DYNAMIC FRICTION MEASUREMENTS OF EGYPTIAN COTTON YARNS

Part 1: Study of frictional behaviour of two component blended staple yarns.

by

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ABSTRACT:

In the present work, the dynamic frictional characteristics of egyptian cotton, Misr polyester and cotton / polyester blended staple yarns were studied. The frictional coefficient of yarns heve been determined by wrapping around a cylindrical pin. The electronic F- Meter R 1182 of firm Rotschild Zurich was used. The frictional coefficient of blended yarns was found to be influenced by fiber constituents, blend proportion, yarn linear density, threadline speed, pretension and angle of contact (loop size).

I. Introduction:

Textile materials pass over many kinds of surfaces and rub against each other during yarn and fabric manufacturing operations. The complexity of these operations and the large number of factors which affect yarn friction have so far made it difficult to correlate many data found in the literature.

In textile industry many variaties of yarns are produced, such as staple yarns, ring or open-end, two component blended yarns, and plied structure yarns. Very little is known about their frictional behaviour. The frictional properties of these yarns are important in many textile process, as winding and weaving operations .The proper functioning of the sewing machines as well as knitting machines are considerably affected by the frictional properties of yarns and threads.

In order to study dynamic frictional behaviour of egyptian cotton and their blended yarns, a suggested plan of work is being made and the subject will be declared through a series of papers. The expereiments lie in two lines to study the frictional properties in term of :

i) Effect of technological variables which include fiber properties, yarn parameters "structure, twist and linear density", chemical treatment (mercerization) and finishing operations (waxing and dying).

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ii) Effect of variations in test conditions: threadline speed, the angle of wrap, pretension, guide diameter, surface roughness, loop size, temprature and moisture content upon friction.

The initial paper of a series covers the effect of blend composition, cotton fiber types and yarn linear density on yarn friction. It also includes the effect of various changes in speed, pretension and angle of contact on cotton/polyester blended yarn frictional behaviour.

II. EXPERIMENTAL PROCEDURE:

2.1. Materials:

In the present work, the frictional chacteristics of many cotton varieties and their blends with Misr polyester fiber, were studied. In the fist set, the samples were selected and constructed into two groups :

i) Regarding the effect of cotton varieties and yarn linear density, the yarns were investigated included different cotton fibers (Giza 31. Giza 70 and Giza 75) also polyester staple yarn with varying yarn counts (30, 20, 15, 12 and 10 tex).

ii) In terms of blend composition, two types of carded blends (G70/PES and G31/PES blends) with blending ratios of 100%C, 50C/50PES, 33C/67PES, 25C/75PES and 100%PES. Also, the samples included three combed blends (G70/PES, G75/PES and G77/PES blends) with different blending ratios of 100C, 67C/33PES, 50C/50 PES, 33C/67PES and 100PES .

In the second set of experiments, the effect of changing test conditions were predominant throughout the following three groups:

i) Varying the threadline speed at seven levels, ranged between 2 and 300 m/min using two types of yarns (Ne 20 of 50C/50PES and Ne 60 of 100% PES .

ii) Varying the angle of wrap (loop size) at four levels (90, 180 360 and 720 degrees) each at five levels of threadline speed and using yarn count Ne 20 of Giza 31 cotton fibers.

iii) Varying the pretension at different levels using three yarns of counts Ne 20, 40 and 50 of cotton and cotton-polyester blends with constant or/and varying threadline speed.

2.2. Method of measurement:

Friction coefficients of threads have been measured by winding round cylindrical pin using F-Meter R 1183. A schematic diagram of the apparatus is shown in figure (1). The yarn is drawn by means of a take up device R 1083. The dynamic friction is calculated with the help of an analogue computer built in to the equipment, and which applies the well known Eytelwein formula:

($T_2/T_1 = e^{\mu\alpha}$) govering thread or rope friction.

where: T_1 Tension beyond the friction point
T_2 Tension before the friction point of contact
α Friction angle in rad.
μ The dynamic coefficient of friction
e Base of natural logarithim.

III. Results and discussion:

3.1. Effect of blend composition:

The effect of blend proportion on frictional properties of cotton /polyester blended yarns was investigated. the experimental results were represented graphically in figures (2.1), (2.2) and (2.3). It can be observed that the yarn coefficient of friction increases with increasing polyester content in blend. A similar trend has been found either for carded cotton- polyester or combed cotton-polyester blends.

