INFLUENCE OF PLASTIC DEFORMATION WARP THREAD ON BASIC PHYSICAL AND MECHANICAL DATA WARP-KNITTING FABRICS

V. Chaban

Kiev National University of Technologies and Design
Nemirovich-Danchenko 2, 01011 Kiev, Ukraine
chaban.v@knutd.com.ua

***Abstract**: Considered influence of stretch basic thread on amount of theirs plastic deformation. Here are results of the experimental researches in 3 forms of the thread: synthetic thread – polyester thread (PETF) 16.8 Tex, polyamide thread (kapron) 15.6 Tex, artificial hydrocellulose thread (viscose) 16.6 Tex.*
***Keywords:** warp-knitting machine, knitting fabric, plastic deformation, rate of surface density.*

1 INTRODUCTION

Formulation of the problem: Quality of warp-knitting fabrics largely depends from feeder and tension warp threads. Oscillation in tension threads lead to appearance a number defects and first of all to irregularity and incorrectness of loop structure of knitting fabric, to change its physical and mechanical properties. [1-3]. Successful solution of the problem for further improvement warp-knitting machines is target to improve quality of warp-knitting fabrics. In this should be considered influence of physical and mechanical properties warp threads on quantity of theirs plastic deformation after linkage in fabrics. Target of researches became analytic research of influence plastic deformation warp-threads link aged in knitting fabric on basic physical and mechanical data warp-knitting fabrics.

2 EXPERIMENTAL

2.1 Textile materials

It was chosen for experimental researches of definition influence warp threads on physical and mechanical properties of warp-knitting fabric was used fabric from three kinds of packages and three kinds of threads: polyester thread (PETF) 16.8 Tex, polyamide thread (Kapron) 15.6 Tex, viscose thread 16.6 Tex.

2.2 Research methods

Object and methods of research: Object of researches elected warp-knitting fabrics and influence of plastic deformation warp thread on basic physical and mechanical properties. Definition of surface density was conduct by standard method (merged sizes and weight of spot sample). Definition of rate of thermal conductivity was conduct by standard method (merged temperature of layers warp-knitting fabric on permanent power of heat flow). For definition rate of air permeability was used device VPTM-2, that merges quantity of air that coming through unit of area in unit of time. For definition rate of stability to abrasion was used device DIT-M, that working on planetary motion at sample.

3 RESULTS AND DISCUSSIONS

3.1 Surface density

Define influence of plastic deformation on quantity surface density of fabrics. Calculation will be conducted by the formula [4].

$$PP = \frac{m}{S_{\mathrm{P}} + S_{\mathrm{P}i}}, \tag{1}$$

where *PP* – is surface density, *m* - mass of selected sample, S_p - area of sample without plastic deformation, S_{pl}- additional area, which added because of plastic deformation.
Results of the calculations by the formula (1) illustrated on Figure 1. It should be noted, that for all types of threads calculation conducted for the biggest tension, that reached 30. For this value of tension was considered quantity of plastic deformation, that was got by thread after link aging in jersey fabrics.
Analysis of the obtained data allowed making further conclusions. The biggest decreasing of surface density was observed in fabrics with polyester threads to 5.6%. The lowest decreasing of surface density was observed in fabrics with polyamide thread to 1.5%. In fabrics with viscose threads decreasing of surface density was 3.2%. These results explained by physical and mechanical properties of the given threads, in particular relative strength and relative elongation.
These decreasing of surface density leads to decreasing canvas resistance to abrasion, to decreasing thermal properties, to increasing air permeability. Certainly, in each specific case should be considered purpose of produced fabrics.

3.2 Thermal properties

Define influence of plastic deformation on thermal properties on knitting fabrics. Evaluate degree thermal conductivity will be at a rate of thermal conductivity. [4].

$$\lambda = \frac{Q\delta}{S(t_1 - t_2)} \qquad (2)$$

where *Q* - power of thermal flow, δ- thickness of the material, *S* - area of the material and t_1, t_2 - surfaces temperature layer of material.

