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# COMPARATIVE ASSESSMENT OF QUALITY OF PARA-ARAMIDE RUSAR FIBERS AFTER NATURAL AND ARTIFICIAL LIGHT AND WEATHER EXPOSURE

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Para-aramide Rusar fibers have a broad field of application. They are used for production of different types of products for industrial use: heavily stressed textile materials, rescue-aid and safety means, optical and electrical cables, ballistic protection means, high-tenacity composites and others. In storage and during use, products made of para-aramide fibers experience exposure to different environmental impacts, including humidity of air, insolation and others that can reduce their operating reliability and terms of potential service life. Products should withstand long-term affect of these factors with maximum possible retention of initial physical-mechanical characteristics, i.e. quality of these products. Quality improvement of products, starting from the phase of planning up to the phase of exploitation, requires first of all, knowledge of properties which determine quality of products, abilities to correctly and objectively measure, evaluate and monitor quality characteristics, to have purposefully an influence on conditions and factors, which significantly affect quality of products. To the factors, which have main affect on quality of products, belong light and weather exposure.

High-tenacity high-modulus fibers heterocyclic para-aramide Rusar fibers of different types that are manufactured in Russia by NPP "Thermotex", are intended for manufacture of ballistic protection means: #1 – nascent Rusar fiber; #2 – heat-treated Rusar fiber; #3 – additionally heat-treated Rusar fiber; #4 – high-tenacity Rusar fiber.

Fibers have been subjected to natural light and weather exposure within six months during the spring-summer-autumn period in North-Western area in Moscow region. Insolation in artificial conditions has been carried out during 24 hours in the daylight device DLD in accordance with GOST 10793 [1] and in Xenotest device.

Main criterion for evaluation of light and weather fastness is relationship of values of rupture-stress characteristics of yarn before and after insolation.

Determination of mechanical properties of para-aramide Rusar fibers has been carried out in accordance with GOST 6611.2 [3] with the Instron test system of 4411series. Clamp length of samples is 500mm, movement speed of the the upper clamp is 200 mm/min.

Results of tests are given in Table 1. From data in Table 1 conclusion can be made that the minimal change of mechanical properties is observed in the sample #4, the maximum change – in sample # 1. It can be noted that sharpest decrease of tenacity in all samples under investigation is observed during first months of natural light and weather exposure and during the first hours of artificial insolation.

Table 1

| Type of exposure | Insolation time | Breaking load, cN | | | | Elongation at rupture, mm | | | | Relative breaking load, cN/tex | | | | Relative elongation at rupture, % | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | № 1 | № 2 | № 3 | №4 | № 1 | № 2 | № 3 | №4 | № 1 | № 2 | № 3 | №4 | № 1 | № 2 | № 3 | №4 |
| Without exposure | 0 | 4938 | 14864 | 14174 | 16180 | 20,95 | 17,51 | 20,95 | 16,51 | 71,94 | 245,69 | 232,82 | 267,17 | 4,19 | 3,50 | 4,19 | 3,30 |
| Natural light and weather, months | 1 | 3054 | 10750 | 11590 | 13702 | 14,84 | 13,30 | 15,10 | 15,20 | 44,01 | 176,00 | 189,63 | 223,31 | 2,97 | 2,66 | 3,02 | 3,04 |
| | 2 | 2572 | 7850 | 10440 | 10500 | 9,09 | 10,21 | 12,60 | 13,60 | 35,92 | 121,79 | 158,47 | 163,93 | 1,82 | 2,04 | 2,52 | 2,72 |
| | 3 | 1492 | 5870 | 8000 | 8852 | 5,96 | 7,93 | 10,70 | 12,70 | 20,53 | 85,46 | 117,22 | 127,69 | 1,19 | 1,59 | 2,14 | 2,54 |
| | 4 | 1392 | 4570 | 7390 | 7940 | 5,44 | 6,50 | 9,50 | 11,10 | 19,99 | 71,22 | 120,08 | 124,66 | 1,09 | 1,30 | 1,90 | 2,22 |
| | 5 | 1115 | 3125 | 5500 | 7251 | 4,15 | 4,89 | 7,00 | 9,58 | 16,15 | 49,15 | 89,85 | 115,66 | 0,83 | 0,98 | 1,40 | 1,92 |
| | 6 | 975 | 2867 | 3723 | 6187 | 3,25 | 3,87 | 4,98 | 7,25 | 14,14 | 45,65 | 61,05 | 99,84 | 0,65 | 0,77 | 1,00 | 1,45 |
| DLD, hours | 6 | 3054 | 10240 | 12000 | 13702 | 14,84 | 12,5 | 15,3 | 16,4 | 44,01 | 167,65 | 196,34 | 223,31 | 2,97 | 2,50 | 3,06 | 3,28 |
| | 12 | 2572 | 7990 | 10760 | 10540 | 9,09 | 10,21 | 12,6 | 15,05 | 36,97 | 126,01 | 172,08 | 167,74 | 1,82 | 2,04 | 2,52 | 3,01 |
| | 18 | 1492 | 5950 | 9732 | 8852 | 5,96 | 7,93 | 11,79 | 13,89 | 20,20 | 91,69 | 148,82 | 135,27 | 1,19 | 1,59 | 2,36 | 2,78 |
| | 24 | 1392 | 5302 | 8892 | 8270 | 5,44 | 7,67 | 10,66 | 13,59 | 20,02 | 84,08 | 140,94 | 132,00 | 1,09 | 1,53 | 2,13 | 2,72 |
| Xenotest, hours | 6 | 3158 | 9350 | 10958 | 13888 | 14,14 | 11,94 | 14,87 | 14,16 | 45,64 | 147,06 | 170,66 | 218,43 | 14,14 | 11,94 | 14,87 | 14,16 |
| | 12 | 2358 | 7100 | 8220 | 9722 | 8,25 | 9,51 | 11,75 | 12,21 | 31,93 | 105,03 | 119,18 | 146,00 | 8,25 | 9,51 | 11,75 | 12,21 |
| | 18 | 1644 | 4300 | 6070 | 8987 | 5,16 | 7,23 | 8,50 | 10,74 | 20,50 | 55,71 | 85,01 | 119,64 | 5,16 | 7,23 | 8,50 | 10,74 |
| | 24 | 889 | 2321 | 3035 | 5915 | 2,85 | 3,27 | 4,48 | 6,85 | 12,14 | 35,24 | 45,06 | 81,07 | 2,85 | 3,27 | 4,48 | 6,85 |

