AUTOMATED TESTING SYSTEM FOR TEXTILE ENTERPRISES

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An automated diagnostic testing complex was developed for monitoring the quality of chemical fibres based on technological transformations in their production. The PVS meter and LP meter included in the complex allow assessing the textile processability of the fibres.

Improvement of aviation, space, ship-building, and other branches of engineering requires the creation of new textile-based composite materials having high strength and rigidity combined with low weight. However, for obtaining high-quality composites, it is necessary to process chemical fibres without damaging their structure, forming nap, and separating fuzz. It is important to study the structure and properties of the fibres, and to improve the methods used and create new methods of processing them for solving this problem, and this is directly related to the use of efficient methods and agents of quality control and product testing.

The Stekloplastik—Sertifikat Co. and the Metrotex Scientific and Technical Center Corp. occupy a leading position in Russia in production of automated diagnostic-test systems for assessing and predicting the quality of chemical, including glass, fibres, filaments, cloth, and composites. These companies are developing and implementing supplies for computer-based automated diagnostic testing systems in textile enterprises for production of glass and chemical fibres in Russia and CIS countries. All of the developments are protected by patents and Inventor’s Certificates.

The diagnostic testing systems consists of: an LP meter, an automated setup for assessing irregularities in the linear density of complex fibres; an ATE meter, an automated installation for assessing friction and failure of the moving fibre in thread guides and assessing the specific energy of interlaminar adhesion in separation of the fibre from the pack during unreeling; a PVS meter, an automated installation for assessing the interaction of the liquid and textile material.

The LP meter is designed to monitor the nonuniformity of complex fibres which negatively affects their mechanical properties during processing and worsens the quality of the finished products. It can be used to monitor the irregularity of complex fibres in different stages of production and is used to assess the level and character of irregularity of a complex fibre; detect and count defects in the material (thickened parts, thin parts, knots); determine the sources of fibre irregularities in the technological process.

Technical characteristics of the LP meter: linear density of fibres (5-300 tex); drawing speed (25-400 m/min); duration of measurement (1-20 min); irregularity (0.15-40%); nonuniformity index, number of defects in the material with selective resolution (-30, -40, -50, -60% for thinning; +35, +50, +70, +100% for thickening; +140, +200, +280, +400% for knots); statistical characteristics (mean, deviation from mean, coefficient of variation, confidence interval).

Principle of Action. The fibre successively passes through a system of thread guides, an adjustable stretching device, condenser-sensor slot, power-driven rollers, and is collected in a thread collector by a pneumatic nozzle. The irregularity sensor signals go to the computer through an analog-digital converter. The manipulated variables of the measurement process (speed, drawing length, fibre tension, etc.) are set and the measuring process is controlled by computer with specially developed software. The experimental and processed data from the tests are displayed on the monitor and are printed out (Fig. 1). The results are exported to an Excel electronic table editor for statistical processing of a large amount of data.

The area of application of the ATE meter is relatively broad:
— study of the features of interfibre adhesive interactions, failure of the adhesive joint in peeling of a fibre glued to the surface of the pack, separation of the fibre into strands, separation and failure of the fibre with complex tensile and flexural strains;

Fig. 1. Graphic representation of the results of testing a complex viscose fibre with a linear density of 14 tex on an LP meter installation: a) experimental data; b) diagram after averaging for 1-m length; c) frequency distribution diagram; d) irregularity gradient diagram.

— estimation of the tension, friction coefficient, and irreversible energy of deformation of fibre material in friction during interaction with different types of friction bodies and fibre stretching devices;

— selecting the profile, friction body material, and degree of surface cleanliness which optimize the friction coefficient and decrease the irreversible failure deformation energy of the fibre material on contact with the friction body.

The principle of action of the ATE meter consists of the following. The moving fibre material (fibre, ribbon, etc.) is in contact with the friction body. The friction body is mechanically connected to a system of strain gauge sensors which record the tension before and after the friction body without contact with the fibre material and the frictional force, and this is used to calculate the irreversible failure deformation energy and dynamic friction coefficient of the fibre material against the friction body on a PC in real time conditions.

Technical characteristics of the ATE meter: specific energy of separation (0-1 J/m); effective angle of separating the fibre from the pack (0-90°); dynamic friction coefficient (0-1); hysteresis energy of separation and failure of a fibre in a thread guide (0-0.1 J/m); electrostatic charge on the fibre (0-10 -7 C/m); adjustable temperature in the friction zone (0-100°C); fibre tension in unwinding of the pack (0-2 N); adjustable fibre drawing speed (0-1 m/sec).

The PVS meter is designed for automated estimation of the kinetic spreading and the wetting rate, dynamics of the change in controllable properties during wetting of a porous system, assessing the wettability of the fibre by oiling agents and polymer binder, assessing the kinetics of impregnation and the capillary-pore structure of a bundle of fibres.

Technical characteristics of the PVS meter: surface tension of liquid (0-100 mN/m); contact angle of wetting (0-90°); spreading area (0-2·10 -4 m²); wetting rate (0-10 3 deg/sec); spreading speed (0-1 m/sec); surface energy (0-10 -3 J/m); potential energy of lifting of meniscus (0-10 -4 J/m); wetting energy (0-10 -3 J/m); cohesive energy (0-10 -3 J/m); wetting temperature coefficient (0-10 -4 J/(m deg)); adjustable temperature in the interaction zone (0-100°C); integral lag (0-10 sec); dynamic viscosity in the spreading zone in the meniscus (0-1 Pa·sec); dynamic viscosity in interfibre pores (0-1 Pa·sec); specific electric resistance of liquid in pores (0-10 7 Ω·m); longitudinal spreading rate of liquid in pores (0-1 m/sec); transverse spreading rate of liquid in pores (0-0.1 m/sec); pore distribution histogram by equivalent diameters (for a bundle of fibres).

Principle of Action. The liquid studied (ooling agent, sizing, binder) is placed in contact with the sample held in a clamp and connected to a strain gauge sensor. The conditions of measurement, sample characteristics, and control of the test