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AN INVESTIGATION INTO THE PROPERTIES OF KNITTED FABRICS MADE FROM VISCOSE MICROFIBERS

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ABSTRACT

The purpose of this study is to compare the properties of the knitted fabrics made out of micro denier(< 1 denier) and normal denier(> 1 denier) viscose yarns and to investigate the physical, mechanical, comfort properties of such fabrics to explore the use of microfibers to achieve enhanced levels of comfort for apparel use.

Viscose microdenier fibers and normal-denier fibers were procured from Grasim Industries, India. Ring yarns were spun according to specifications given below and single jerseys knitted fabrics of identical parameters were produced from normal and microdenier fibers.

Microfiber fabrics show excellent drapeability. The moisture transmission properties like wicking and water absorbency show better results than viscose normal denier fabrics. The microfiber knitted fabric is dimensionally more stable when compared to that of normal denier knitted fabric because of less loop shape deformation and characterized by better stitch density and tightness factor.

Keywords: Viscose fiber, Microdenier, Wicking, Scanning Electron Microscopy

1. Introduction

Development and innovation of various man-made fibers has found an end use in different applications for textiles, industrial, medical, geotextiles and even contributing to the space technology. Synthetic fiber, especially microfiber development, has made a big way for sophisticated textiles and apparel, medical and allied applications.

During the last few years, major fiber producers have gone for more value added products with improved properties. In recent years, there has been a trend towards

finer filaments, as fineness of fiber is very important in determining the aesthetic properties of fabric. Microfibers are defined as fibers whose denier is less than one. Microfibers were first mainly used for artificial leather in the 1970s and various sorts of microfiber have since been developed and used for variety of purposes. Microfibers have found their way into varied applications conceivable as their novel properties offer huge potential in terms of both function and aesthetics.

Microdenier fibers have excellent flexibility and yarns with better regularity and elongation contribute for perfect knittability ensuring knitted fabrics with better softness, drape, dimensional stability and wicking than normal denier fiber knitted fabrics thus ensuring excellent mechanical and comfort properties. The hairiness of the microfiber yarns are very low and this in turn creates a low lint shedding propensity and it will generate lesser fly during knitting. These two aspects of lint shedding and fiber fly are very crucial for the improved efficiency of the knitting machine.

The influences of physical properties of microdenier fiber and processing parameters for the production spun yarns have been carefully studied. Also the nature of interaction between fiber and machine elements at different stages of spinning has been highlighted and careful selection of machinery for the processing of microfiber is insisted with a view to achieve better quality of yarns (R.Chattopadhyay,1997). The developments of microfibers have led to their application in various fields that includes apparel, medical and some of industrial products. However the author expresses deep concern over the high cost, lack of experimentation, less research in the field of new machinery and want of expertise to handle these new fibers may hinder its growth. Today fashion no longer concerns polyester or polyamide but microfiber or microfiber reinforced woven or knitted fabrics. (Jurg Rupp, Akira Yonenaga, 2000). Properties of microfiber fabrics produced from various bi-component spinning systems have been analyzed and the merits and demerits of the properties have been explained. (Taro Murata, 1993). Microfibers can be spun into very fine yarns on modern OE Rotor spinning machines and with rotors of appropriately small dimensions at high speeds. (Gert Bock, 1993). “Micrell” polyester microfibers are so fine that it enables fabrics to be produced with silky handle, good comfort, and better drape and wear resistance (Lesina V1992).

Comfort properties of polyester microfiber fabric are much better in terms of wicking when compared with polyester micro/cotton blends and pure polyester non-micro fiber fabrics. (Anjali Karolia, 2005). Better wicking is found in samples having greater proportion of polypropylene and they also dry fast. Maximum water vapor permeability and air permeability is seen on fabrics having polypropylene on both faces of fabrics (BK. Behara, MP Mani et’al, 2002).

2. Methodology

Material

Microfibers of 0.8 d * 38 mm specification and normal fiber of 1.2 d * 38 mm kindly supplied by Grasim Industries India, Gwalior India were used.

Sample preparation

Both Micro and normal yarn were spun on a conventional ring frame to 25s Ne. The yarn was knitted to form single jersey knitted fabrics of identical parameters using a circular knitting machine of gauge 24 (details given below) and dyed. Fibers, yarns and fabrics were tested for physical, mechanical and comfort properties according to specifications in Table I.

