STUDY ON ASSESSMENT OF OPENING DEGREE OF COTTON IN ASPECT OF PHENOMENA ASSOCIATED WITH COMPRESSION OF FIBRE AGGREGATIONS

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The process by which yarn is manufactured largely depends on the degree to which the fibre is opened, cleaned, and mixed. The three papameters also affect the quality of the resultant yarn.

The opening process is one by which a compressed mass of fibre is changed into a loosely opened mass consisting of finy aggregations of fibres referred to fa fibre tufts.

In order that the further processes, mainly carding, could proceed correctly it is necessary that the specific weight of the raw material in bales, often as high as 500 kg per cu. m, were reduced, following the opening processes, to about 15 kg per cu. m /1/. Otherwise, there will occur an intensive breaking of the fibres on the card, and heavier wear of the card clothinh.

Besides, impurities are easier to separate from a well opened mass of fibre, while finer tufts ensure better mixing, which is especially important in blending.

The preliminary opening of fibre stock has been the object of research for more than thirty years. It is aimed at improving the design of the preliminary opening machines as well as their performance. It is also contributory to optimizing the spinning processes especially in view of the present trend to reduce to a minimum the blowroom (opening room) processes and machinery. In today's manufacturing practice the problem is particularly conspicuous in the munufacturing of fine OE yarn, where cleanness of the raw material is of key importance.

Preliminary processing in spinning is carried out on opening and cleaning machines which include special devices such as lattice openers, vertical openers, drum openers, and beaters.

The opening process can be devided into several stages. In the first stage the volume of the fibre stock increases as a result of relaxation of the stresses which arose in baling. In the second stage the fibre mass is separated into individual tufts. The machines involved are bale breakers and hopper feeders.

Further opening takes place as a result of impact action of the drum openers and beaters following which the number of the tufts is further increased and adherence between the fibres and between the fibres and the impurities is reduced.

Analysis of the opening process shows that the action of the opening and cleaning machines results in:

- reduction of the size of the fibre tufts
- change in the shape of the fibre tufts
- increase in the volume of the fibre mass
- separation of the impurities
- mechanical damage to the fibres.

The effect of opening a fibre stock is important to the designer of the opening machines, and it is assessed by the following methods:

1. mean tuft weight method
2. cpecific volume method
3. method based on fibre mass density
4. aerodynamic method
5. method based on porosity of the fibre mass.

Of the heretofore methods it can be said that for assessing the degree of opening of fibre masses they rely on such parmeters as weight, behaviour in air stream, or interadherence of the fibres. It has not been determined so far which of the above methods gives the most objective results. For the most part the methods are tedious and time-consuming and require a large number of samples.

Questions about some effective index of fibre opening, one that would ensure correct operation of the card, continue to be asked.

It seems that such criteria as weight of the fibre tufts or their volume are insufficient for assessment of the actual degree of opening. Use of samples of a weight many times the weight of an individual tuft would give a result better characterizing the opened fibre mass and, at the same time, much less samples would be required.

The expectations seem to be met by a method based on the mechanical phenomena occurring in compressing a set of fibres/2/.

A sample of cotton was subjected to compression in a cylinder of known diameter. The measurement was carried out as follows.

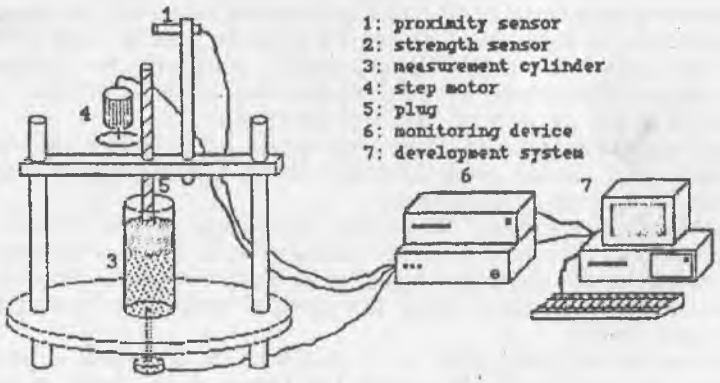


Fig.1. A diagram of the test station

The results were printed on chart in the form of relationship between pressure and height. The difference between high-opened cotton and low-opened cotton is shown by the graph of compression.

Upon logarithmic acale thansformation a relationship between the pressure and the height of the fibre aggregations was obtained, as shown in Fig. 3.

