PREPARATION OF POLYESTER FIBRE FROM POLYETHYLENE TEREPHTHALATE MODIFIED WITH CAPROLACTAM

I. F. Osipenko, D. V. Lopatik, O. M. Bondareva,
V. A. Levdanskii, A. P. Gorbatenko, and O. Ya. Karpova

UDC 678.674

Chemical modification of polyethylene terephthalate (PET) can be used to improve the dyeability of polyester fibre. We have shown that the introduction of a small amount of pentamethylene units into the PET chain makes it possible to improve the dyeability of the modified fibres with disperse dyes while maintaining the physico-mechanical properties of the fibres at the level of control specimens [1].

A very small number of copolyesters prepared from simple and available comonomers has found practical application for the preparation of modified fibres [2]. From this point of view, the preparation of fibre-forming copolyesteramides using such an available monomer as ε-caprolactam has practical importance. The object of the research described in the present article was to make a pilot plant check of the process of prepared caprolactam-modified Lavsan fibre on the unit of the Mogilevsk "Khimvolokno" Industrial Association, and to determine the physico-mechanical characteristics of this fibre and its ability to undergo textile processing.

The basis of the technological process of preparing the modified PET was the method of polymer synthesis by polycondensation of dimethyl terephthalate with ethylene glycol. At the end of the transesterification stage, an aqueous solution of ε-caprolactam, used in the amount of 3 mole percent based on the starting dimethyl terephthalate, was introduced into the reaction mixture. To make the synthesis regime for the modified PET milder, the polycondensation temperature was reduced to 280-282°C. The lots of PET which had been synthesized with caprolactam which had been synthesized (900 kg) were characterized by the following physico-chemical indices:

Property	Lot 1	Lot 2
in o-chlorophenol	0.611	0.614
Softening temperature, deg C	260.22	258.72
Yellowness	off curve	
Brightness	35.56	34.32
TiO_2 content, % by wt.	0.50	0.46

As compared with standard PET, the polymer obtained had reduced values of polymer solution specific viscosity and polymer softening temperature.

A mixture of the lots of modified PET was processed into staple fibre of the worsted type, having a linear density of 0.33 tex. In the course of processing, by technological stages the waste was 3.6% in the spinning works, and 5.9% in textile processing, which indicates good ability of the modified fibre to pass through processing. The experimental fibre has a yellow color, and reminds one of natural wool in its external appearance, but corresponds to standard lots of staple Lavsan fibre in physico-mechanical properties:

Linear density, tex	0.34
Relative breaking load of an elementary filament, cN/tex	37.9
Elongation at break, %	49.0
Cut length, mm	89.8
Number of twists per cm	4.1
Shrinkage, %	0.2
Defects	None

Translated from Khimicheskie Volokna, No. 3, pp. 37-38, May-June, 1989. Original article submitted December 14, 1987.

 0015-0541/89/2103-0228 $12.50

The ability of the modified fibre to be dyed with disperse dyes was investigated. Dyeing was carried out at 100°C in beakers, at a dye content of 3% based on fibre weight and a bath ratio of 1:200. Data on disperse dye sorption by the modified and unmodified Lavsan fibres (in mg/g) are given below:

Dye	Modified fibre	Control fibre
Disperse red	28.5	22.5
Disperse brown	22.2	19.8
Synthene gray	16.2	13.6
Synthene dark blue	12.0	9.8
Santhene orange*	11.0	8.0

*Concentration, 1.5% by wt.

From the data given, it is evident that the modified fibre sorbs 20-30% more of the disperse dyes from the dye bath at 100°C than the control fibre. Similar results were obtained in dyeing the modified fibre in the "Obermayer" company laboratory apparatus. In the dyeing process using the dyes Synthene Dark-brown P-26L, Synthene Brown PRBL, and Disperse Yellow 63, the fibre was dyed uniformly, but somewhat lighter than in dyeing ordinary fibre at 130°C.

It was found that the modified fibre is characterized by a somewhat lower thermal stability than the control fibre. The decomposition temperature of the modified fibre is 355°C, and its thermal decomposition energy is 193 kJ/mole; for the unmodified fibre, these figures are 364°C and 197 kJ/mole, respectively. However, this drop has no practical importance for technical purpose fibres.

In the Minsk worsted combine, thread of linear density 25 tex was made from the modified Lavsan fibre mixed with wool in a 50:50 proportion; from this cloth of the type "Landysh" 21868 was made. In technological processing, the experimental lot of modified fibre had reduced breakage in spinning as compared with control fibre (ordinary coarse Lavsan in cut form) (205 vs. 277 breaks per 1000 spindles per hour, respectively), lower coefficients of variation in breaking load and linear density, greater roving and thread uniformity, and fewer numbers of thread thick and thin spots. Below we give values of relative breaking load for experimental and control lots of thread and fabric (in cN/tex):

Material	Experimental	Control	Norm
Thread	12.9	15.3	12.0
Fabric, warp	85.7	105.7	80.8
Fill	82.0	104.0	75.0

All the physico-mechanical indices of the thread and articles made from it conformed to the requirements of first grade materials.

Thus, the properties of modified polyester fibre and fabric, and the availability of the modifier, the possibility of carrying out the processes of preparation and processing by the usual technological regime without significant deviations make it possible to recommend the described method for modifying PET with caprolactam for practical use. This affords opportunity to expand the assortment of polyester fibres for the mass consumption sector.

CONCLUSIONS

A process for preparation of modified Lavsan fibre using caprolactam as the modifier has been proposed and has been checked out on the pilot plant of the Mogilevsk "Khimvolokno" Industrial Association.

The introduction of pentamethylene units into the polyethylene terephthalate macromolecules increases the ability of the fibre to sorb disperse dyes. The modified fibre can be dyed at 100°C without carriers, to a tone of medium intensity.