Knitting Machine Details:
Machine Type: Circular Weft Knitting Machine
Type of Fabric: Single Jersey
Machine Name: BMW
Machine Speed: 28 rpm
Gauge: 24
Cylinder Diameter: 14 inches
No. of Feeders: 18
Total no. of feeders: 1080
Needle type: Groz-Beckert
Texture: 20

The Yarn and fabric was tested according to standard test procedures:

Table I-Standards of test methods for yarn and fabrics.

S.No	***Test***	***Standard***
1	Yarn Evenness	ASTM-D-1425
2	Yarn Hairiness	ASTM-D-5647
3	Yarn Tensile	ASTM-D-2256
4.	CPI, WPI, Stitch Density	IS: 1963: 1982
5	Dimensional Changes	IS: 1963: 1981
6.	Fabric Drape	BS 8357
7.	Spirality	AATCC: 179: 2004
8.	Bursting Strength	BS 4768
9.	Wicking	In House Test Method
10.	Water Drop Test	AATCC: 79: 2000

Wicking:

Wicking was done by in-house test method as under:

The water transport rate is measured according to a vertical strip wicking test. One end of a strip (25mm wide X 170 mm long) was clamped vertically with the dangling end immersed to about 3 mm in distilled water at 21˚C. The time in seconds required for water to reach a height of 5 cm, at an interval of 1 cm along the strip is measured and noted. Higher wicking time indicated poorer water transportability.

Scanning Electron Microscopy:

A Jeol [Japan Electron Optics Limited] 1989 Model scanning electron microscope was used to investigate the surface structure of the fabric knitted from microfiber vis-à-vis normal denier fiber. Samples were sputter coated with gold and investigated at a magnification level of 100x.

3. Results and Discussions

The yarn test results summarized in Table II indicate the superiority of microfiber yarn in terms of the Tenacity (RKM), Evenness (Um%), Imperfections, and Hairiness.

Table II-Comparison of yarn test results

Particulars	Micro Denier	Normal Denier
TENACITY	19.25 (6.3)	14.11 (10.2)
ELONGATION	12.59 (7.2)	12.29 (10.1)
Um%	7.85	13.11
THIN PLACES (-50%)	2/km	15/km
THICK PLACES (+50%)	18/km	252/km
NEPS (+200%)	20/km	522/km
HAIRNINESS S3 VALUE	357	1101

(Figures in brackets indicate coefficient of variation)

Overall CV Values of tenacity and U% are better for microfiber yarns when compared to normal denier fiber yarn. This is a result of more uniformity of the yarn due to higher number of fibers in the cross section. This improved values of CV% of tenacity and uniformity makes microdenier yarns suitable for weaving and knitting.

The evenness of the microfiber yarns showed a significant improvement over the normal fiber yarns. The microfibers with their lesser diameter and more flexibility have enabled them to be retained in coherent structure and result in lesser hairiness.

Lower production speeds for processing of microfibers, as generally followed in industry has also contributed to significant reduction in the imperfections, thick places and number of neps in microfiber yarns, thus contributing to overall better quality of fabrics.

Fabric Test Results:

Summary of physical and mechanical properties.

Table III-Dimensional stability

Fabric	Count	Courses Per Cm	Wales per cm	Stitch Density per cm^2	Stitch length mm	Kc	Kw	Ks= Kc*Kw	Tightness factor	Loop Shape Factor
Micro-Denier	23.62	17.32	11.02	190.86	0.266	4.62	2.93	13.54	18.27	1.58
Normal-Denier	24.6	15.75	11.02	173.5	0.274	4.32	3.02	13.05	17.75	1.43

From Table III, the stitch density and tightness factor values are better for microdenier viscose fabrics than normal-denier viscose fabrics, which due to basic fiber fineness. The better tightness factor values for microdenier fabrics gives better handle, drape, durability and strength.

Drape

Table IV-Drape

FABRIC TYPE	WD gm	WS gm	WD gm	DRAPE COEFFICIENT
Micro Denier	4.218	1.974	1.405	0.2023
Normal Denier	4.219	2.010	1.405	0.2150

Table IV indicates the values of drape for micro and normal denier fabrics. It was found that viscose microdenier knitted fabrics has better drape-co efficient than normal denier viscose knitted fabrics, which is due to the basic fiber fineness and the resultant lower bending rigidity of microfibers. The better drape found in microdenier can also be correlated with higher tightness factor.

