NEW TYPES OF CELLULOSE MATERIALS OBTAINED BY AN ALTERNATIVE SPINNING METHOD*

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In re-establishment of the Institute of Textile Fibre Technology, which existed from 1954 to 1970 in Rudolstadt, as the Turing Textile and Plastics Research Institute (TITP) in 1991, its strategic direction changed significantly in accordance with the altered conditions of scientific development and the European market.

In the strategic plan for implementing the method of spinning cellulose materials with a low concentration of harmful substances, intense work on optimization of the method and especially on the creation of new materials based on it has been conducted since that time. The results obtained are represented by ten patents and another ten patent applications. The Institute has not only patented solutions for this new, alternative method which does not use harmful substances, but also is ready to fabricate staple fibres, yarn, profiled and hollow fibres, narrow and ultrathin slivers of film and spun articles, and to develop new materials together with well-known textile enterprises.

The trade mark "ALCERU" (AL = alternative, CE = cellulose, RU = Rudolstadt) was approved in 1944.

The important reasons reported below:
- cellulose as an easily reproducible and biodegradable raw material in an unlimited amount;
- the increasing per capita demand for fibres due to population growth and the demand for textiles and the insufficient coverage of this demand by increasing production of cotton;
- the limited possibilities of optimizing the classic viscose method and the necessity of significant monetary investments for machines, equipment, and installations arising as a result of the great demand for their reconstruction, caused by the justifiably high requirements for environmental conditions;
- the prerequisites for use of sulfur-free process solutions, beginning with preparation of cellulose and ending in processing of cellulose into high-quality, biodegradable products, were created for the first time with the new physical principle of the method of spinning from a mixture of cellulose and N-methylmorpholine N-oxide (MMO method);
- the new, modified or improved properties of the fibres obtained with this method, the filament yarn, narrow bands cut from films, etc., and the versatility of the new types of materials;

all led to intensified development of new process solutions for spinning of cellulose at the end of the 1970s and beginning of the 1980s. Since then, this new method has been increasingly intensely developed, with orientation toward the use and development of materials prepared with this method, in Coventry (staple fibre), Lenzing (staple fibre), Obernburg (filament yarn), Rudolstadt (staple fibre, filament yarn, narrow strips cut from films, etc.), and Teltow-Seehof (basic installations).

According to BISFA, the term "Lyocell" is a serious concept for a new hydrated cellulose fibre obtained by spinning from solution, and a mixture of organic chemicals and water is used as the organic solvent, while dissolution of the cellulose and spinning of the fibre without formation of cellulose derivatives is implied in the spinning method.

EVALUATION OF THE METHOD

In contrast to the classic viscose method with multiple stages of the process and secondary processes used for purification of air and wastewaters, the new method (Figs. 1 and 2) can be restricted to three stages: dissolution, spinning of

Fig. 1. Diagram of the ALCERU process. Preparation of the mixture of cellulose and aqueous solution of MMO.

Fig. 2. Diagram of the ALCERU process. Spinning and subsequent fibre processing.

The fibre with subsequent processing of the fibre, and regeneration of the solvent. The dissolution process is a physical method in which the ground cellulose is mixed with a 60% aqueous solution of MMO and water is removed by stages from this mixture under a high vacuum at a temperature of 85 to 95°C.

The MMO–water–cellulose phase diagram contains a region in which cellulose dissolves with a water content of 13 to 19%. After dissolution for 60-120 min, solutions containing almost no residue are obtained. The spinning process is of decisive importance for determining the properties of the fibres and consequently the yarn obtained with this method. The spinning solutions are processed by wet-dry spinning,* using a dilute aqueous solution of MMO as the spinning bath. After passing through the air space, the fibre enters the spinning bath, where the cellulose is precipitated and the orientation of the cellulose chains created in the spinneret and in the air space is fixed as a result of the effect of a shear field and spinneret drawing. After this, further orientation, for example, by drawing the fibre, is impossible. This means that orientation and cross-linking are completed in this stage. During this new spinning process, long crystallites and stretched voids arise, and cluster formation decreases.

*See Fig. 2 and its analysis in the article of C. Michels et al.