In order to compare the degree of affect of exposure duration of natural and artificial insolation conditions on mechanical properties of para-armide fibers, relationships have been made, which are illustrated in Fig. 1, 2.

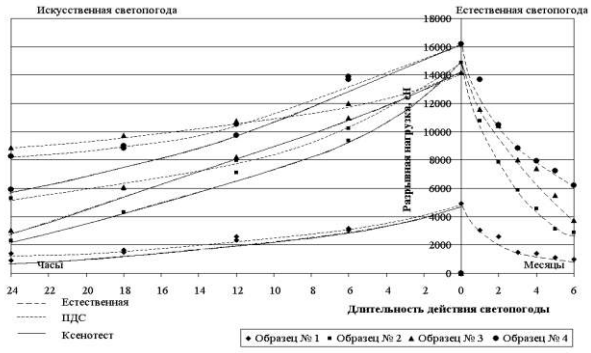


Fig. 1

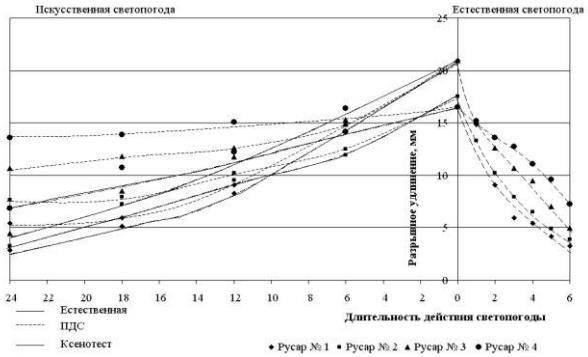


Fig. 2

It can be seen from the diagrams that test values, obtained after insolation in Xenotest device, are close to results obtained after natural insolation. Consequently, 24 hours of light and weather exposure in Xenotest device correspond to 6 months of exposure under natural conditions.

Affect of light weather in DLD on para-aramide fibers is less destructive.

On Fig. 1, 2 diagrams of change of breaking load and elongation at rupture of fibers under investigation depending on insolation time are given. Based on analysis of approximation results of obtained values, conclusion can be made that dependence of breaking load from elongation at rupture of these Rusar fibers from exposure duration with a high degree of accuracy is determined by the following exponential function:

$$y = ae^{-bx}, \qquad (1)$$

where y – breaking load, cN or elongation at rupture, mm; x – durability of light and weather exposure, month or hours; a, b – design coefficients.

As a result, change of radiant energy source does not effect the character of change of mechanical characteristics, but intensity of reduction of strength characteristics does change.

## CONCLUSIONS

Investigation of influence of different methods of treatment of Rusar fibers on change of mechanical characteristics after light and weather exposure has been carried out. It has been established that heat-treated Rusar fibers have a more ordered structure and, as a sequence, higher tenacity as well as light and weather fastness. Consequently, it is advisable to employ this yarn during manufacture of different products that are used for operations carried out in conditions of natural light and weather, including cloths for protective vests providing reliable ballistic protection in case of active light and weather exposure.

Radiation with Xenotest device takes places more rapidly than in DLD, therefore testing by means of the weathering testing equipment Xenotest can be called as express method.

When selecting test conditions, nature of radiation source is to be taken into consideration in order to obtain more accurate results.

## BIBLIOGRAPHY

1. GOST 10793–64. Cotton, viscose, staple and blended fibers. Method for determination of fabric fastness to photooxidative degradation.

2. GOST 6611.2–73. Textile fibers. Method for determination of breaking load and elongation at rupture.

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