The frictional properties of single component yarns, 100% cotton and 100% polyester, are illustrated in figure (3). A considerable variation in the frictional behaviour of these yarns has been observed. Polyester staple yarn gives higher values than that for all cotton yarns. The increase in friction as the percentage of polyester staple fibre increased in blend is attributed to the cylindrical shape of fibers which help in higher area of contact.

The curves in figures (2.1) and (3) show the influence of cotton varieties on the friction of 100% cotton and cotton/ polyester blended yarns. Giza 31 cotton fibers show a higher friction compared with those obtained from Giza 70 and Giza 75 cotton fibers. Also, the variation can be observed with carded blends, while for combed blends the value of coefficient of friction (μ) are very close to each other. This may be due to the variations in cotton fiber properties such as their fiber fineness and fiber length .

3.2. Effect of yarn linear density:

Different yarn counts Ne 20, 30, 40, 50 and 60 were tested to characterize frictional behaviour. Results are given for different cotton fibers and Misr polyester fibers.
The curves shown in figure (3) indicate that the yarn linear density (tex) has a significant effect on the yarn coefficient of friction. Dynamic friction increased with increasing yarn linear density. This behaviour is found for all yarns and attributed to an increase in area of contact. The effect of yarn count is in agreement with the results obtained by Schick / 3 / who studied

frictional properties of two synthetic yarns which differ widely in denier, and found that friction increased significantly with increasing denier .

3.3. Effect of threadline speed:

The effect of threadline speed on yarn friction was examined. The yarns were tested against a ceramic cylinderal pin , 8 mm diameter, at speeds ranging from 2 to 300 m/min. The other conditions maintained as nearly constant as possible. The angle of contact was chosen 180 degree and pretension 9 gramms.

The experimental results are illustrated graphically in figure (4), which shows the coefficient of friction of 50C/50PES and 100% polyester, is highly affected by threadline speed. the results indicate a general similarity between the curves relating cofficient of friction speed. Also, it can be seen that the increase in coefficient of friction is proprtional to threadline speed only up to 100 m/min. Upon further increase in speed, the coefficient of friction of yarn does increase but definitely less than the corresponding increase in threadline speed.

The above results are in agreement with many research workes / 1, 2 , 3 /. Also, in line with Olsen's / 1, 2 / findins a general pattern is followed with almost constant friction at higher speeds. These findins on the effect of speed on friction corroborate the postulate that fundamental differences exist in the frictional behaviour of textile yarns in the boundry, semi-boundry and hydrodynamic regions.

3.4. Effect of pretension:

To study the effect of pretension on yarn friction, investigation was carried out with varying pretensions from 4 grams to 16 grams. The other variables were kept constant .

The results are shown in figures (5.1) and (5.2) covering the widest range in pretension have been plotted in terms of friction versus pretension at constant speed for yarn counts Ne 20 and Ne 50 of Giza 70/polyester blend, also Ne 20 and Ne 40 of Giza 31 /PES blends.It is observed that an approximately linear relationship between friction and pretension does exist. Additional experiment covering the effect of pretension are represented in figure (5.3). It is evident from both curves at two levels of pretension, 8 and 17 grams, that friction force increases with increasing the value of pretension.

3.5. Effect of loop size (angle of contact):

The effect of loop size of a yarn around a cylindrical pin on friction at speed ranged from 20 m/min to 300 m/min has been stidied. The data obtained indicate that the frictional force at $\alpha = 720$ (two loops), $\alpha = 360$ (one loop), $\alpha = 180$ (half loop) and $\alpha = 90$ (one quarter loop). The results, shown in figure

(6), indicates that frictional values are proportioal to the angle of contact as well as threadline speed.

The results of the effect of loop size on friction is in agreement with the results obtained by Schick / 3 /. He mensions in his work that, in boundary region, an increase in contact area leads to an increase in fiber wear with consequent increase in stick-slip, where as in the hydrodynamic region, friction is proportional to are of contact / 4 /.

IV. Conclusions:

From the experiments is reported above some conclusions may be drawn:

1) The coefficient of friction between cotton/polyester blended yarns and cylindrical pin have been studied:

- The single component yarn of 100% of polyester staple fibers show a higher coefficient of friction than that produced of all egyptian cotton fibers.
- The friction of cotton/polyester blended yarns increases as the polyester content increase in blends.
- The variation between the two components (cotton and polyester) can be attributed to the nature of fibers surface.
- The friction increases as increasing yarn linear density. The increase is attributed to the overall yarn thickness (i.e. width contact).