Spirality

Table V-Spirality

Fabric	Spirality angle (Degrees)
Micro Denier	2
Normal Denier	8

The Spirality values noted in table V gives better values for microdenier fabrics than normal denier fabrics which may be due to basic fiber fineness and lower twist multiplier values compared to microdenier yarns during spinning. This lower and acceptable level of Spirality in microdenier fabrics reduces the percentage rejection due to that defect.

Bursting Strength

Table VI-Bursting Strength

Parameters	Micro Denier lb/sq.in	Normal Denier lb/sq.in
Mean	6.80	5.60
Standard Deviation	0.16	0.14

Table VI gives values of bursting strength for viscose normal denier and microdenier knitted fabrics. Microdenier fabrics have comparatively higher bursting strength than normal denier. This may be due to the fact that more number of fibers can be accommodated in the yarn cross section for the same yarn diameter in case of microdenier yarns there by increasing the basic tenacity of yarn and also partly due to higher stitch density and tightness factor values in microdenier fabrics.

Wicking

Table VII-Wick Test

Wale wise. (Time in Seconds)

Height in cm	1	2	3	4	5	6	7	8	9	10
Normal Denier	2	6	11	22	54	107	155	252	384	590
Micro Denier	1	4	9	20	35	62	105	185	273	391

Course wise. (Time in Seconds)

Height in cm	1	2	3	4	5	6	7	8	9	10
Normal Denier	2	8	20	48	78	155	213	282	401	556
Micro Denier	1	4	12	25	53	112	184	257	360	481

From Table VII, it can be inferred that wicking values which are better for microdenier fabrics due to better packing coefficient of microdenier spun yarns than that of corresponding normal denier yarns. It is therefore expected that average capillary size would be less in microdenier spun yarns. Low capillary diameter is expected to increase capillary pressure and drive water faster into the capillaries of yarn. This has resulted in higher wicking height in micro-denier yarns than normal denier yarns at any given time.

Water Drop Test

Table VIII-Water Drop Test

PARTICULARS	Micro Denier	Normal Denier
Height of burette tip – 10cm	15 s	21.3 s

From table No VIII it can be inferred that drops of water on microdenier fabrics, spread quickly than fabrics of normal denier yarns, which is due to higher surface area of microdenier fibers.

Scanning electron micrographs [Fig 1,2] clearly indicates finer and lesser number of loops for the microfiber knitted fabric. The surface thus develops a smoother look though the same moisture absorption capacity is retained.

SEM

Fig.1 Loop formation for Normal fibers on knitted surface

Fig. 2 Loop formation for Microfibers on knitted surface

The overall surface as characterized by Figs 3,4 which show the uniform surface of the microfiber knitted fabric.

Fig. 3 Surface of Normal fibers knitted fabrics.

