STUDY OF THE EFFECT OF TEMPERATURE AND HUMIDITY ON NYLON FABRICS UNDER STORAGE

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ABSTRACT

Investigations were undertaken to study the effect of temperature and humidity on the storage life of nylon fabrics. Nylon fabrics were stored under controlled conditions of temperature and humidity and their breaking and bursting strength were determined periodically. It was found that there was no significant change in the strength of the fabrics even after a period of about 8½ years when stored at temperatures as high as 85°F and relative humidities as high as 90%.

Introduction

Nylon is a synthetic fibre—a long chain polyamide type resulting from the condensation of hexamethylene-diamine and adipic acid. It is known to have a high tenacity, a high resistance to abrasion and general immunity against attack by micro-organisms. These features have contributed to its increasing demand for use in apparel fabrics and service items. A review of the literature shows that nylon when exposed to sunlight loses considerable strength [1, 2, 3] but no specific informaton is available as regards the effect of temperature and humidity on the nylon when stored under normal storage conditions away from sunlight. Messrs British Nylon Spinners Ltd., have in their technical publications on nylon, recommended the maintenance of the lowest practicable humidity and temperature, absence of direct sunlight and adequate ventilation for purposes of storage.

It was felt that while protection from sunlight and provision of adequate ventilation could easily be ensured, it may not always be practicable in a country like India to provide for the storage of fabrics resorting to the costly methods of air-conditioning or other similar elaborate arrangements. It was therefore, considered useful to study the effect of temperature and humidity on nylon fabrics during storage and also to ascertain how long nylon fabrics could safely remain in storage without significant deterioration.

Experimental

Investigations were undertaken with two nylon fabrics one white (No. 1) and the other light olive drab (No. 2). The storage trials were planned at 70°±2°F and 85°±2°F and relative humidities 30, 40, 50, 60, 70 and 80% which normally exist in storage depots in different parts of India throughout the year.

In order to study the rate of deterioration in the strength of fabrics, test strips 2″×10″ in dimensions were cut out in the warp direction and divided into two groups, each one being selected for storage under different conditions of temperature and humidity. Only the warp strips were selected for this investigation since the breaking strength results in the warp direction are known to vary to a lesser extent than in the weft.

The cut strips were stored in large desiccators, in which relative humidities of 30, 40, 50, 60, 70 and 80% respectively were maintained by means of aqueous solutions of potassium hydroxide of appropriate concentrations. These desiccators were then kept in two rooms in which constant temperatures of 70°F and 85°F respectively were maintained throughout the period of storage.

The test strips were removed from the desiccators for determining the breaking strength in two sets at intervals of one month initially which was later raised to 2 months and afterwards to 3 months. The breaking strength test results on the fabrics No. 1 and 2 are given in tables I and II respectively. The results showed that there was no significant change in the strength of the nylon fabrics after a storage period of about two years.

Further trials were then undertaken to see how long nylon fabrics could be stored without deterioration. For this purpose two nylon fabrics undyed (No. 3) and dyed olive drab (No. 4) which had already been in storage for over six years, were selected. The storage trials were conducted on the same lines as for fabrics 1 and 2 except that the fabrics were stored in three different relative humidities viz. 30, 60 and 90% in lieu of six and the relative humidity was raised from 80% to 90%. Bursting strength test was also included in addition to the breaking strength test. The test results obtained periodically on these nylon fabrics are give in tables III and IV.

Discussion

The results at tables I to IV however, show that all the four fabrics did not register any significant loss in their strength after being in storage. Fabrics No. 1 and 2 were in storage for about two years and fabrics No. 3 and 4 for over eight years of which six years were in a storage depot in India and about two years in the laboratory under controlled conditions of different humidities and temperatures. Since it was felt that the investigation could be completed earlier if fabrics which had already undergone a certain period of tropical storage were used, fabrics No. 3 and 4 which had been stocked in a depot for over six years, were selected for the latter part of the investigation instead of continuing the same with fabrics No. 1 and 2.