2) The friction is affected by various changes in threadline speed, pretension and angle of contact (loop size).

- The increase in friction with increasing angle of contact and increasing pretension is attributed to an increase in area of contact.
- The variation in threadline speed within the limit of the previous experimentation, i.e in hydrodynamic region leads to the increase of friction. The friction in hydrodynamic region is dependent on viscosity. This effect is attributed to an increase in shear stress in the continuous film between cylindrical pin and liquid lubricated fiber with increasing viscosity.

References:

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3. Schick M.J., Textile Res. J. part I: 43, 103-109 (1973),
   part III43, 254-259 (1973).
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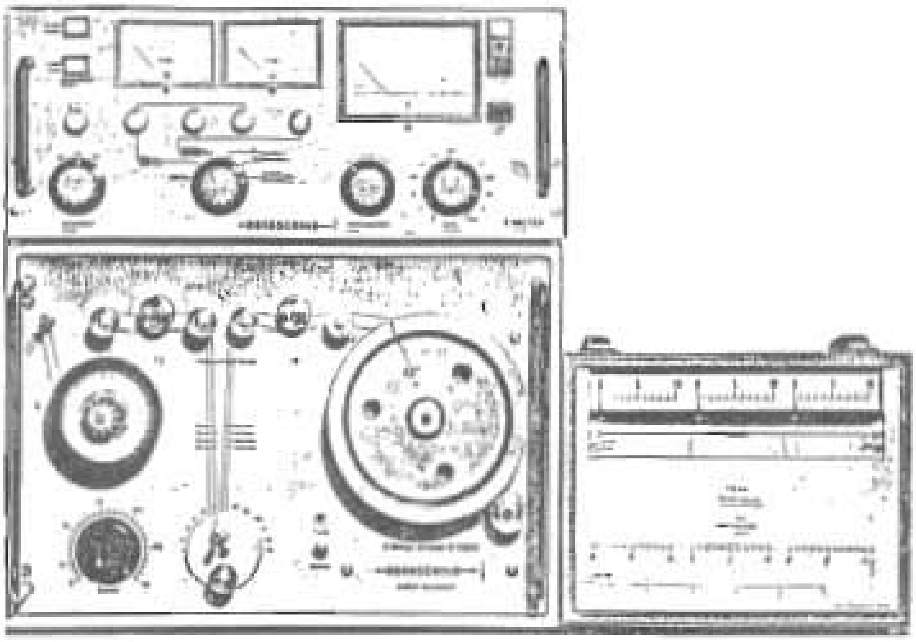
Fig. (1) F - METER R - 1187

