MODAL FIBERS

SUBMITTED TO:

Mr. Vasant Kothari

Assistant Professor- DFT

SUBMITTED BY:

Prashant Verma

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MODAL: FIBRE TO FABRIC

Vasant Kothari, Assistant Professor, Department of Fashion Technology

Prashant Verma, Master of Fashion Technology

ABSTARCT

The purpose of this article is to introduce the reader with Modal fibers; there properties, applications etc and why at all there is a need to introduce this fiber. Herein Modal acts as a second-generation viscose rayon fiber fulfilling humans' eternal quest for a fiber combining both aesthetics and utility performance.

HISTORY

To dissolve and spin the cellulose, method developed by English men[3.5] "Cross bad Bevan" became most popular and was adopted exclusively by Lenzing. During the First World War, with shortage of raw material, viscose rayon manufacturers discovered that it was possible not only to produce filament fibres but also by cutting the fibres into short staples, to create a substitute over cotton. The viscose rayon staple fibres thus continued to be recognized as substitute for cotton until the Second World War.

Considerable improvements to the fibre, which Lenzing make, boosted fibre prestige leading to its classification as a distinct species. Modal fibers' staple versions were initially developed in 1930s for industrial textiles (in tires, conveyor belts and hose pipes), and for blending with rapidly growing synthetics. Changes in viscose rayon processing such as spin conditions; chemical solutions and stretching sequences produced viscose rayon fibers with increased crystallinity and thus greater strength. Additional developments in Japan in 1951 by S. Tachikawa led to the production of Modal fiber with high wet modulus called polynosic fiber.

INTRODUCTION

Modal is a wood pulp based cellulosic fiber, made out of pure wooden chips from the beech tree, technically as the European Schneider Zelkova[3.2] tree. While viscose rayon can be obtained from the wood pulp from a number of different trees, Modal uses only beech wood, thus it is essentially a variety of viscose rayon; a generic name for modified viscose rayon fiber that has high tenacity and high wet modulus.

Modal was first developed by Austria based Lenzing AG Company who trademarked the fabrics' name, but now many manufacturers make their own versions. It was initially imported from Czech Republic, Slovakia, Hungary and Germany; but now for Indian market, it is catered to by Lenzing, Austria, which has tied up with Rajasthan Textile Mills.

What is Modal: Definition

Modal fibers are defined in International Standard ISO 206: 999 (E) as high wet modulus, high breaking strength regenerated cellulose fibers produced by using particular viscose rayon, and regeneration bath compositions which allows greater molecular orientation during stretch and coagulation of the fibers.

Again, Modal as defined by the International Bureau for Standardization of Manmade Fibres (BISFA) is a distinct viscose rayon fibre genre, which has a higher wet modulus and satisfies a minimum value of tenacity in the wet stage at 5% elongation.

MANUFACTURING PROCESS

The process of Tachikawa patent, following wet spinning, manufactures modal fiber. It is considered as bio based[3.1] rather than natural because though the raw materials used to make it are natural, they are heavily processed using a number of chemicals. The process followed for the manufacturing of Modal is similar to that of viscose rayon except slight modification in one or two steps. The basic steps followed are:

1. Steeping and Pressing

The objective of this process is to convert cellulose to its alkoxide derivative (alkcell). Here pulp is steeped in an aqueous solution of sodium hydroxide 17%, causing fibers to swell and converting cellulose to sodium cellulosate. The slurry so obtained is pressed to remove excess soda from the alkcell slurry.

2. Shredding

Alkcell here contains 30- 36% cellulose and 13- 17% soda. To assist subsequent mercerizing and xanthation reactions, alkcell slurry is opened to facilitate the penetration of oxygen and CS_2.

3. Mercerizing

HWM viscose rayon can also be mercerized, like cotton, for increased strength and luster. The reduction in DP is achieved by oxidative depolymerisation or can also be achieved by irradiative depolymerisation[1.1].

