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PROCESS OF INCREASING THE TENSILE STRENGTH OF CYANOETHYLATED COTTON TEXTILE FIBERS BY SOAKING IN SPECIFIC CHEMICALS AND PRODUCTS PRODUCED THEREBY

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This invention relates to an improved form of cyanoethylated cellulose and particularly cyanoethylated cotton.

In recent years the cyanoethylating of cellulose has attracted increasing interest because of the number of advantages obtained by the treatment, notably greatly increased mildew proofing, crease abrasion resistance, heat resistance and in most cases a moderate increase in tensile strength and in tenacity. The best cyanoethylated yarns show a nitrogen content of from about 3 to 4½%. For some purposes even greater tensile strength and tenacity are desirable. The present invention relates to processes and product which effect improved tensile strength and tenacity.

We have found that treatment with various liquids bring about changes in cyanoethylated cotton and similar cellulose fibers resulting in increased tensile strength and usually increased tenacity. For the most part, percentage elongation is not greatly changed, varying from slight decrease to moderate increase. It is not known what the treatment actually does to the fiber, and whether the change is of a chemical, physical or other nature. Therefore, the present invention is not intended to be limited to a theory of why the improved tensile strength is obtained or to a mechanism by which the improvement results. Similarly, insofar as the final product is concerned, it is not known whether there has been any chemical change. There is a very definite physical change in properties.

The treating liquids belong to three classes. First is polyhydric alcohols, such as glycols, glycerine, ether alcohols of the polyglycol type, polyvinyl alcohol in low degrees of polymerization where it is soluble in water and the like. The second class are aqueous solutions of salts of polyvalent metals which are not strong bases, such as, for example, copper sulfate, zinc sulfate and the like. The third liquid is concentrated nitric acid. In each case, a marked increase in tensile strength is obtained. In most cases, the degree of swelling is comparable to that effected by cyanoethylation, which as a general thing results in a moderate increase in denier. Only in the case of copper sulfate solutions is the swelling sufficiently greater than with cyanoethylated cotton alone, so that the tenacity is not increased.

In general, except in the case of concentrated nitric acid, the treatment requires a fair amount of time. For example, periods of time up to about an hour. In each case, it is desirable that the yarn be under slight tension. In the case of concentrated nitric acid, a very short exposure time, i.e., less than that which results in apparent fiber degradation, of the order of magnitude of several minutes is desirable. In general, temperature is not critical, and it is an advantage of the present invention that the treatment may be effected at room temperature. Somewhat higher temperatures may be used, but with concentrated nitric acid, the increased speed of whatever reaction takes place renders the control of the treatment somewhat critical, and for simplicity of operation, therefore, it is undesirable to use materially elevated temperatures when treating with concentrated nitric acid. In

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each case, after treatment, a thorough washing with water is required as it is undesirable to leave any of the unreacted treating chemical in contact with the finished yarn. This is not to say that there has been no reaction taking place, but it is essential that the treating chemical be thoroughly washed out for, if in fact there is a chemical change in the fiber, the amount of treating material is greatly in excess of that which actually enters into reaction. It is desirable to effect washing while the yarn is still under slight tension. Material used in the specific examples which follow was of standard, plain cotton yarn, 40s/-2 unmercerized. Part of the yarn had been cyanoethylated to a nitrogen content of 3.31% and all results on cyanoethylated cotton were from the same shipment so that variations other than that introduced by the treatment of the present invention were completely eliminated.

The invention will be described in greater detail in conjunction with the following specific examples, the physical properties of the products obtained being summarized in a table following the examples.

Example 1

Eight meter lengths of cotton yarn were wound around wire gauze cylinders under slight tension. The cylinders were arranged in pairs, one being cyanoethylated yarn and the other plain yarn. The cylinders were subjected to soaking at room temperature with ethylene glycol for a period of approximately one hour at temperatures between 20 and 30° C. The cylinders were then removed from the soaking bath and washed thoroughly with water until the wash water was substantially free of ethylene glycol. The cylinders were then dried at 70° C. under the slight original tension.

Example 2

The procedure of Example 1 was followed substituting glycerine for ethylene glycol.

Example 3

The procedure of Example 1 was repeated, substituting diethylene glycol for ethylene glycol.

Example 4

The procedure of Example 1 was repeated, replacing the ethylene glycol with an aqueous solution of polyvinyl alcohol.

Example 5

A pair of gauze cylinders containing plain cotton yarn and cyanoethylated cotton yarn as described in Example 1 were contacted at room temperature with concentrated nitric acid for two minutes. They were then removed and washed thoroughly with water until the wash water was substantially free of nitric acid. There upon the cylinders were dried at 70° C. as described in Example 1.

Example 6

The procedure of Example 1 was repeated, replacing the ethylene glycol with the 6% aqueous solution of copper sulfate.

Example 7

The procedure of Example 6 was repeated, replacing the copper sulfate solution with a 6% zinc sulfate solution.