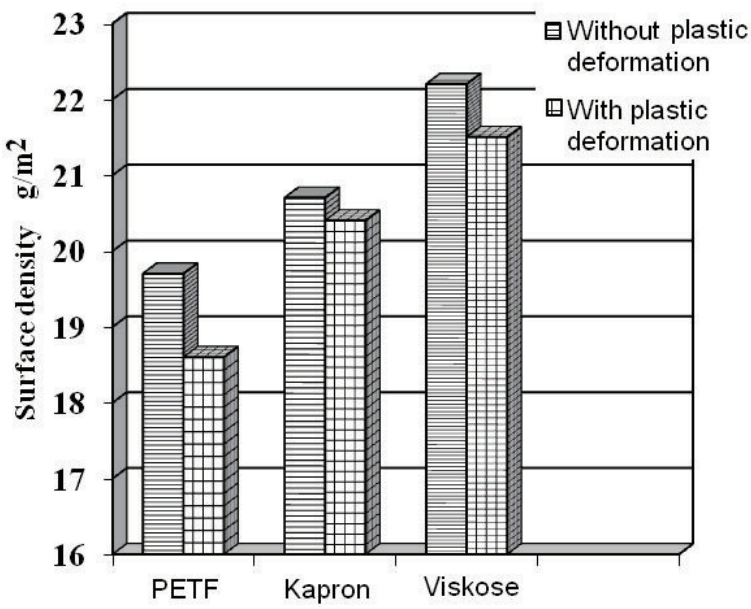

Figure 1 Definition of surface density

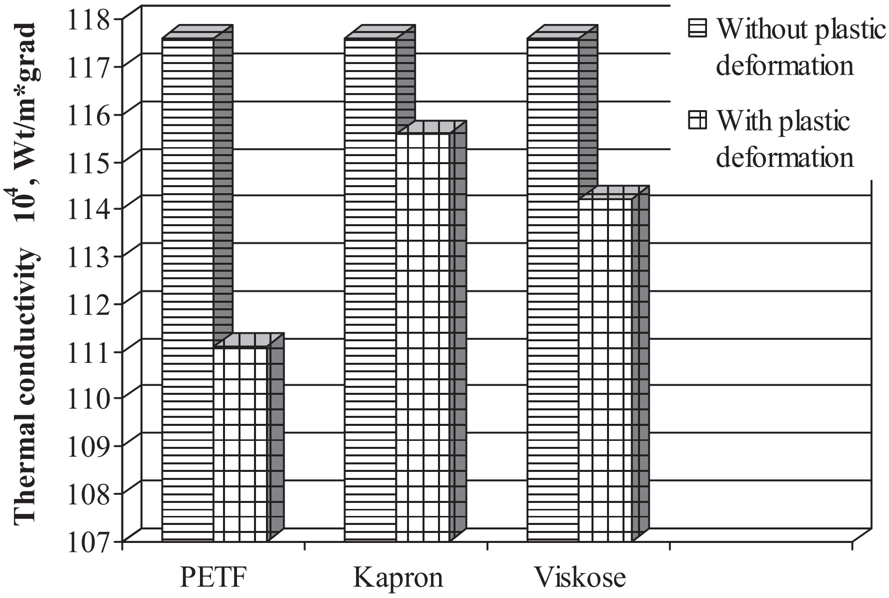

Figure 2 Results of calculation rate of thermal conductivity

Analysis of the obtained data showing that the biggest difference in its quantity will be in polyester threads – 6.5*10^{-4} Wt/(m*grad). For PA thread and viscose thread quantity of the rate of thermal conductivity in case with plastic deformation and without it will be close values. Explanation of this is that polyester threads got the biggest value of thickness – 16.8 Tex. It should be noted that in case without plastic deformation structure of knitting fabrics is denser with minor air “pillows”.

3.3 Air permeability

Define influence of plastic deformation on air permeability. For this is easy to use rate of air permeability. Rate of air permeability equals:

$$B = \frac{V}{ST} \tag{3}$$

where B - rate of air permeability, V- quantity of air that passes through material, S - area of the material, T - air passing time
Calculation results of the rate of air permeability are illustrated on Figure 3.
These results explained by in case with plastic deformation structure of knitting fabrics obtained more discharged and knitting fabrics easier passes over air. For polyester knitting fabrics this rate equals respectively 1.47 and 1.38. It should be noted that quality assessment knitting fabrics depends on its functional purpose.

3.4 Stability of knitting fabrics to abrasion

Let’s analyze process definition stability knitting fabrics to abrasion counting the presence plastic deformation. The main indicator, that characterizes stability jersey fabrics to abrasion, is rate of stability knitting fabrics to abrasion K_y [5]. As calculation formula adopted dependence [5]

$$K_Y = \frac{n}{m} \tag{4}$$

where n - number of abrasion cycles until destruction of sample warp-knitting fabrics, m - mass for 1 m^2 of warp-knitting fabrics [g].

Calculation results of the dependence rate of stability knitting fabrics to abrasion to type of raw illustrated on Figure 4.