4. Xanthation

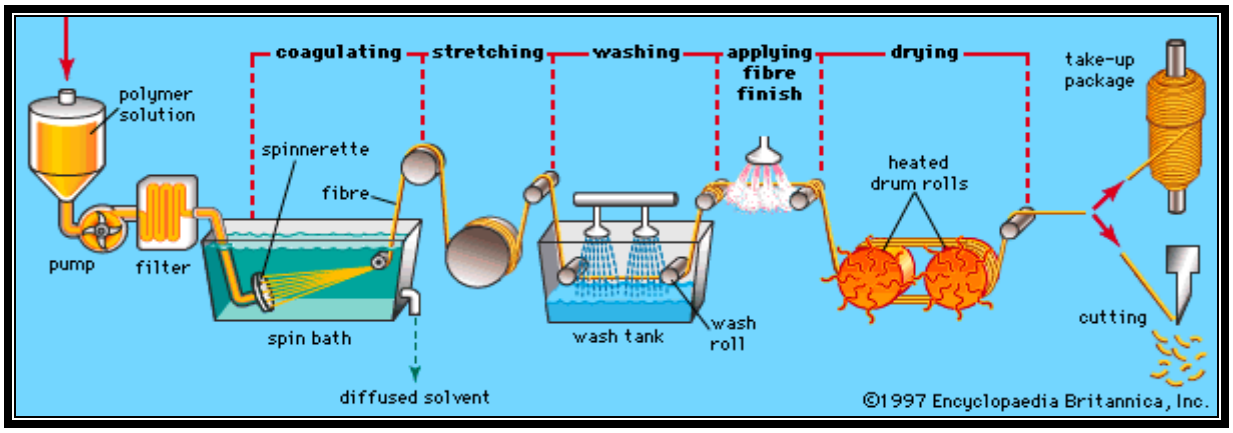
Here mercerized alkcell reacts with CS_2 vapor, under vacuum, to form sodium cellulose xanthate. To form the solution, xanthate is dissolved in dilute sodium hydroxide solution to give final composition in terms of percentage cellulose and soda in viscose rayon.

5. Filtration and Deaeration

The impurities present (substantial) must be removed prior to spinning to prevent blockage of spinneret holes. Lenzing KKF[1.4] is exclusively using automatic mechanical filters of sintered metal screens with automatic back flush. Then it is de-aerated, by applying vacuum, to remove any dispersed air forming bubbles.

6. Spinning

Very high modulus and tenacity is achieved when cellulose is spun from liquid crystalline solution[1.2]. Unlike viscose rayon, the use of zinc in the spin bath is eliminated completely, and only short period immersion in cold low acid-low salt bath is followed. Jets used to spin these fibers are fabricated from platinum/gold alloy.



: Typical layout of wet spinning process:

7. Coagulation Bath

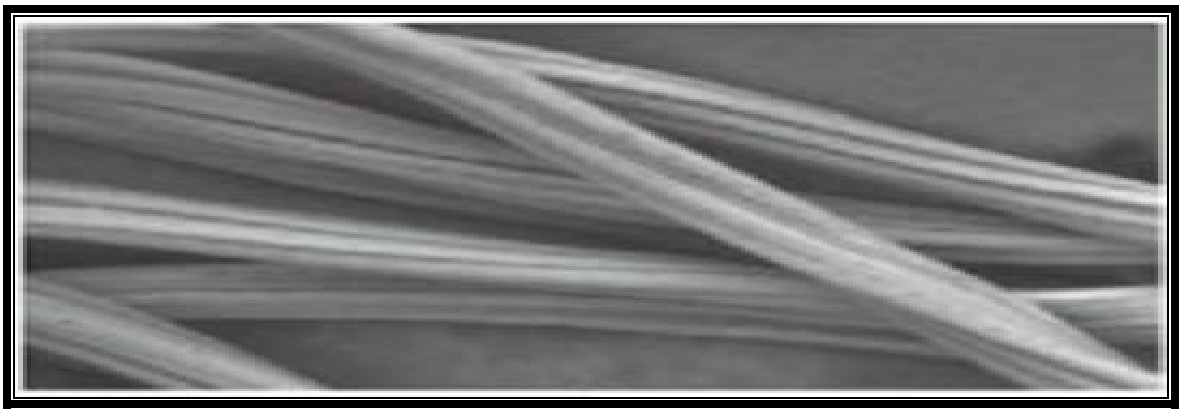
In Modal process, coagulation and stretch occur together and are followed by regeneration, leading to high wet modulus. Unlike viscose rayon, filaments in the bath are stretched 3 times their spun length before regeneration, thus forming a structure with fibrillar texture. This stretch orients the cellulose molecule to a very high degree resulting in very high dry and wet strength ratio[1,5].