Example 8

This example produced control yarn. Again two wire gauze cylinders were wound with plain cotton and cyanoethylated cotton, respectively, as described in Example 1 and were subjected to the water washing and drying treatment as described in the preceding examples. They were, however, not treated with any of the soaking liquids.

In this example, as in all others, the tension under which the yarn was wound on the wire gauze cylinders was kept the same and temperatures were kept in the same range, except that in the case of the nitric acid treatment, the temperature was not permitted to rise materially above room temperature.

The properties of the products of the different examples are set forth in the following table.

Type of Cotton	Liquid Soak	Denier	Tensile Strength in Grams	Percentage Elongation	Tenacity
Plain	None	273	600	5.0	2.2
Cyanoethylated	do	304	760	5.5	2.5
Plain	Ethylene Glycol	290	590	5.0	2.0
Do	Glycerine	251	565	5.0	2.2
Do	Diethylene glycol	275	595	5.0	2.2
Cyanoethylated	Ethylene glycol	299	800	6.0	2.7
Do	Glycerine	313	800	6.0	2.6
Do	Diethylene glycol	313	835	6.0	2.7
Plain	Aqueous polyvinyl alcohol	281	280	2.0	1.0
Cyanoethylated	do	290	805	5.0	2.8
Plain	Cone. HNO ₃	258	155	0.5	0.6
Do	6% CuSO ₄	297	155	1.0	0.5
Do	6% ZnSO ₄	274	160	1.0	0.6
Cyanoethylated	Cone. HNO ₃	298	865	4.5	2.9
Do	6% CuSO ₄	321	795	5.0	2.5
Do	6% ZnSO ₄	304	790	5.5	2.6

It will be noted that cyanoethylation resulted in a substantial swelling of the yarn, increasing the denier from 273 to 304. This is normal with cyanoethylation procedures. Tensile strength increased considerably more than the swelling, and therefore the tenacity increased. At the same time there was a slight increase in percentage elongation. As a result the tenacity was also substantially increased.

Treatment with polyhydric alcohols in the case of the plain cotton resulted in loss of tensile strength ranging from slight in the case of the low molecular polyhydric alcohols to very great in the case of aqueous polyvinyl alcohol. For the most part, there was no significant swelling, and in the case of glycerine, there was actually a considerable shrinkage. As a result, tenacity varied from the same figure as the plain cotton down to less than half in the case of aqueous polyvinyl alcohol.

When the cyanoethylated cotton was treated with the polyhydric alcohols, a very different result was noted. Again the swelling varied from less than that for cyanoethylated cotton alone to slightly more for the material treated with glycerine or diethylene glycol. There was, however, a very substantial increase in tensile strength, and as a result a substantial increase in tenacity. The lower molecular weight polyhydric alcohol resulted in a substantial increase in percentage elongation, whereas aqueous polyvinyl alcohol had the same figure as plain cotton.

With the copper sulfate the swelling was such that the tenacity remained the same.

We claim:

1. The process of treating cyanoethylated cotton textile fibers having a degree of cyanoethylation corresponding to a nitrogen content of from about 3 percent to about 4½ percent which consists essentially of soaking said fibers with ethylene glycol for a period sufficient to increase the tensile strength of the fibers.

2. The process of treating cyanoethylated cotton textile fibers having a degree of cyanoethylation corresponding to a nitrogen content of from about 3 percent to about 4½ percent which consists essentially of soaking said fibers with glycerine for a period sufficient to increase the tensile strength of the fibers.

3. The process of treating cyanoethylated cotton textile fibers having a degree of cyanoethylation corresponding to a nitrogen content of from about 3 percent to about 4½ percent which consists essentially of soaking said fibers with diethylene glycol for a period sufficient to increase the tensile strength of the fibers.

4. The process of treating cyanoethylated cotton textile fibers having a degree of cyanoethylation corresponding to a nitrogen content of from about 3 percent to about 4½ percent which consists essentially of soaking said fibers with a dilute aqueous copper sulfate solution for a period sufficient to increase the tensile strength of the fibers.

5. The process of treating cyanoethylated cotton textile fibers having a degree of cyanoethylation corresponding to a nitrogen content of from about 3 percent to about 4½ percent which consists essentially of soaking said fibers with a dilute aqueous zinc sulfate solution for a period sufficient to increase the tensile strength of the fibers.

6. The process of treating cyanoethylated cotton textile fibers having a degree of cyanoethylation corresponding to a nitrogen content of from about 3 percent to about 4½ percent which consists essentially of soaking said fibers with an aqueous solution of polyvinyl alcohol for a period sufficient to increase the tensile strength of the fibers.

7. The product produced by the process of claim 1.
8. The product produced by the process of claim 2.
9. The product produced by the process of claim 3.
10. The product produced by the process of claim 4.
11. The product produced by the process of claim 5.
12. The product produced by the process of claim 6.

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