Electronic Friction Coefficient Meter



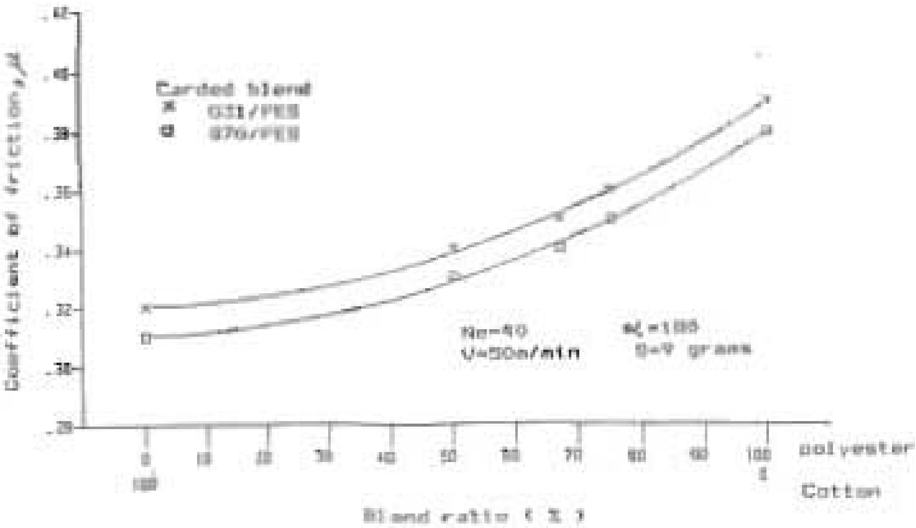


Fig. (2.1.) Effect of blend composition on friction of two component yarns

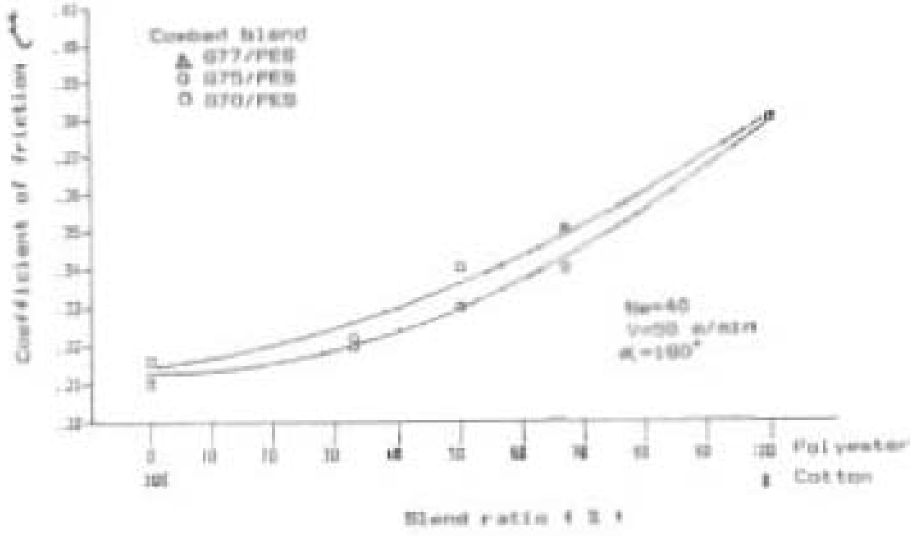


Fig. 12.2) Effect of blend composition on friction of two component yarns

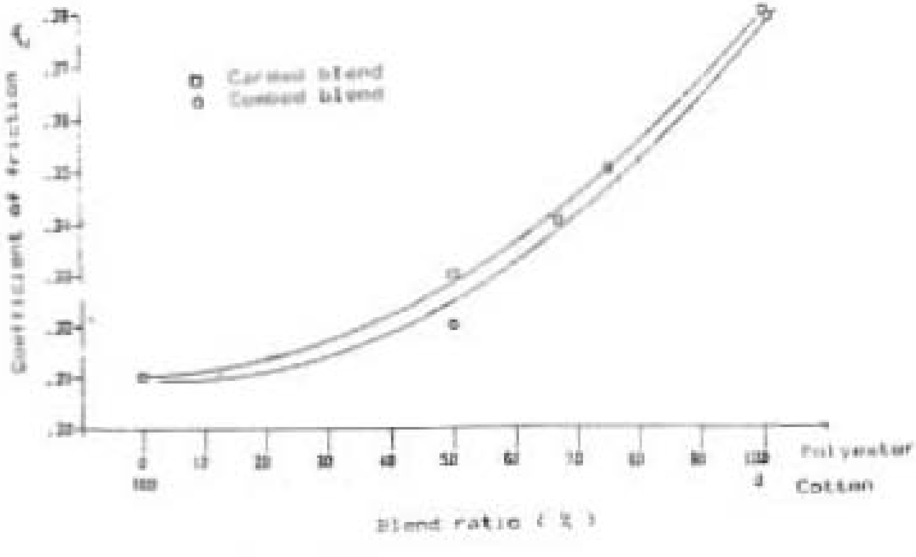


Fig. 12.2.3 Effect of blend composition on friction of two component yarns