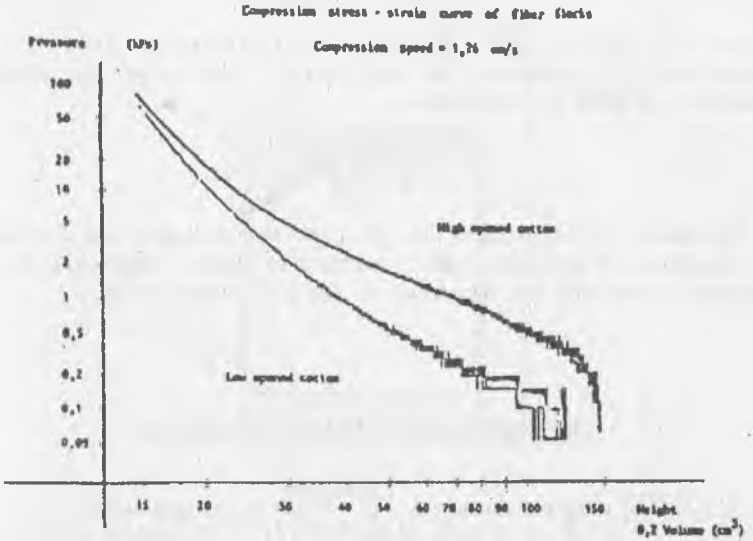


Fig.2. Graph showing fibre compression levels

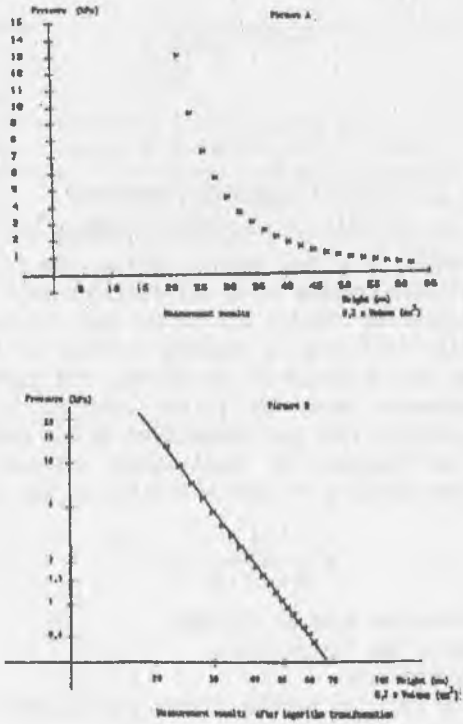


Fig.3. Graphs of fibre compression prior to and following logarithmic scale transformation

Degree of opening was defined as extrapolation from a volume corresponding to a pressure of one Pascal. The volume is assumed to correspond to i gram of fibre mass.

$$V_o = \left(\frac{m}{a}\right)^{\frac{1}{b}}$$

As the method of preparation of the test sample poses some difficulties it is suggested to analyse elastic recovery of fibres compressed as a set. Measurement is carried out according to the following diagram:

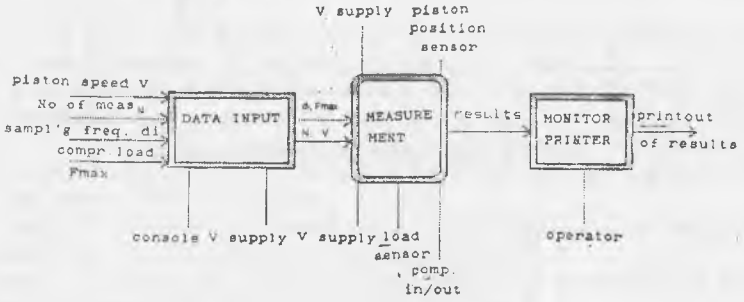


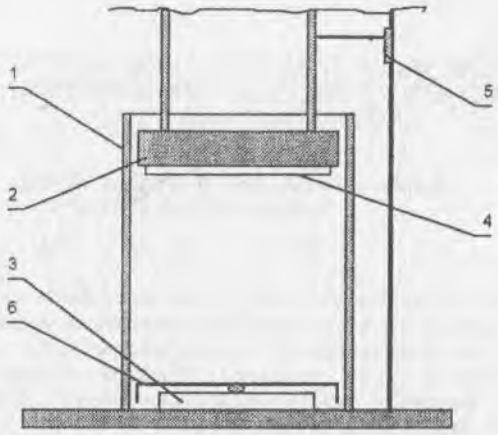
Fig.4. Principle of measurement

The measuring unit (Fig. 5) is a cylinder provided with a movable bottom plate under which there is a load sensor. Inside, the cylinder is provided with a piston which reciprocates along the cylinder axis. For the purposes of analysis of the printed results the piston has, in its bottom, another sensor for measuring the forces of elastic recovery of the fibres in the cylinder during the return stroke of the piston. The piston motion control system includes elements measuring piston location in unit time. All signals from the measuring unit are transmitted to the recording computer.

Theoretically, the equation of relationship between the density and height of the compressed fibre set may be written in the following form:

$$\gamma = \frac{A}{\mu \cdot l \cdot C_2 \cdot E} \cdot \left(1 - e^{\frac{\mu \cdot l}{2A} h}\right)$$

where: A - cross-section area of cylinder
E - Young modulus of the tested fibre
l - cylinder circumference
μ - coefficient of friction between fibres and cylinder wall
h - height of fibre set
C_2 - constant value



1 - cylinder; 2 - piston; 3,4- load sensors; 5 - piston position sensor; 6 - movable bottom

Fig.5. Measuring unit

The index of fibre opening can be written:

$$\gamma = \int_{h_1}^{h_2} f(h)dh$$

Literature:

1. Jacek Rutkowski. Assessment of fibre opening level in the preliminfry opening processes. Przegląd WŁókienniczy No. 7, 1994.
2. M. Renner, B. Bertheux, J. Y. Drean. Vechanical aspects of compressing fibre tufts used as a method of determing the degree of opening. Paper presented at IMTEX'89, Lodz, October 17-19, 1989.