Absorbs up to 20% moisture before it begins to feel damp

i) Enhances wicking property owing to hollow fiber interior

j) Prevents bacterial growth making it ideal for towels, bed spreads, upholstery, curtains

k) Retains heat and cold from human body due to insulating property

l) Keeps cool in the summer and traps warmth in winter

m) Resists static electricity and avoids danger of static shock during wear

n) Alleviates arthritis and dermatitis due to hypo-allergenic power

o) Induces better sleep due to anti-stress property

p) Enhances usage comfort due to air permeability and breathability

q) Needs less water, fertilizers and insecticides during farm cultivation

r) Resists dirt and stains hence easy to wash and clean

s) Retains physical appearance due to non-pilling tendency and no lint formation

t) Enhances aesthetic appeal due to presence of slubs or small knots in the yarn

u) Resists harmful electromagnetic radiation from sunlight

Gleaning from the research articles and review material on Linen, given below is concise information on flax farming, fiber extraction, yarn preparation, mechanical operation, machinery involved, wet processing methods and the end user applications. Cultivation. Linen fiber is extracted from flax plant (Latin name linum). Plant grows about 1 meter within 100 days from sowing to harvesting. A variety of seeds are used for plant breeding based on fiber content, weather tolerance, crop protection and weed control behaviour.

Traditional harvesting is usually done by plucking off the flax plants, tying them in bundles and allowing them to rot in the field to achieve decomposing of stalk and easy separation of fiber. This process is called retting it helps remove gummy substances from the bast fibers. Retting can also be done by other methods like:

a) Pond retting-leaving the flax plant stalks in tanks of water, it takes about 2-4 weeks

b) Stream retting-plants are immersed in slow moving streams the quality of the fiber separation is better than pond retting

c) Chemical retting-involves immersion of the dried plants in a tank in acidic or alkaline solution. Though this process is comparatively economical and time saving it tends to affect color and strength of fiber if not controlled adequately.

d) Enzymatic retting-fastest and costliest process makes use of pectinolytic enzymes for loosening fibers within few hours

e) Dew retting-widely used, highly stainable but slow process, the stalks are left in the field for about 6 weeks, considered to provide best result. After retting, to remove the woody matter, the stalks "scotched" to remove woody matter by crushing them between two metal rollers. Then they are heckled and combed to separate out short fibers. The short fibers are collected for making coarser sturdy goods for upholstery usage while the remaining long and fine fibers are used for making apparel clothing. The fibers vary in length from about 25 to 150mm and 12-16 micrometers in diameter. The long fibers are then processed using a 'wet spinning' technique, while the short fibers are spun using a 'dry spinning' technique.

The long Linen fibers are put through machines called spreaders, which combine fibers of the same length and laying them parallel for creating a sliver. Then it is passed through a set of rollers to make a roving. The roving's are drawn out into thread and ultimately wound on bobbins or spools. The yarn is knitted or woven into fabric as 100 % Linen or in blends with other substrates as per the end use requirement.

Chemical composition

The stem of flax is made up of 5 layers-epidermis, cortex, bast, cambium and woody tissues. The outer layer is covered with thin layer of wax during plant growth. The cortex contains pectin and natural coloring components which impart hues varying from of grey to light brown. Linen fiber contains only about 70 % cellulose while remaining is hemi cellulose, lignin, wax and woody matter sprit. Hence, the conventional alkaline scouring and oxidative bleaching results in about 25-30% weight loss and adversely affects strength of the yarn.

Wet processing

The Linen fiber is processed in many of its forms like Rove yarn, packaged bobbins, knitted material or woven fabric depending on the substrate, machinery available and the subsequent processing steps. The pre-treatment is carried out depending on the requirement of whiteness for full white or for bright light | pastel shades, semi bleach (3/4 white) or partial bleach (1/2 white) by a multi-step scour bleach process.

Demineralization is carried out first to get rid of heavy metal ion contamination from the fiber and to help achieve improved whiteness and minimum yarn strength damage. Oxidative bleach with Sodium Chlorite is considered to give best results, however, due to eco concerns non-chlorine bleach like hydrogen peroxide

or per acetic acid is preferred. Further, it is considered that a final treatment with reductive bleaching agent helps improve whiteness. In practice it is desired to minimize and control weight loss during pretreatment process to about 10-12% from cost economy as well as yarn strength retention point. Given below is a guideline pretreatment process based on widely used industrial practice

Step 1: Demineralization- 30 minutes at 60 oC

0.5-1.0g|l	RUCOGEN WBL (non-ionic wetting agent)
2.0-2.5g|l	VEROLAN NBX (acid demineralizer)

Step 2: Scouring - 30 minutes at 95 OC

5.0 ml|l	Caustic Soda (50%)
10.0g|l	Soda ash (Na2CO3)
2.0g|l	VEROLAN NBO (sequestering |dispersing agent)

Step 3: Peroxide Bleaching: 60 minutes at 95 OC

1.0-2.0g|l	RUCOGEN WBL
1.5-2.0g|l	RUCO-STAB OKM (Peroxide Stabilizer)
10.0g|l	Soda ash (Na2CO3)
10.0ml|l	Hydrogen Peroxide (50%)

Step 4: Peroxide Bleaching: 60 minutes at 95 OC

1.0-2.0 g|l	RUCOGEN WBL
1.5-2.0 g|l	RUCO-STAB OKM
6.0 g|l	Soda ash (Na2CO3)
10.0 ml|l	Hydrogen Peroxide (50%)

Step 5: Reductive bleaching | Peroxide neutralization: 20 min at 80 OC

1.0-2.0g|l RUCORIT INPK (Reductive bleaching agent)

Step 6: Neutralization and pH control: 20 min 45 OC

1.0-2.0g|l RUCO-ACID ABS 200

Dyeing being a cellulosic fiber Linen can be dyed with a range of dyestuffs like Direct, Reactive, Sulphur and Vat. Considering the brilliancy of shade and fastness properties, Reactive and Vat dyes are most preferred. Depending on the substrate form and the machinery in use, Linen can be dyed by exhaust, semi continuous (Cold Pad Batch) and continuous (Pad-dry-Pad-steam, Pad-Dry-Cure) methods.

Considering the basic requirement of dye diffusion and uniform level dyeing, the high exhaust, high energy specialty bis-monochlorotriazine based Reactive dyes like TULACTIV XLE are most popular for exhaust application while TULACTIV C dyes for CPB and PDPS application. Linen is known for its long lasting durability, therefore for high end apparel clothing end use application it is desired that the color should also last till the fiber lasts. In this aspect Vat dyes owing to their excellent light, wash fastness properties are highly recommended. NOVATIC MD a micro disperse variety is widely used for both exhaust as well as continuous application and TULACON C a liquid variety is preferred for dyeing of light pastel shades in one step Pad-Dry-Cure process.

Summary

Based on various ecological and superior performance criteria, Linens regaining its lost position. It is used in apparel as well as various home furnishing items like bed spreads, towels, curtains, table cloth, etc, the fashion savvy young generation has realized benefits of Linen in terms of its wearing comfort in any kind of weather, varying climatic conditions, durability, sustainability as Linen is one of the most biodegradable and stylish fabrics in fashion history.

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