At present polycaproamide (PCA) textile yarns are prepared by a shortened semicontinuous scheme which includes demonomerization of the melt and eliminates the stage of water-stabilization treatments [1]. The efficiency and advisability of this process are obvious. Moreover, the classical variant of PCA yarn manufacture, which provides for teating the yarn with hot water on a rigid package, has apparently not exhausted all of its possibilities. This point of view has brought about a search for different methods of enlarging the assortment of the very important types of textile raw material.

Actually, in the water-stabilization treatment of drawn PCA yarn, low-molecular-weight fractions are extracted (not just monomer), and also the yarn structure is set, which leads to an increase in its form-stability [2]. Thereupon, apparently, important changes take place in the fine structure and porosity of the polymeric substrate. The changing porosity in water-stabilization treatments makes it possible to realize effectively numerous variants of chemical and inclusion modification of PCA yarns on the same technological equipment where accomplishment of these by other methods is difficult.

In the present article we examine the changes in structural-mechanical properties of PCA yarns on water-stabilization treatment.

For the investigation we took lustrous PCA textile yarn on bobbins after a KV-150-14 twisting and stretching machine. Its linear density was 10 tex; the relative strength, 37.8 cN/tex; the elongation at break, 45%. The content of low-molecular-weight fractions (LMF) before washing and stabilization was 6.2% by wt.; the shrinkage was 13.7%.

The sorption of water vapor and alcohols was investigated by use of a McBain spring balance at 25(±0.1)°C [3]; crystallinity of the polymeric substrate was evaluated by the x-ray diffraction at small and large angles. Thermomechanical characteristics of the PCA yarns were determined on the instrument described in [4].

It is well known that PCA yarns containing about 3% of LMF which have not been subjected to subsequent setting have the trait of undergoing a considerable (up to 13-15%), nonuniform shrinkage; and fabrics and tricotage made from such yarns are practically impossible to dye uniformly [5]. Washing the drawn yarn on perforated bobbins with hot water makes it possible to attain two effects: removal of the excess LMF which appear in the polymeric substrate during spinning, and also elimination of the excess stresses which have built up during the orientation stretching process, thereby fixing the structure of the PCA yarn and increasing the form-stability of the yarn.

To investigate the structural changes which take place in PCA yarn in washing it with hot water on perforated bobbins under pressure, we evaluated the thermomechanical properties of the yarns after washing denoted as DAN and DWB. The effect of washing was evaluated by the x-ray diffraction at small and large angles. It was ascertained that the porosity of the polymer substrate decreases after washing, which suggests the elimination of the excess stresses.

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Increasing the water content of a yarn considerably lowers the devitrification region of the polymeric substrate. The increasing mobility of the polymeric substrate macromolecules on washing with hot water, which rises not only under the effect of fibre heating but also under the plasticizing action of the water, favors diffusion of monomeric caprolactam and oligomeric components of the LMF out of the fibre into the wash liquid. The pores and hollows which are found thereupon are obviously filled up with water.

The cross section of single fibres increases by 28-31% on keeping in the free state in water at 25°C for 60 min and by 37-40% on holding it at 90°C for 30 min. Since the fibre being washed is apparently a swollen, stressed gel which is in a highly elastic state, collapse of the pores and hollows cannot be very significant. In Fig. 1 we show the results of a study of the kinetics of washing out the LMF from PCA yarns in washing on a bobbin at 90°C. The total pore volume was determined from methanol sorption at 25°C. The data obtained indicate that the main amount of the LMF is washed out of the fibre in the first 10-15 min. Thereupon, the fibre porosity rises in the same sense. But even after 20-30 min, the process reaches a practically quasi-stationary state, the total pore volume remaining practically constant.

Evaluation of the temperature dependence of the kinetics of LMF washout from PCA yarns at 70-96°C showed that the apparent activation energy of this process is 40-55 kJ/mole.

After completion of the hot water washing, the PCA yarn is an amorphous-crystalline, uniaxially oriented polymeric substrate. As was found by x-ray study of the yarn structure before and after washing with hot water (90°C) for 60 min, the degree of polymer crystallinity rises from 0.48 to 0.55. The mean values of the large period change thereupon from 8.9 to 9.4 nm and the mean size of the amorphous regions decreases from 9.1 to 6.3 nm. The washed yarns have a comparatively well-developed system of pores and hollows, the total volume of which is about 0.170 cm³/g.

In Fig. 2 we give differential curves for the distribution of pores and hollows in PCA yarn by radii after washing, before and after heat-setting at 140°C. Two extremes are manifested on the porogram of the washed yarn, constructed from the methanol desorption isotherms in the 1 and 2 nm regions. Maxima in the 7-10 nm and 20 nm regions are noted on the porograms obtained by the mercury porometry method. If one considers that the diameter of the