8. After Treatment

Modal fabric is given a clean soft touch finish by impregnating the fabric with an acid donor; heat treating in gaseous atmosphere to activate the acid and subsequently dyeing, washing and drying it. The resulting fabric has a sheen and glossy peach touch finish

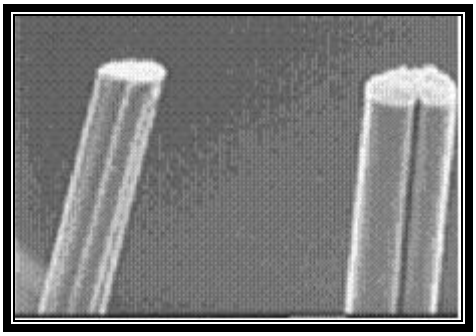
STRUCTURE

The “all skin” high tenacity yarns consist of finer and more uniform texture. When coagulation and stretch occur together, before regeneration and crystallization of cellulose, structure has a fibrillar texture[1,3]. The Cross section is either circular or bean shaped.

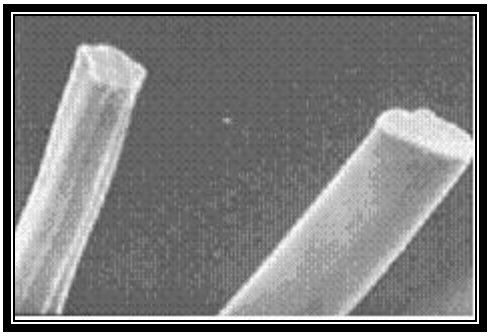


: Microscopic view of Modal Fibers:

The cross section analysis of both Modal and Viscose rayon fibers are analyzed[3.3] and are shown in figure below:



: Regular Viscose rayon:



: Modal Fiber:

PROPERTIES AND COMPARISON

In brief, Modal posses lower elongation and higher wet modulus as it has high rate of polymerization. Its exceptional similarity to cotton/silk in terms of texture (luster, sheen and gloss) results in a surface smoother than mercerized cotton.

A typical comparison of properties of High wet modulus viscose rayon with commonly used convectional fibers is as follows:

PROPERTIES	HIGH-WET MODULUS	COMMONLY USED			
	Modal	Viscose rayon	Cotton	Polyester	Wool
Density (g/cm^3)	1.53	1.51	1.55	1.39	1.31
Moisture Regain (%)	11.8%	12.5%	8.5%	0.4%	13.5%
Tenacity (GPD)	2.2-4.0 **dry**	1.2-3.0	3.0-5.0	3.0-5.8	0.8-2.0
	3.8-5.0 **wet**	0.5-0.8	4.0	2.4-3.0	1.0
Bkng Elongation (%)	7.0% **dry**	15-30%	3-10%	19-55%	20-40%
	8.5% **wet**	30%	10%	47%	31%

Work of rupture (mN/tex)	11.5	25	20-23	-	-
Initial Modulus (mN/tex)	13300	8850	5450	8830-10150	4300

As for 1.3 dtex Modal fiber, given by Ford and Courtaulds[1.6/2].

ADVANTAGES

In many ways Modal acts like cotton, but it also have some significant advantages over cotton.

Modal: Functional Utility

1. Modal displays high dimensional stability, both for low shrinkage and low unrecoverable extension. It blends beautifully with almost all textile fibres, viz. Cotton, wool, silk synthetics, elastene.