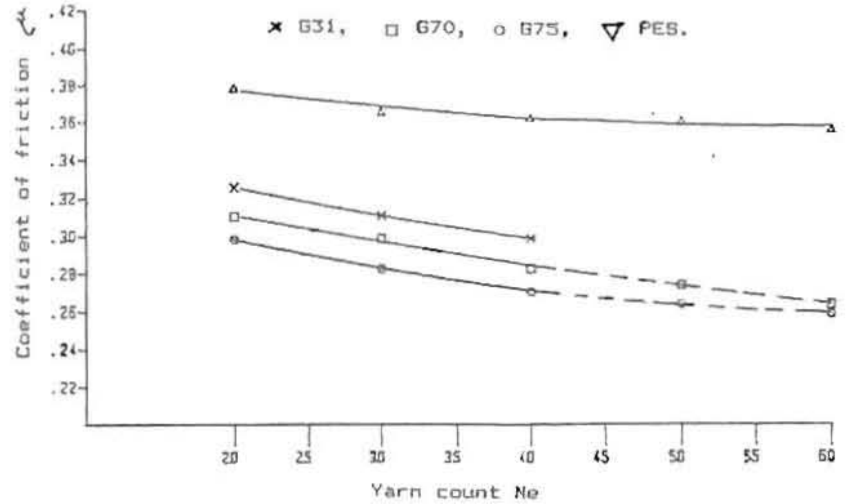


Fig. (3) Friction of yarns as a function of cotton variaties and yarn linear density

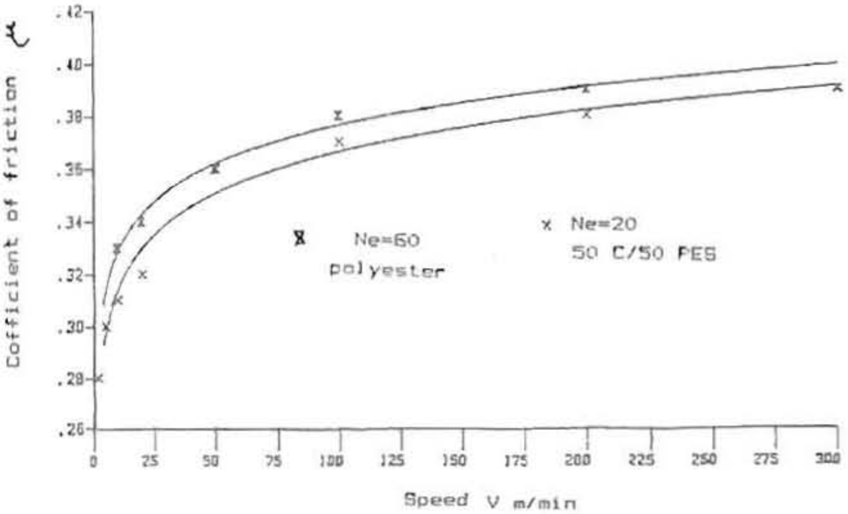


Fig. (4) Effect of threadline speed on friction of cotton/polyester nlended yarns

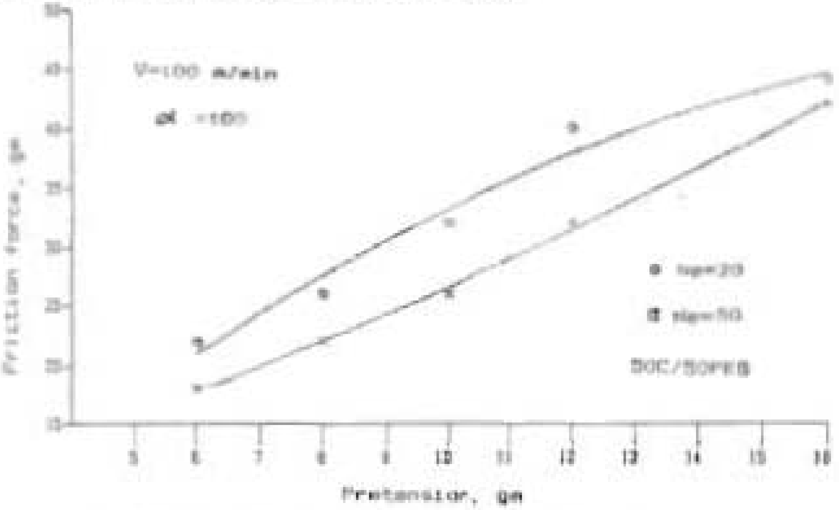


Fig.(5.1.) Effect of pretension with varying yarn linear density on friction of blended yarns

