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Measurement of Inverse Creeps in Nylon Multifilament Yarns

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Abstract: *Creep and Inverse creep are the important fundamental properties of textile materials. These properties determine the relaxation behavior of the product. We have designed and fabricated an instrument which can measure the creep and inverse creep. The instrument consists of a Trans - Receiver unit interfaced with Embedded System along with the Personal Computer. Existing technique for measuring inverse creep does not measure the instantaneous extension or contraction. The newly fabricated instrument, can measure the instantaneous extension and contraction of the yarn of an accuracy of 0.02%. This can be measured after every 500 µs. The position of the yarn, which is to be hanged, is vertical. The 'Electronic Timer Unit', replaces a meter scale. Set up is improved by using electronic utilities. The capability is enhanced to next level of time and distance resolutions. Automation enables to have flexibility of time from microseconds to minutes. Data is stored in different text files. Different samples of Nylon multifilament yarn were used in the experiment. The length and the load were altered. Change in stress lead to instantaneous extension or contraction followed by creep or inverse creep. This can sensed by the sensor and further stored in the memory of the Computer. The percentage creep and inverse creep were measured and have been reported in this present paper. Your paper should be in the same format as this file. The abstract goes here. Your abstract should be a maximum of 200 words here clearly outlining the contribution of your paper. Abstract is in italic fonts.*

Keywords: Creep, Inverse creep, Transmitter, Receiver, Embedded System, Nylon-6.

I. Introduction

Creep has been known and studied for textile materials for decades. In comparison, a newly observed phenomenon of inverse creep seems not to have received much attention. A new instrument has been fabricated to measure creep and inverse creep in textile materials particularly yarns. Creep and Inverse creep measurements on a few Nylon Multifilament Yarns at different levels of stress have been studied, using the new instrument and results are reported in the present paper clearly explain the nature of the problem, previous work, purpose, and contribution of the paper.

II. Materials and Methods

2.1 Materials

Nylon multifilament yarn of 70 denier, 24 filaments (sample A) and 111 denier, 24 filaments (sample B) and were used in the study. Gauge length was kept as one meter (1 m). Yarn was loaded with a pan with clamping arrangement. This assembly weighed 28 gm.

2.1.1. Nylon Multifilament Yarn of 111 Denier

A weight of 117 gm was added to the pan, developing tension of 145 gm in the yarn. After every 5 minutes loads of 25 gm, 25 gm, 25gm, 25 gm, and 17 gm were removed from the pan sequentially. Five times this method was repeated. In the second observation, with same yarn, a weight of 92 gm was added in the pan. After every 5 minutes loads of 25gm, 25 gm, 25 gm and 17 gm were removed from the pan sequentially. Five times this method was repeated.

In the third observation, with same yarn, a weight of 67 gm was added in the pan. After every 5 minutes loads of 25 gm. 25gm and 17 gm were removed from the pan sequentially. Five times this method was repeated.

2.1.2. Nylon Multifilament Yarn of 70 Denier:

Just like in the above yarn of denier 111, the same combination of load was selected for the yarn of denier 70.After every 5 min same combinations of weights were removed from the pan. Thus loads on the pan with respect to time, for both yarns of denier 70 and denier 111 are as given below:

Obs. No.	Time Duration (min)	Load (gm) Weight in the pan + 28.36gm	Load (gm) Weight in the pan+ 28gm Load (gm)	Load (gm) Weight in the pan + 28gm
1	0 min – 05 min	117+ 28.36 = 145.36	92 + 28.36 = 120.36	67 + 28.36 = 95.36
2.	5 min – 10 min	120.36	95.36	70.36
3.	10 min – 15 min	95.36	70.36	45.36
4.	15 min – 20 min	70.36	45.36	28.36
5.	20 min – 25 min	45.36	28.36	--
6	25 min - 30 min	28.36	--	--

The peripherals which are used in an instrument are as follows:

1. Ultrasonic Trans-receiver: Trans-receiver (Operating Frequency: 40 KHz): It is a pair of pezo-electric transducers.
2. Oscillator: It consists of Schmitt-Trigger NAND gate (IC 4031) and R-C network, which produces 40 KHz frequency signal. The output of the Oscillator is given to one terminal of the Transmitter and the same out put of the Oscillator is inverted and is fed to the second terminal of the transmitter.
3. Amplifier: It is a combination of a inverting and non-inverting amplifiers designed by Operational Amplifiers (IC 741). The appropriate gain is adjusted.
4. Buffer: This is a tri - state buffer generally known as a line driver. IC 74LS244 is used for this purpose
5. Level shifter: Basically it converts the signal ± 2.5V to Digital Signal (0V-5V). Consists of a common emitter amplifier. PNP transistor is used. (SL - 100)
6. Embedded System Unit: An Embedded system with a Micro-Controller 89V51RD2 is used which has serial and parallel ports. IC 89V51RD2 (Philip's Make) is used and run by Assembly Language Program.
7. The Assembly Language Program is a source program, which waits for the transmitted pulse and on receiving the same; it starts the internal timer and immediately stops the Oscillator. So this disables instantly the transmitter. Receiver receives the first transmitted pulse. The moment the transmitted pulse is received by the receiver it sends the pulse to the microcontroller. On getting this pulse the timer stops and the time difference is loaded on the ports. A pulse is sent to the PC to indicate that data is available on the port. Computer receives the data and sends a pulse to the microcontroller, indicating it to have the next pulse from the transmitter. The cycle repeats again.
8. Personal Computer: Intel Branded motherboard with Flash Magic Software and a Turbo-C editor is used. Flash Magic Software is used to load the Assembly Language Program in Micro Controller IC- 89C51RD2 through the serial port. The C- language program is used to load the data (time difference) in the PC. The program stores up to1000 data units in the file. And after that it opens another text file to store next 1000 data items. The data port of the Printer Port is used to transfer data items from Micro Controller Port to the PC. For Hand Shaking (acknowledgement) between Micro Controller and PC, one terminal of both Control port and Status Port is used. Microsoft Excel can be used to see the results graphically.

Patent application for the device has already been filed with the Controller General of Patents, Mumbai Office, India (850 / MUM / 2007).

2.2 Methods;

2.2.1 Operating Procedures

Yarn segment is caught at both the ends by clamps. One end is hooked at the upper end of the 3m stand. At the other end the weighing pan is attached on which the load can be enforced at a particular time instant. When the load is put in the pan, the first pulse from transmitter is transmitted and instantaneously the Timer is started in the Micro-Controller. When the receiver receives the same pulse, the Timer is stopped. The Timer of the Micro-Controller computes the time duration and it puts the byte on its port. Thus time taken by the ultrasonic pulse to travel from transmitter to receiver is measured. This time is usually in microsecond. Moment the pulse is sensed by the receiver circuit, it send signal to the transmitter circuit to put off the transmission. Once the data is processed and stored in the data file by the computer, computer sends signal to the transmitter to start transmitting signal again. The time duration in the successive measurements is approximately one second. This can be reduced to few microseconds with the same Instrument.

Time lag between the transmission of the pulse by the transmitter till it is received by the receiver is converted into change in distance between the two transducers which is nothing but the displacement. Thus with the passage of time measured by the timer of the computer, displacement of the receiver and therefore, the extension in the yarn is measured to a great accuracy. (Fraction of mm)

The extension / reduction in length of the yarn are being stored in the data file of the P.C., for about every second. This text file then can be opened in MS-Excel. From the data and the corresponding graph, the creep and inverse creep behaviour can be observed.

III. Results and Discussions

A typical inverse creep graphical presentation is shown in FIG.1. Point O corresponds to the start of the experiment. At O, certain load (that is stress S_1) is applied to the yarn. As a result there is immediate extension OA in the yarn followed by extension corresponding to the curve AB over a period zero to t_1.At the time t_1, the stress S_1 is reduced partially to S_2 by removing a part of the load. Corresponding to this reduction in stress from S_1 to S_2, we get immediate reduction BC in the extension of the yarn, followed by the reduction in extension corresponding to the curve CD over the period from t_1 to t_2. In the present experiments, zero to t_1 and t_1 to t_2 were both 300 sec. It may be seen from figure that extension A'B' corresponds to creep in the specimen over the period zero to t_1 under stress S_1.The reduction in extension C'D' corresponds to inverse creep in the specimen at reduced stress level S_2 over the period t_1 to t_2.These creep and the inverse creep values have been reported in tables.