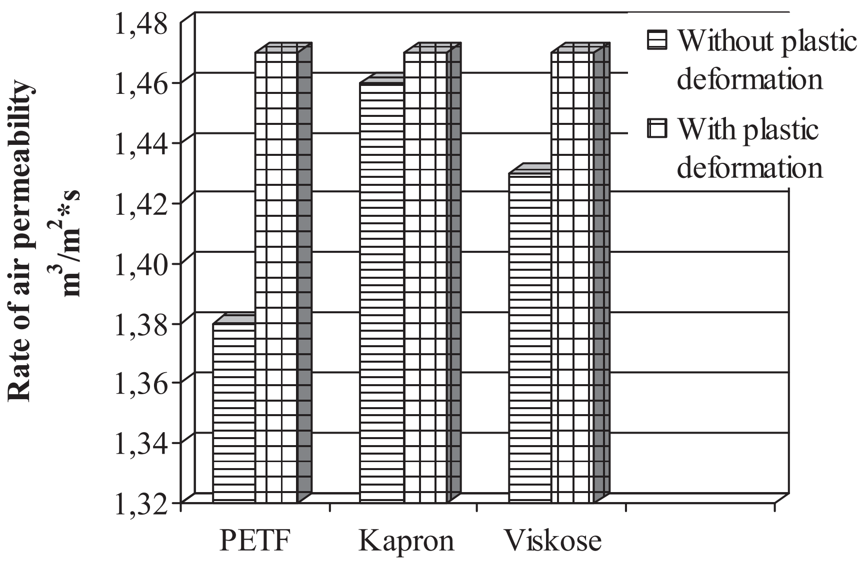

Figure 3 Value of rates of air penetrability

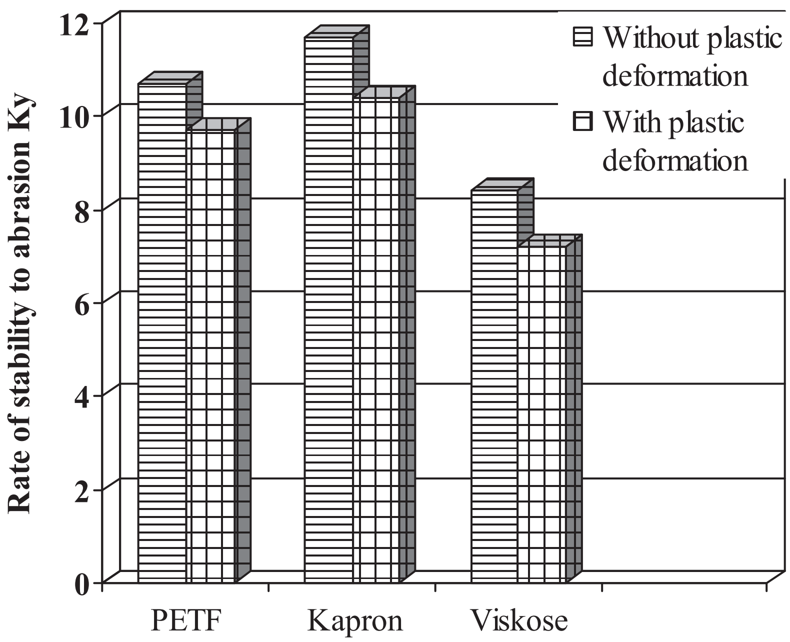

Figure 4 Value of rate of stability knitting fabrics to abrasion

Analysis of the obtained data showing that in all three variants bigger stability to abrasion shows knitting fabrics, in which threads have got minimal plastic deformation. That explained by bigger dense in structure, when filling sample volume of knitting fabrics by material will be maximal. The biggest value rate of stability to abrasion observed in knitting fabrics, that made with PA threads and equals respectively 10.4 and 11.7 Tex. Interesting, the dependence rate of stability to abrasion depends on quantity of plastic deformation in warp threads. Let's consider this example of warp-knitting fabrics made of polyester threads 16.8 Tex. As a result experiment was got further values that illustrated in Table 1.

Table 1 Value rate stability of stability to abrasion on different values of plastic deformation

quantity of plastic deformation $\varepsilon_{P\ell}$ [%]	3.0	3.5	4.0	4.5	5.0	5.5
rate of stability to abrasion K_y	10.5	10	9.81	9.8	9.75	9.73

To obtain calculation dependence is necessary to approximate data from Table 1. For this there was developed special software with algorithm that based on polynomial approximation. Polynomial approximation allows realizing automatic choice of degree of polynomial that leads to definition rates in regression equation and obtaining result with given accuracy. In calculation result obtained further regression equation of dependence rate of stability to abrasion from quantity of plastic deformation.

$$K_Y = 14{,}72 - 2{,}06\varepsilon_{P\ell} + 0{,}21\varepsilon_{P\ell}^2 \quad (5)$$

4 CONCLUSIONS

- Defined influence of quantity of plastic deformation on surface density, on thermal properties, on air permeability, on stability to abrasion of warp-knitting fabrics that allowed creating background for analysis of knitting fabrics products.
- Developed special software for approximation experimental data by definition quantity of plastic deformation of knitting fabrics on quantity rate of stability to abrasion.

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