Assessment of Structural Behavior of Thermocool and Polyester Yarns

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Abstract-Polyester fiber has taken the foremost position in textile all over the world. This material that has many uses like strength, light weight, resistance to shrinking, stretching, mildew, creasing and ultraviolet radiations but comes few drawbacks also that are causes wearer to get overheated and sweaty, gives the wearer a rather cheap and scruffy look, does not feel very nice on the skin & hydrophobic in nature. These drawbacks have been overcome by a new fibre named Thermocool which has introduced three developments using its thermo regulating, moisture-wicking Thermo°Cool™ technology. In this view, the purpose of this study is to understand the morphology of both the fibres using XRD, FTIR & DCS test. The result showed no difference in XRD but difference was clearly seen in FTIR & DSC test.

Index Terms-Polyester, Thermocool, X-ray diffraction, Fourier Transform Infrared Spectroscopy, Differential Scanning Calorimetry

1 INTRODUCTION

THE great appeals of textile lies in their comfort properties which are enhanced while create a fabric. The comfort properties of material depend upon the characteristic of the material, the way in which fibers are arranged and finishing techniques applied. Nowadays, people prefer the comfort properties of fabric over appearance. Among synthetic fibers, polyester fiber has taken the foremost position in textile all over the world, while synthetic clothing in general is perceived by many as having a less natural feel compared to fabrics woven from natural fibers.Polyester is the material that has many uses, but it also comes with quite a few drawbacks. Polyester fibre has some advantages like strength, light weight, resistance to shrinking, stretching, mildew, creasing and ultraviolet radiations. As far as polyester clothing goes, it gives the wearer a rather cheap and scruffy look. Polyester also does not allow air to travel through it very well, and this causes wearer to get overheated and sweaty. It does not feel very nice on the skin & also hydrophobic in nature. The orientation of polyester fiber shows higher percentage of

crystallinity which requires higher temperature for dyeing. But higher temperature leads to fabric degradation most of the times. So it is important to improve the structure of polyester by some surface modification which can have an improved effect on hand, thermal properties, permeability and hydrophilicity.

Therefore, a surface modification has been done by the Netherlands-based polyester fibre manufacturer Advansa which has introduced three developments using its thermo regulating, moisture-wicking Thermo°Cool™ technology **[Textile news 2010].**Thermo°Cool fibre have following benefits are evaporative cooling, knows when to keeps things cool and comfortable, thermo buffering, protects the user from temperature changes, comfortable, fabrics are fast-drying, breathable, and moisture wicking , renewable and biodegradable - Eco-friendly options are fabricated from corn, a renewable resource that is 100% biodegradable, plus all Thermo°Cool fibers are made from recycled polymers.

In few researches has done the modification to to overcome some drawbacks such as low moisture regain, static electricity and soiling problems, this three drawbacks are interrelated and associated with hydrophobicity of the polyester. **[Prince 2009].** Another research has been carried on surface modification of polyester fabric which states that Hydrolysis of polyester fabrics with sodium hydroxide has been studied with a view to imparting hydrophilicity and other comfort-related properties to polyester textiles. **[Dave et al 2003].**

2 MATERIAL & METHODS

Yarns selected for the study were 100% polyester and 100% thermocool yarns.

2.1 XRD (X-ray Diffraction)

X-ray diffraction is an analytical technique looking at X-ray scattering from crystalline materials. % crystallinity of thermocool and polyester was calculated using this technique. Each material produces a unique X-ray "fingerprint" of X-ray intensity versus scattering angle that is characteristic of its crystalline atomic structure. Qualitative analysis is possible by comparing the XRD pattern of an unknown material to a library of known patterns. **[Kyawthetlatt 2014].**

2.2 FTIR (Fourier transform infrared spectroscopy)

Fourier transform infrared spectroscopy was performed to determine the functional groups present in both the yarns. IR radiation is passed through a sample. Some of the infrared radiation is absorbed by the sample and some of it is passed through (transmitted). The resulting spectrum represents the molecular absorption and transmission, creating molecular fingerprint of the sample. An infrared spectrum represents a fingerprint of a sample with absorption peaks which correspond to the frequencies of vibrations between the bonds of the atoms making up the material.

2.3 DSC (Differential scanning calorimetry)

Differential scanning calorimetry is a technique which is part of a group of techniques called Thermal Analysis (TA) used to determine the thermal behavior of both the yarns. Thermal Analysis is based upon the detection of changes in the heat content (enthalpy) or the specific heat of a sample with temperature the specific heat of a material changes slowly with temperature in a particular physical state, but alters discontinuously at a change of state. Such enthalpy changes may be detected by thermal analysis and related to the processes occurring in the sample.