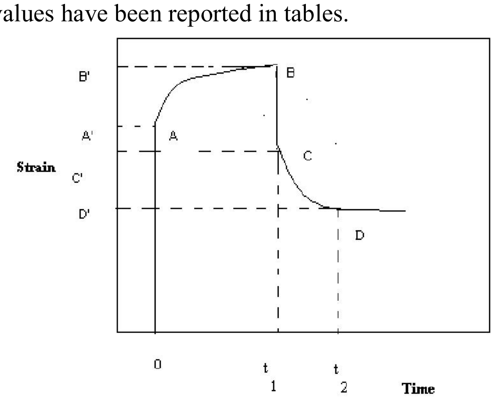


Figure 1

Table A and Table B give inverse creep data for the two yarn samples A and B respectively, studied with initial stress S_1 corresponding to 120 gm load. This load was reduced by 25 gm after every 300 sec and 17 gm last time, giving reduced stresses in the yarn. The stress values are expressed in mN/dtex while the extension values are expressed in percentage of initial length of the yarn. The length of the yarn was maintained at 1m.

For the Yarn A having denier 70, of length 1m, it may be seen from figure that at stress level S_1 both the samples show creep as expected. For reduced stress levels S_2, S3, S_4, S_5, S_6 all the samples show inverse creep. When 148.36

gm load is reduced to 120.36 gm, it is found that the ratio of inverse creep at stress S_2 to creep at S_1 is comparatively small (8.23%). When the load is reduced by 25 gm four times, the inverse creeps at reduced stresses S_2, S_3, S_4, S_5, are 8.23%, 21.36%, and 17.05 %, with respect to the creep at S_1 respectively. Fifth time load of 17 gm was removed. And inverse creep was noted. The ratio is 21.17%. For the same Yarn A of denier 70, -of length 1m, the initial weight is taken as 120.36 gm and then it is reduced to 95.36gm, 70.36 gm, 45.36 gm, and 28.36 gm. The respective ratios of inverse creep values with respect to the creep value are 08.97%, 08.69%, 28.57%, and 24.22%.

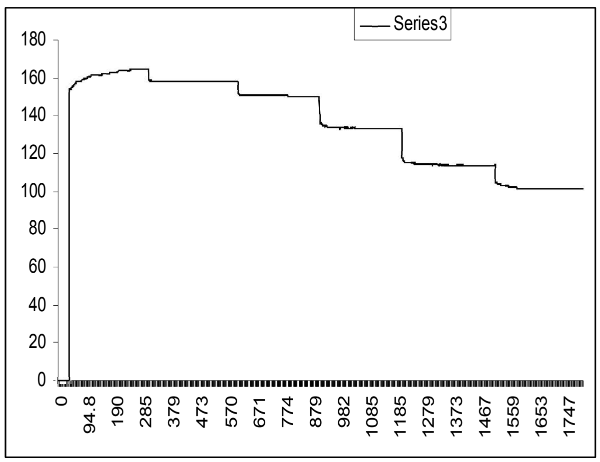
In the third attempt Yarn A is loaded initially with 95.36 gm and 25 gm of weight is removed after each 5 minutes. And finally weight of 17 gm is removed. The observed percentage inverse creep with respect to the creep is 9.73%, 25.95% and 34.51% respectively. From the above results it can be seen that the inverse creep for Yarn A of denier 70, of length 1m, is not uniform.

For the another Yarn B of denier 111, when the load is reduced by 25gm four times, 20 gm last time. The inverse creep at reduced stress S_2, S3, S_4, S_5, S_6 is 14.29%, 19.06%, 26.20%, 38.12%, and 38.12% of the creep at S_1 respectively.

The initial load values were altered further and were kept 120.36 gm and 95.36 gm. The ratios of percentage inverse creep with respect to the creep are 8.61%, 20.0%, 24.0%, 27.20 and 14.60%, 9.20%, 20.80%.

From the above results it can be seen that the inverse creep for Yarn B of denier 111, of length 1m, is not uniform.

Table A: Yarn A; Nylon Multifilament Yarn of 70 Denier and 24 Filaments.



Extension verses Time curve of 70 Denier Yarn.

