HAND BEHAVIOUR OF POLYESTER MULTIFILAMENT WOVEN FABRICS

by

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CERTIFICATE

1. I am satisfied that the thesis presented by Mukesh Kumar Singh is worthy of consideration for the award of the degree of Doctor of Philosophy and is a record of the original bonafide research work carried out by him under my guidance and supervision and that the results contained in it have not been submitted in part or full to any other University or Institute for award of any degree/ diploma.

2. I certify that Mukesh Kumar Singh has pursued the prescribed course of research.

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ABSTRACT

The alacrity desire of comfortable fabrics has become steering of present competitive global market. The suppressing availability of natural fibres for gigantic population of the world has compelled the manufacturers to adapt the engineered and architected man-made fibres and fortunately polyethylene terephthalate (PET) is readily available to fulfill the demand of future. A dramatic shift in apparel goods have registered from durability to functional and aesthetic aspects and increasing purchase power and awareness of customer fueled it up. The rapid change in fashion trends and market demand have compelled the fabric manufacturer to follow the engineered product design right from fibre manufacturing stage rather than relying upon experienced cloth manufacturing with conventional fibre design.

The concept of high quality apparel fabrics to achieve desired level appearance, handle and wearing comfort was finalized under pioneer chairmanship of S Kawabata after set up of Hand Evaluation Standardization Committee (HESC). The establishment of any objective and scientific method for fabric evaluation has been a challenging task. Eventually, Kawabata Evaluation System for fabric (KES-FB) has been accepted as an objective method of evaluating fabric mechanical comfort.

The present research effort addresses to extract out maximum mechanical and transmission comfort from world's most promising fibre PET. Therefore, the first step was centered to know the position of PET fibre among its other natural and synthetic counterparts from fabric hand point of view. In order to achieve this target, different apparel grade fibres and its common blends have been considered for comparative hand study. The results and literature indicate that PET continuous filament fabrics are not satisfactory on hand and comfort scale

and these consequences derived to make some extra efforts on PET continuous filaments to make it closer and somewhat better than natural fibre based fabrics.

In next step of this research, different filament configured yarns were explored and applied in different commercially accepted combinations to extract out the best yarn configuration combination from hand point of view. Intermingled, textured, flat and twisted yarn configurations were used to produce different fabric samples. Intermingled warp with textured weft and twisted warp with twisted weft combinations were found most suitable for winter and summer applications respectively.

The higher residual extensibility of wool fibre has guided to develop different residual extensibility PET yarns to understand the influence of residual extensibility on fabric hand. In this context, five PET multifilament yarns having residual extensibility from higher to lower side with constant yarn configuration i.e 50/36/0 were produced on state of the art melt extruding system. The results inferred that 19% residual extensibility is best suitable to produce PET fabrics for higher hand value for ladies thin dress materials.

The fineness of silk filament and glory of silk fabrics motivated to study the influence of filament fineness in both flat and textured form on fabric hand. Micro to heavy denier filaments have been included (0.6, 0.7, 0.9, 1.0, 1.1, 1.4, 2.1, 4.3 denier per filament) for this study to understand the influence of denier per filament (DPF) on fabric hand. Natural fibres vary in their linear density and posses some very impressive hand and comfort aspects leads to incorporate a mix DPF yarn consisting 2,3 and 4 denier filaments in a common multifilament yarn. Results indicated that fine mix denier yarn is able to produce fabrics of improved hand.

The colouration of PET fibre, yarn and fabric is tricky and crucial and generally performed under high temperature high pressure conditions. Colouration of PET fibre was performed at various stages of manufacturing like at mass colouration at fibre forming stage, high temperature high pressure (HTHP) dyeing at fibre stage and carrier and HTHP dyeing at fabric stage. Fibres remain at different stresses in fibre, yarn and fabric form. Consequently, the influence of dyeing stages on low stress mechanical properties and fabric hand were studied in this part of research. Results of this study indicate that the presence of carrier in polyester dyeing plays a decisive role by decreasing its bending rigidity. The carriers are more prone to facilitate the penetration of dye and other particles into fibre interior. The treated PET fabric sample in presence of carrier in carrier dyeing conditions shows THV of 3.97 for winter application on 0-5 scale.

Cross-sectional shapes of fibres are an important parameter which governs many functional as well as aesthetic properties of the apparel goods. Bending behaviour of fibres, yarns and fabrics is prime contributor of mechanical comfort as well as aesthetic appeal. The bending rigidity is the multiplication of modulus and moment of inertia.

Bending rigidity of different cross-sectional shapes calculated theoretically and compared with experimental data. Statistical analysis found a good correlation between theoretical and experimental bending rigidity. This study infers that the engineering of a fibre of desired bending stiffness is possible.

Different cross-sectional shapes like circular, trilobal, octagonal, sea-island, split-micro, Y-shape or TBL plus, Square, rectangular, I-shape or dumble shape, plus-shape, hexalobal and multilobal were included in this part of research. The fabric samples of comparable areal densities were developed from yarns of common specification with varying cross-sectional

shapes of individual filaments. These fabric samples were tested for different comfort aspects e.g. total hand value (THV), air permeability, wickability, moisture vapour transmission rate and thermal behaviour. The shape factor for different cross-sectional shapes was emerged out as powerful engineering parameter. Generally, higher shape factor has posed higher wickability and lower moisture and air permeability. This study infers that the textured configuration of novel cross-sectional shapes is able to produce improved comfort.

The fabric hand has considered seventeen different attributes; consequently, shape factor influences different primary hand expressions in different ways. Study concludes that engineering of PET fibre structure can be made to produce fabrics of desired mechanical and thermal comfort.

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