3 RESULTS AND DISCUSSION

3.1 X-ray Diffraction

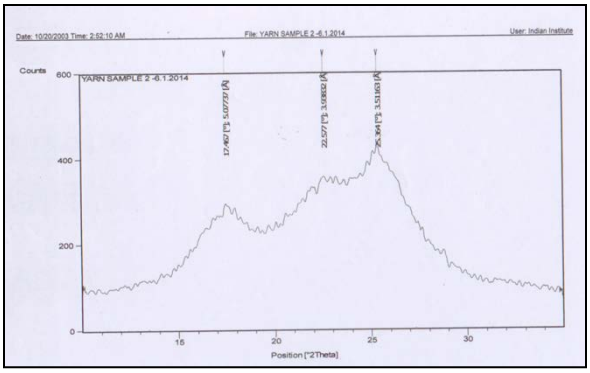

Figure.1 XRD Thermocool

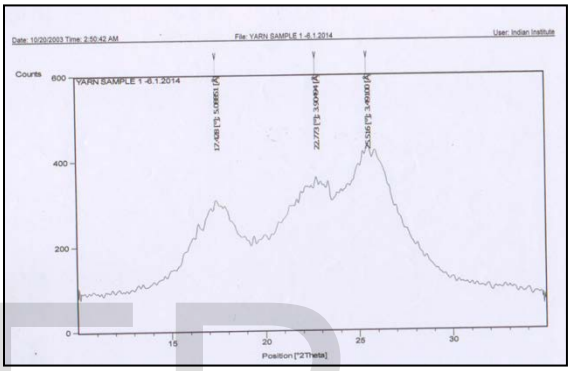

Figure.2 XRD Polyester

After separation, total area of diffracted pattern is divided into crystalline component (Ac) amorphous component (Aa) of thermocool fiber.

As per the results of thermocool,

Ac = 66889

Aa =83609

% of crytallinity (Xc%) was measured as ratio of crystalline area to total area.

%Xc = Ac/(Aa+Ac) x100

= **44%.**

As per the results of polyester fiber,

Ac = 66500

Aa = 85211

% of crytallinity Xc% was measured as ratio of crystalline area to total area.

%Xc = Ac/(Aa+Ac) x100

= 44%

According to the calculation the % of crystallinity of thermocool and polyester yarns was 44%. This result shown in Figure 3.1 and 3.2, a thermocool and polyester yarn which has been used in the study has no difference in their % of crystalline and amorphous.

3.2 Fourier Transform Infrared Spectroscopy

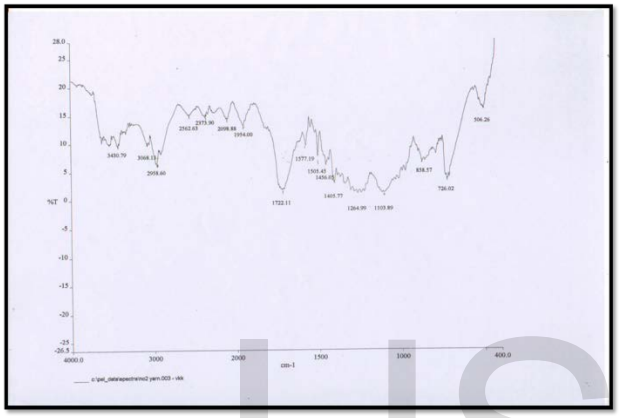

Figure.3 FTIR Thermocool

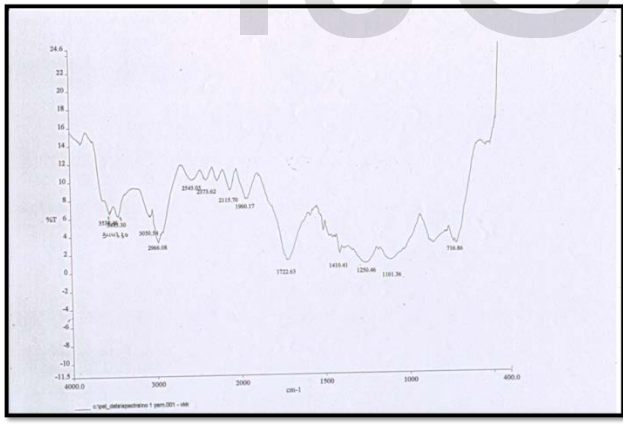

Figure.4 FTIR Polyester

From the above result, polyester in this study has shown the presence 2° alcohol at 1101.36 cm-1, presence of aromatic chain at 1250.45 cm-1, presence of C-H venyle at 1401.41 cm-1, presence of C=O group at 1722.63 cm-1, also C-H stretch alkane at 2966.08 cm-1 and lastly the presence of O-H stretch (alcohol, broad and strong band) from 3500-3200 cm-1 which completely makes it a PET.

