EFFECT OF REGIME AND CONSTRUCTION PARAMETERS ON THE DRYING KINETICS OF POLYAMIDE YARN

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Continuous man-made fibres prepared by the wet-spinning method pass, after finishing, through a dewatering stage which includes preliminary squeezing out and drying. Depending on the method of yarn take-up, drying may be convective (in working up a cake) or contact (in winding yarn onto a package). In the present article we examine questions of preliminary dewatering of moist polyamide yarn which is taken up on a package, and some regime-construction features of contact drying which may show up in the physicomechanical indices of the yarn obtained when the output of the spinning and finishing equipment is increased.

After finishing and before drying, freshly spun polyamide yarn contains a large amount of moisture, which may amount to 550-600%. It is inadvisable to deliver all this moisture to the drying units. In increasing the output of the spinning and finishing equipment, it is necessary to remove the main part of the free moisture by mechanical means. The use of squeeze-out mechanisms for each individual complex yarn offers the possibility of reducing its moisture content by 100-110%, as a result of which the drying time is cut down by 5-6%. However, after mechanical squeeze-out, there is still a large amount of free moisture in this yarn, removal of which at normal temperature requires large mechanical forces, which may affect the quality of the yarn. A rational solution of the question of preliminary dewatering of yarn was found as a result of using preliminary heating of the yarn before squeeze-out. For this purpose, the moist yarn was heated at temperatures of 20, 40, 60, 80, and 100°C, and each time, after this, it was mechanically dewatered. Results of these studies are shown in Fig. 1.

It was found that, after warming from 20-100°C and subsequent mechanical squeeze-out, the moisture content of polyamide yarn having a linear density of 170 tex was reduced from 350 to 290%, that is, by 60%. The moisture content of the yarn at low drying temperature and a steam pressure of 0.2-0.5 MPa in the drying rolls changed slowly. Therefore a reduction of initial moisture content by 60% is an important contribution to the process of yarn dewatering.

Considering the effect obtained on heating the yarn, a device construction was proposed for continuous steam and liquid treatment of yarn, which was a chamber for liquid and steam treatment, with simultaneous take-off of the treating medium and moisture, and with subsequent hermetization of the chamber.* This device simultaneously affords the possibility of increasing yarn quality upon this steam—liquid treatment, reducing the viscosity of the treating liquid, and further separating the main part of the liquid phase from the yarn with the aid of a squeeze device — porous rubber.

Spinning-finishing machines for the preparation of polyamide yarn, which have been set up for a vertical spinning scheme, contain contact drying units which consist of two cylinders — a drying cylinder and a directing one. The drying cylinders are heated with saturated steam at a pressure of 0.2-0.5 MPa, as a result of which a temperature of up to 130°C is developed on their surfaces. However, it is complicated to maintain the high pressure in these cylinders because of the lack of tightness of the rotating seals, therefore the drying temperature is basically kept in the range of 105-110°C.

When the output of the equipment is increased, an increase in the speed of rotation of the drying cylinders takes place, as a result of which the frequency of passage through the contact and convective parts of the drying mechanism also changes. As a result of this, at the very same drying temperature, deviations in the productivity of the process are possible. The effect of spinning speed of the kinetics of yarn drying was examined at spinning speeds of 17, 25, 30, and 35 m/min and at a drying temperature of 105°C. As is evident from the data given in Fig. 2, at various spinning speeds and at a final moisture content of 10-12%, the drying times are approximately identical, and are 90-95 sec. Since the yarn path during the drying process is


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Fig. 1. Effect of heating temperature on residual moisture content, $W$, of yarn after squeeze-out.

Fig. 2. Kinetics of yarn drying at spinning speeds of 17 (1), 25 (2), 30 (3), and 35 (4) m/min.

Fig. 3. Kinetics of yarn drying on heating one (1-3) or two (1'-3') drying cylinders. Drying temperature (in °C): 1) 105; 2) 170; 3) 250; 1') 105 + 170; 2') 170 + 170; 3) 250 + 170.

proportional to the rate of cylinder rotation, from this it follows that, on increasing spinning speed, it is necessary either to increase the gross dimensions of the drying cylinders or to increase the drying temperature. The first solution is undesirable because of the increase in volume of metal and size of the machine; the second, because of imperfections in construction of rotating seals.

On some spinning and finishing machines, two heatable cylinders are used to increase the productivity of the drying equipment; this significantly complicates the construction of this mechanism and increases losses of heat into the environment. Considering the advantageous and adverse sides of a drying unit with two heatable cylinders, it was of interest to examine the advisability of using such a unit as applicable to various temperature regimes. With this objective, we used a previously developed laboratory stand for contact drying which permitted one to vary some constructional parameters and obtain temperatures on the surfaces of the main and directing drying cylinders up to 400°C. As results of these studies showed (Fig. 3), for drying polyamide yarns of high linear density on domestic machines of type PN-300-I2 at low temperatures, where it is impossible to increase additionally the number of turns of yarn on the drying cylinder, the use of a second heatable cylinder increases the rate of the drying process.