SEMICONTINUOUS PRODUCTION OF VISCOSE TEXTILE FIBRES

M. B. Radishevskii,* A. V. Kalacheva,* and A. T. Serkov**

A semicontinuous method for production of viscose textile fibres in which spinning is conducted at a rate of 500 m/min with takeup to a centrifuge is examined. Here 10-20 twisted fibres are joined into roving, treated on continuous aggregates, and after drying in drums are taken up on warping beams weighing 10-20 kg. The fibres made by the semicontinuous method have high uniformity of dyeing and high strength of 28-30 cN/tex.

Thin fibres with a linear density of 5 to 50 tex are widely used in the textile and knits industry and in the industrial sector. Fibres made of nonmelting polymers are of special interest: viscose, acrylonitrile, aramid. They usually have unique properties due to the presence of strongly polar groups.

Viscose fibres with three hydroxyl groups in the elementary unit are characterized by high hydrophilicity and thus comfort in clothing. Polycrylonitrile (PAN) fibres have been used in production of thin carbon tapes used in the aviation industry and in aerospace engineering to fabricate shields for power photocells. Thin thermostable Arimid, Oxalin, Tverlan fibres, and high-strength Armsos and Terlon fibres are very popular in different branches of industry. However, the wide use of these fibres has been held back by their high cost due to the use of low-productivity production methods.

Due to the high melting points of the polymers, all of these fibres are manufactured by dissolution and then precipitation of the polymer from the solution, washing out of the solvent, and drying of the fibre. The fibres can be spun at a high speed, 500 m/min and higher, including jet formation and hardening. Washing (finishing) and drying are the stages that limit the speed. In washing, in addition to the low rate of diffusion processes, serious difficulties arise due to high pressure loss and spraying of finishing solutions. For this reason, it has been proposed* that the fibres be finished in tanks where the linear velocity of the material is low and the finishing operations take place sufficiently completely. However, the design of such tanks is complicated. The quality of the fibres also deteriorates.

There is another possibility for implementing high-speed wet spinning of thin fibres by applying the semicontinuous principle. The fibre is spun at a speed of 500-1000 m/min and is taken into a centrifuge where it is twisted. This part of the process is periodic. The twisted fibres from 10-20 packs (cakes) are joined into one roving and are finished in continuous finishing machines — such as AVK-0.6-4 or LP-24-PAN, for example, used in production of viscose cord and PAN rovings for manufacturing carbon fibre at the ordinary speed of 30-60 m/min. The fibres are taken up on warping beams and are the finished commercial pack. Despite the low finishing speed, since 10-20 fibres are combined in one roving, the actual productivity is equivalent to a processing speed of 500-1000 m/min. The combination of high-speed spinning with finishing of twisted fibres collected in rovings thus allow realizing high-output production of thin fibres with a linear density of 5 to 50 tex.

The method described is protected by a RF patent (application No. 2003128593). Ugolekhimvolokno SEC is involved in the practical implementation of the method primarily for production of 33.3 tex PAN fibres used in manufacture of Elur-0.08 P carbon tapes for which there is an acute need in the aviation industry. The use of this method in production of viscose fibres on existing equipment — centrifugal spinning machines and AVK-0.6-4 spinning-finishing aggregates is also realistic.

The process scheme for spinning and finishing viscose fibres with the semicontinuous method is illustrated in Figs. 1 and 2. Dry-wet spinning is conducted at a speed of 500 m/min. The spinning solution is fed by proportioning pump 1 to


*Ugolekhimvolokno Science and Engineering Center, Mytishchi; **All-Russian Scientific-Research Institute of Polymer Fibres, Mytishchi. Translated from Khimicheskie Volokna, No. 6, pp. 15-17, November—December, 2003.
Fig. 1. Diagram of high-speed spinning of viscos textile fibres with the dry-wet method: 1) proportioning pump; 2) spinneret; 3) spinning bath; 4) spinning tube; 5) disk; 6) pinch roll; 7) funnel; 8) centrifuge; 9) electric spindle.

spinneret 2 (Fig. 1). The jets of spinning solution fall through an air gap into spinning bath 3, and with spinning tube 4, the spun fibre is taken off onto disk 5. The spent bath goes into trough 10 and is removed for regeneration. The fibre is moved by device 6 into funnel 7 and enters centrifuge 8 which is rotated by electric spindle 9.

The cakes formed (10-20) are placed in ventilated boxes 1 and transported to the AVK-0.6-I finishing unit (Fig. 2), where 10-20 fibres are joined into one roving and go through rope feeder 3 to triple feed rollers 4. Here 60 rovings, i.e., 600-1200 fibres, are simultaneously processed in the finishing unit. Rovings go from triple rollers 4 to plasticizing trough 5 and then to triple drawing rollers 6. The rovings are treated with a 2% solution of H₂SO₄ at 95°C in the plasticizing trough and then undergo final regeneration, orientational drawing by 60-80%, and distillation of 30-40% of the CS₂ given in xanthation. Acid and sulfates are washed off the regenerated rovings in troughs 7 and 9, they are treated with brightener in trough 10, and transported by dual rollers 11, are fed into drying drums 12 and then to warping beams 13.

The semicontinuous method has many advantages over bobbin, centrifugal, and continuous methods. First, this concerns the productivity of the equipment and labor involved. For manufacturing 25 tons/day of fibres with 10 tex linear density, no more than 30 machines with 80 positions each are required in high-speed spinning, while no less than 240 machines are required with the usual centrifugal method. The output in high-speed spinning increases not only due to the speed but also the 60-80% orientational drawing. Due to drawing, a thicker fibre, which has a linear density of 14.3 tex even with 12% shrinkage, goes into the centrifuge in the finishing unit.

Labor productivity is increased as a result of eliminating the operation of rewinding the fibre from the cakes onto bobbins. In this method, the principle of warping from cakes is essentially implemented. Repeated attempts in the past to implement this progressive operation ended in failure primarily due to the high end breakage rate caused by the high warping speed of 200-400 m/min and damage to the cakes during finishing and drying due to nonuniform shrinkage. In the given case, warping of the unfinished cakes is conducted at a low speed of 30-60 m/min. The warping beams weigh 10-20 kg, which reduces the frequency of removal in comparison to bobbin machines, where the pack weight is no greater than 2-3 kg.