(*Negative sign indicates the Creep in the Yarn)

Obs No.	Time (sec)	Stress (mN/ dtex)	Ext/Cont (Initial Load 145.36 gm)	Inverse Creep(%) (Init. Load 145.36 gm)	Ext/ Cont (Initial Load 120.36 gm)	Inverse Creep(%) (Init. Load 120.36gm	Ext/Cont (Initial Load 95.36gm)	Inverse Creep (%) (Init. Load 95.36 gm)
01.	0	03.6	0	-	0	-	0	-
02.	0.8 S_1	18.3	149.2	-	115.8	-	86.9	-
03.	300	18.3	166.2	-1.70*	166.2	-1.61*	98.2	-1.13*
04.	300.8 S_2	15.2	160.9	-	158.0	-	90.8	-
05.	600	15.2	159.5	0.14	156.7	0.13	89.6	0.11
06.	600.8 S_3	12.0	153.3	-	143.0	-	73.7	-
07.	900	12.0	151.8	0.14	141.2	0.14	70.2	0.34
08.	900.8 S_4	08.9	138.6	-	123.9	-	53.9	-

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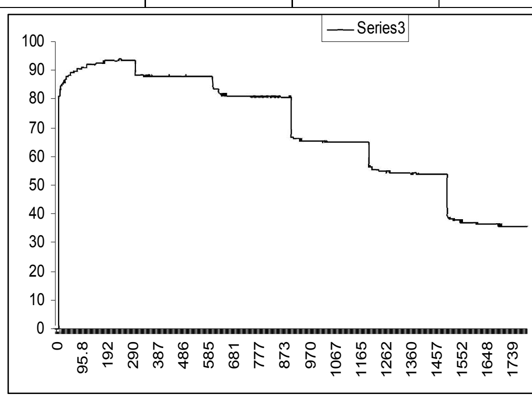
09.	1200	08.9	136.1	0.25	120.8	0.46	49.9	0.39
10.	1200.8 S_5	05.7	118.9	-	109.2	-	-	-
11.	1500	05.7	116.0	0..29	105.2	0.39	-	-
12.	1500.8 S_6	03.6	102.4	-	-	-	-	-
13.	1800	03.6	98.7	0.36	-	-	-	-

Table B: Yarn A; Nylon Multifilament Yarn of 111 Denier and 24 Filaments

Obs No.	Time (sec)	Stress (mN / dtex)	Ext/Cont (Initial Load 145.36gm	Inverse Creep (%) 145.36 gm	Ext/Cont (Initial Load 120.36 gm	Inverse Creep (%) 120.36 gm	Ext/Cont (Initial Load 95.36gm	Inverse Creep (%) 95.36 gm
01.	0	2.3	0	-	0	-	0	-
02.	0.8 S_1	11.6	150.2	-	115.8	-	86.9	-
03.	300	11.6	165.8	-1.55*	131.9	-1.25*	98.2	- 0.89 *
04.	300.8 S_2	9.6	161.0	-	123.7	-	90.8	-
05.	600	9.6	158.9	0.21	122.4	0.13	89.6	0.13
06.	600.8 S_3	7.6	153.3	-	108.8	-	73.7	-
07.	900	7.6	152.0	0.23	106.9	0.25	70.2	0.24
08.	900.8 S_4	5.6	138.7	-	89.6	-	53.8	-
09.	1200	5.6	136.2	0.34	86.5	0.30	49.9	0.26
10.	1200.8 S_5	3.6	118.9	-	74.8	-	-	-
11.	1500	3.6	116.1	0.54	70.9	0.34	-	-
12.	1500.8 S_6	2.3	102.6	-	-		-	-
13.	1800	2.3	98.7	0.50	-		-	-



Extension verses Time curve of 70 Denier Yarn.
(*Negative sign indicates the Creep in the Yarn)

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IV. Conclusion

From the above observations it is seen that the percentage inverse creep increases when the reduced stress decreases in case of both the samples of Nylon yarn. It is quite evident from the above results that all these materials exhibits inverse creep and the extent of inverse creep increases as the stress is decreased. Inverse creep value is dependent on its stress history. The phenomenon is newly observed and has not been much studied. The present attempt is the just the beginning of its study. Lot more work needs to be done on different types of textile material.

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4. Tata Institute of Fundamental Research, Mumbai.
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