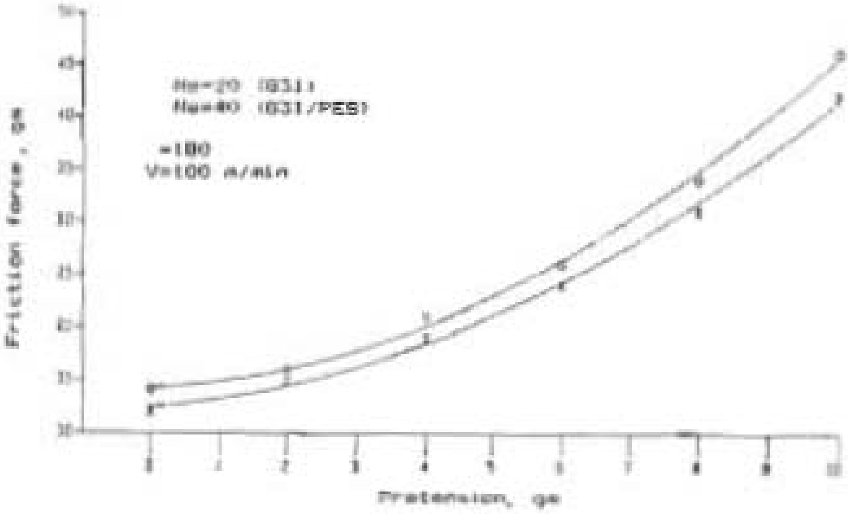


Fig.(5.2) Effect of pretension with varying yarn linear density on friction of blended yarns

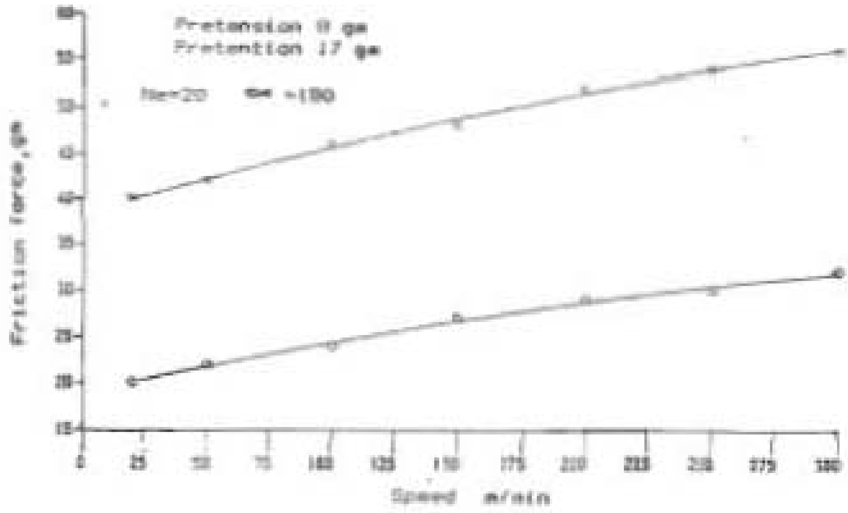


Fig. 15.3.1 Effect of pretension with varying yarn linear density on friction of blended yarns

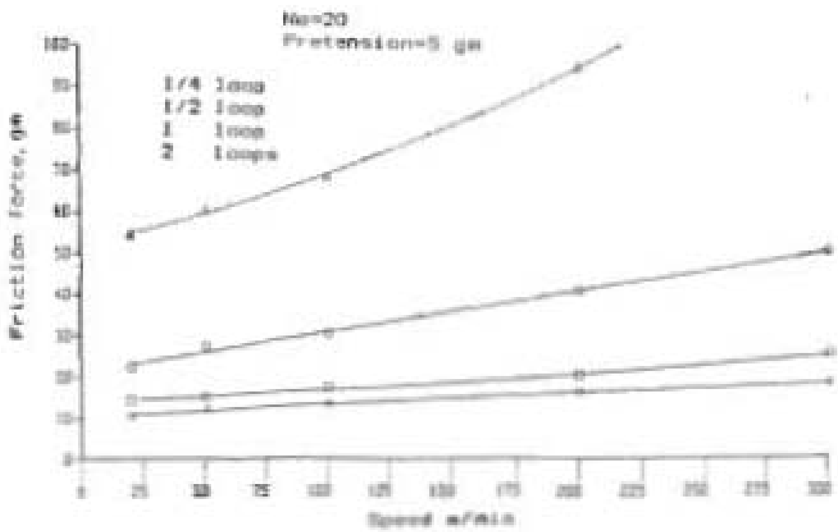


Fig. (6) Effect of loop size with varying threadline speed on friction of cotton yarns