2. It is more hygroscopic in nature i.e. absorbs 50% more water than cotton[3.4], and as strong as polyester[3.2] with excellent wear resistance.

Modal: Aesthetically Appealing

1. Garments made from Modal fabrics can benefit by acquiring a desirable clean, soft touch finish on the surface of finish. Its smoothness makes hard water deposits less likely to adhere to the surface (say lime from hard water), so the fabric stays soft through repeated washings.

2. Unlike cotton, Modal fabrics show more resistance to shrinkage, has good moisture regain and air permissibility, thus considered best for exercising clothing and health suit.

3. Reduced growth of bacteria when compared to cotton, if both stored for the same long period of time; and doesn't age like cotton.

4. Modal has an advantage that it is less likely to fade or to form pills as a result of friction.

5. Modal achieves rich colors, and also retains its appearance after several washes[3.3] as shown in figure below; also they maintain anti crease properties (in blends) and have relatively easy care.

MODAL: After 25 washes

COTTON: After 25 washes

Modal Replacing Cotton: Case Study

1. University of Utrecht in Netherlands carried out a life cycle analysis of Modal fibers i.e. evaluated all of the environmental impacts caused by making fibers. The topics examined were over fertilization, the excess acidity of air, water and soil consumption, global warming and the effects on human health. Another important point was the consumption of non-renewable resources, as in the case, is raw material wood. Utrecht came to conclusion that with Modal, the toxic load on fresh water and soil is 100 times less as compared to cotton.

2. The yield of Modal is up to 6 times higher; and for their cultivation, needs 10-20 times less water in contrast to cotton.

3. Since Modal uses beech wood i.e. sustainably grown forest plantations, thus the land could not have been used for any other purpose. Cotton on other hand requires agricultural land.

APPLICATIONS

Today Modal is widely used in clothing as a replacement for cotton, with an annual production of more than 4000 tons with Indian textile industries. Modal may be used on its own or in a blend with cotton, wool and other synthetic fibers viz. spandex etc.

1. It is very soft and thus is popular for both clothing and house hold textiles.

2. Used for tablecloths and bed linen (beddings), bathrobes, upholstery and in home furnishings. Also used as outerwear, sportswear and leisurewear.

: Used as Leisure Wear:

: Comfortable Sportswear:

3. Also find applications in undergarments and toweling purposes.

4. Lenzing Modal is used exclusively for soft flowing tops and lingerie; exclusively in knitwear markets having high-end apparel/non apparel products.

5. For socks and stockings, as well as in technical applications, such as tire cord, abrasive ground fabric, rubber cloths and other coating supports

LIMITATIONS

1. 100% Modal requires ironing, and has tendency to pile due to long fibers.

2. Modal is more expensive than viscose rayon and cotton.

3. Processing the beech wood into a cellulose fiber is a man made process which uses more energy than processing natural fibers.

CONCLUSION

Thus it is cleared that Modal fiber is replacing the cotton from its current dominant market. Its' eco-friendly, 100% biodegradable characteristics has made it accepted globally within a short period of time.

REFERENCE

1. **Reference 1:** Regenerated Cellulose Fiber- Calvin Wooding**:**

   Ref 1.1 P45

   Ref 1.2 P220

   Ref 1.3 P206, 219 (Hearles')

   Ref 1.4 P49

   Ref 1.5 P248-250

   Ref 1.6 P209-211

2. **Reference 2:** Handbook of textile fiber- Gordon Cook

3. **Reference 3:** Online source**:**

   Web 3.1 http://resources.alibaba.com/topic/44914/Modern_Fibres_1_MODAL.htm

   (Source: Yarn trade journal: article by A.G.Chettiar)

   Web 3.2 http://www.holistic-interior-designs.com/modal-fabric.html

   Web 3.3 http://www.modal.at/index.php?id=14&L=1

   Web 3.4 http://en.wikipedia.org/wiki/Modal_(textile)

   Web 3.5 http://www.reliancespinning.com/PRODUCT/MODAL/modal.htm