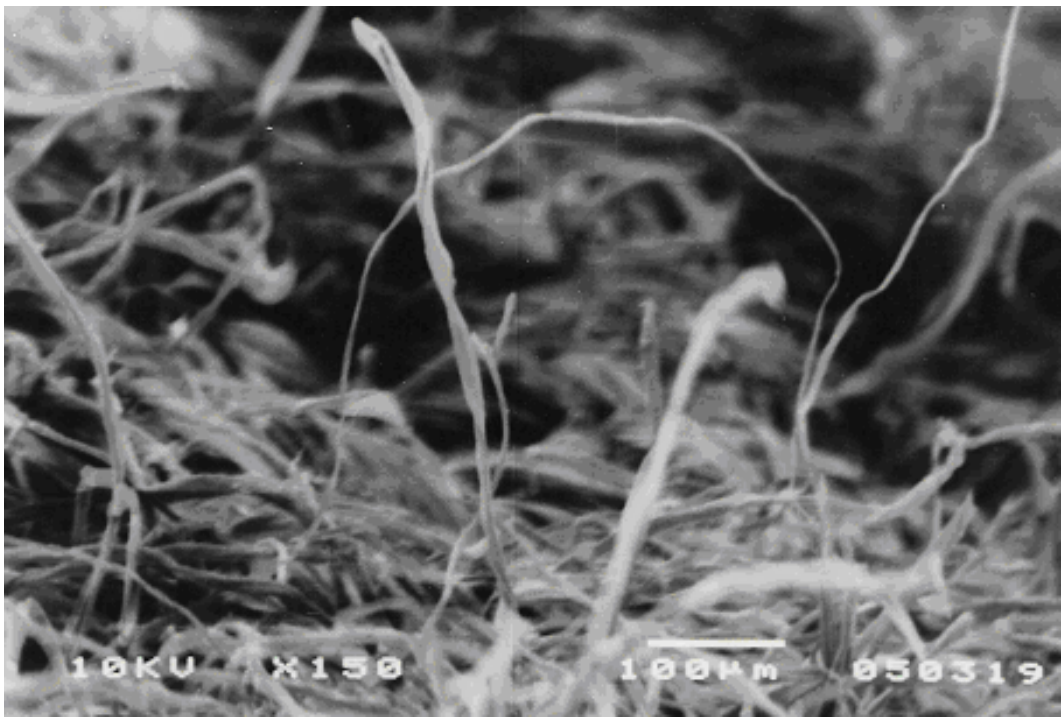
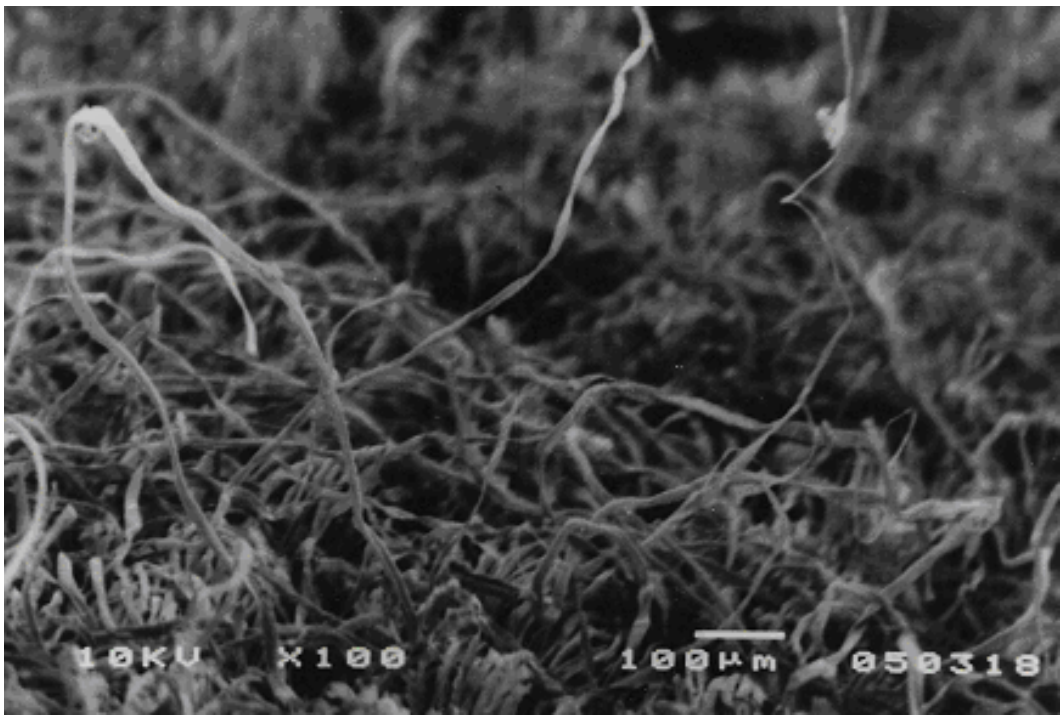


Fig. 4 Surface of Microfiber knitted Material



Scanning electron micrographs (Fig 1.2) clearly indicates finer and lesser number of loops for the microfiber knitted fabric compared to that of the normal denier fiber. The finer denier microfiber being more pliable in nature gets better incorporated in the yarn resulting in a neat surface appearance. The surface thus develops a smoother look though the same moisture absorption capacity is retained. The overall surface as characterized by (Fig 3,4) shows the uniform surface of the microfiber knitted fabric. The surface viewed from a different angle which gave a glimpse of the overall surface appearance of the three knitted structures under consideration. The lesser number of loops resulted in a more coherent structure of the microfiber knitted structure. The thicker protrusions of the normal knitted structure impart an overall rougher appearance.

4. Conclusions

Microdenier fabrics have shown superior properties when compared to normal denier fabrics in various aspects of physical, mechanical and comfort properties.. The microfiber fabrics are characterized by high drapeability, acceptable Spirality, excellent moisture transmission properties such as, wicking rate, and water absorbency. The microfiber knitted fabric is dimensionally more stable when compared to that of normal denier knitted fabric because of less loop shape deformation and characterized by better stitch density and tightness factor. The superior properties of microfiber fabric can be conveniently utilized to explore and optimize new products for apparel and sports wear.

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