It is also interesting to note from the results in tables I to IV that, unlike the case of textile materials made from natural fibres, the changes in the humidity, however large, have no significant effect on the strength of nylon fabrics. This is possibly due to its much less moisture regain ($6\frac{1}{2}$% at 100% RH) as compared to the natural fabrics, the moisture regain of some of which is as much as 35% at 100% Relative Humidity. It is stated in the book by Kaswell[4] that "for each fiber the greater the degree of hydrophobility, less is the difference between the dry and wet diagrams and Nylon, Orlon, Dacron and Dynel show small or no difference because they absorb little or no water",

As there was no appreciable difference in the life of nylon fabrics after storage for over 8 years under temperatures upto 85°F and relative humidity upto 90% which are ordinarily prevalent in well ventilated storage depots in India, it can safely be inferred that nylon fabrics are capable of being stored over long periods of time without any fear of deterioration.

Conclusion

Nylon fabrics can be safely stored indoors for long periods of time at temperatures upto 85°F and relative humidity upto 90%. No elaborate storage arrangements such as air conditioning therefore, appear to be absolutely necessary for the purpose of their safe storage in the tropics.

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TABLE I

Fabric No. 1 Cloth .. Undyed

Temperature of storage 70°F

% R.N.	Average Breaking Strength in lbs after storage for months											
	Initial	1	2	3	5	7	9	11	13	15	19	22 months
30	132	134	131	129	122	126	120	128	133	131	130	128
40	132	132	133	141	134	139	132	129	131	129	136	129
50	132	134	131	137	137	136	135	138	137	139	140	128
60	132	120	129	138	138	140	132	137	132	135	142	133
70	132	130	131	130	137	136	134	138	137	133	138	134
80	132	131	134	135	137	132	125	140	142	139	142	134

TABLE II

Fabric No. 2 Cloth ... Dyed light Olive Drab

Temperature of storage 85°F

% R.N.	Average Breaking Strength in lbs after storage for months										
	Initial	1	2	4	6	8	10	13	16	19	22 months
30	122	123	123	122	120	117	128	128	118	118	117
40	122	123	117	120	121	115	118	125	115	118	118
50	122	120	118	121	119	110	119	128	127	119	118
60	122	119	123	124	123	117	125	125	125	121	118
70	122	117	120	124	124	116	118	126	127	119	119
80	122	120	120	121	124	115	123	119	126	118	117

TABLE III

Breaking strength and bursting strength results on Fabric No. 3

Storage periods	Breaking strength in lbs.						Bursting strength in lbs./Sq. inch.					
	Temperature 70°F			Temperature 85°F			Temperature 70°F			Temperature 85°F		
	30% R.H.	60% R.H.	90% R.H.	30% R.H.	60% R.H.	90% R.H.	30% R.H.	60% R.H.	90% R.H.	30% R.H.	60% R.H.	90% R.H
Initial	118	117	115	117	118	118	167	168	164	163	165	164
After 3 Months	110	109	107	106	107	106	162	164	164	163	163	164
„ 6 „	119	116	115	118	115	116	177	175	170	170	171	170
„ 10 „	115	114	112	111	112	108	165	173	170	168	170	167
„ 16 „	115	113	110	111	110	108	166	170	167	162	163	162
„ 22 „	123	118	122	122	121	121	158	156	155	157	156	154
„ 28 „	111	108	106	108	108	106	*	*	*	*	*	*

*Further Bursting Strength readings could not be taken due to the test apparatus going out of order.

TABLE IV

Breaking strength and bursting strength results on Fabric No. 4

Storage period	Breaking strength in lbs.						Bursting strength in lbs./Sq. inch					
	Temperature 70°F			Temperature 85°F			Temperature 70°F			Temperature 85°F		
	30% R.H.	60% R.H.	90% R.H.	30% R.H.	60% R.H.	90% R.H.	30% R.H.	60% R.H.	90% R.H.	30% R.H.	60% R.H.	90% R.H.
Initial	125	124	123	119	121	117	174	174	169	175	178	175
After 9 months	110	114	111	109	105	105	175	171	172	170	172	169
„ 18 „	119	121	121	119	120	116	166	155	159	156	162	153
„ 27 „	123	123	126	124	120	120	*	*	*	*	*	*

*Further Bursting Strength readings could not be taken due to the test apparatus going out of order.