Where as if the peaks of ftir spectra of thermocool yarn are considered, it showed the similar results like polyester with little shifted peaks which may be due to the modification done by the manufacturer. The result is as follows, peak at 1103.89 cm-1 which is due the presence of 2° alocohol, peak at 1405.77 cm-1 due the presence of C-H vinyle in plane bend, the aromatic chain can be identified at 1505.45 cm-1 and 1577.19 cm-1, the presence of C=O at 1722.11 cm-1, C-H stretch alkane at 2958.60 cm-1and presence of OH stretch (alcohol, broad and strong band) from 3500-3200 cm-1. There is an additional peak which is stated as "typical band of amorphous PET" and makes this thermocool fiber slightly different from the polyester which shows a peak at 1458 cm-1 which indicates of CH2 bending.

3.3 Differential Scanning Calorimetry

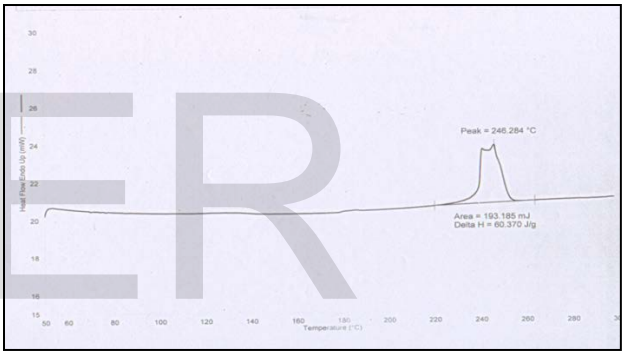

Figure.5 DSC Thermocool

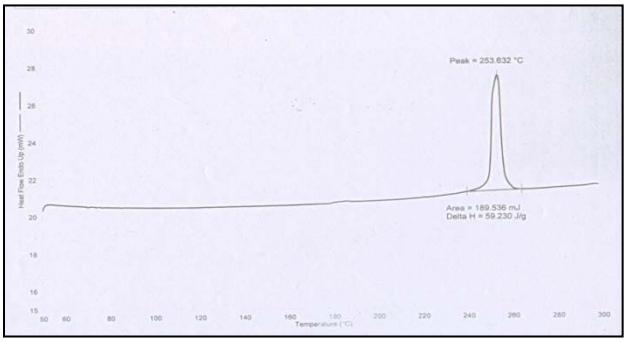

Figure.6 DSC Polyester

From DSC analysis shown in Figure 3.5 and 3.6, it was observed that thermal degradation of thermocool started at 246°C, where as in case of polyester the thermal degradation began at 253°C. The difference in the degrees of thermal

degradation of both the sample was 7°C. In general the bottle grade PET has a melting temperature (Tm) between255 and 265°C which is a crystalline PET **[Silva].**

4 CONCLUSIONS

Morphological study was carried out of thermocool and polyester yarn by examining x-ray diffraction, fourier transform infrared and differential scanning calorimetry. According to the results obtained for XRD, % crystallinity of thermocool and polyester was found to be the same . The results of FTIR also showed no difference in the functional groups in the thermocool and polyester fiber except a few shifted peaks in case of thermcool yarns which might be the result of some surface modifications. But in the analysis of DSC, difference in their meting points was seen which indicates thermal degradation of thermocool started at lower temperature as compare to polyester yarn.

From the above results we could assume that some surface changes had occurred in the polymer structure of thermocool during its manufacturing which have multi-channel fibers that enable condensation to move quickly from the inside to the outside, improving the wearer's comfort and also retaining high insulation values owing to the combination of differently engineered cross sections in the fiber mix.

5 REFERENCES

Dave et al, *"Modification Of Polyester Fabrics I: Alkaline Hydrolysis"* text. Res. J (2003).

Kyawthetlatt . *"Material Characterization By X-Ray Diffraction (XRD)"*, 2014