THE EFFECT OF AIR POLLUTION ON GARMENTS OF LABOURS WORKING IN FERTILIZER FACTORIES

BY

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خلاصة : يهدف هذا البحث الى دراسة سلوك التآكل لأقمشة ملابس العمال فى مصانع الأسمدة وقد اختيرت شركة النصر للأسمدة والصناعات الكيماوية بطلخا لتنفيذ هذه الدراسة . وقد تم اختيار ثلاث أنواع من الأقمشة لتعريضها لجو المصنع - احداها مصنوع من القطن الخالص وأخرى من البولى استر الخالص والثالثة من القطن المخلوط بالبولى استر بنسبة ٣٥ - ٦٥ ٪ . وقد صممت حجرة من الزجاج على شكل متوازى مستطيلات وضبط تركيز الأمونيا فى حدود التركيزات الموجودة بجو المصنع وقيست درجة الحرارة والرطوبة النسبية أثناء فترة التعرض وعرضت بداخل هذه الحجرة عينات من الأقمشة القطنية المأخوذة من مراحل التجهيز المختلفة وهى القطن الخام والقطن المغسول بالصودا الكاوية والقطن المبيض والقطن المصبوغ بالصبغة الكبريتية . وقد أوضحت هذه الدراسة أن الأقمشة المصنوعة من البولى استر الخالص كانت أكثر مقاومة للتآكل الناتج من الملوثات الموجودة بجو المصنع عن الأقمشة المصنوعة من القطن الخالص . كما أتضح من النتائج المعملية أن عمليات التجهيز المختلفة لها أثرها الضار على الأقمشة القطنية حيث أنها تعجل تآكلها عند التعرض لغاز الأمونيا . وأتضح أن سلوك العينات التى عرضت لغاز الأمونيا بالمعمل مشابه لسلوك العينات القطنية التى عرضت للتلوث الجوى بمصنع السماد مما يدل على أن غاز الأمونيا هو العامل ذو التأثير الفعال بجو المصنع .

ABSTRACT - Long time exposure to air pollutants, usually cause a fast deterioration effect on clothes. The effect of air pollutants-exsits in the atmosphere of EL-Nasr Co. for Fertilizers and Chemical Industries at Talkha - on the labour garments have been investigated. Three different fabrics made from pure cotton, polyester, and cotton-polyester blended fabric were chosen for the exposure to the factory atmosphere. An experimental rig was developed for the investigation of the effect of ammonia gas on grey cotton fabric, scoured cotton fabric, bleached cotton fabric and on dyed cotton fabric. It was found that fabric made from pure polyester has a higher resistance to the adverse effect of air pollutants mounting in the factory atmosphere, where the highest resistance obtained in the laboratory was from the grey cotton fabric. The behaviour of the specimens exposed to the ammonia in the static rig was similar to those exposed to the factory atmosphere indicating that the ammonia gas is the most effective agent in the factory atmosphere.

1. INTRODUCTION :

The durability of a garment and its resistance to wear in different environmental conditions have equal importance as its price. Also, the choice of the kind of clothes should be adapted to the conditions prevailing in the environment. Therefore, clothes to be used in factories should retain a suitable resistance to the adverse conditions in these factories. Fertilizer industries usually emits different air pollutants according to the type of fertilizers produced. Ammonia gas and nitrogen oxides are the preponderant emissions from the production of nitrogen fertilizers, (as in the case of EL-Nasr Co. for Fertilizers and Chemical Industries at Talkha).

Although the deleterious effects of air pollution on cotton yarns and fabrics have been the object of a small number of studies, these studies have been limited to laboratory exposures and or exposures of yarns to outdoor. Race[1] reported the loss of strength of cotton yarns exposed in the English industrial town of leeds . He attributed the higher loss of strength in the less actinically active winter months to the increased coal consumption and greater humidity resulting in higher atmospheric acidity. Another laboratory study by Bogaty et al[2] revealed that the contribution of atmospheric ozone to cotton fabric degradation is relatively small. A study conducted in the metropolitan areas of St. Louis, Missouri, and Chicago, showed that high levels of SO_2 content, dustfall, and suspended particulate matter accelerate degradation of untreated cotton duck[3]. Morris et al[4] described the adverse effects of oxides of nitrogen in the atmosphere on exposed cotton yarns.

The aim of the undertaken work is to investigate the wear behaviour of labour garments working in EL-Nasr Co. for Fertilizers and Chemical Industries at Talkha.

2. EXPERIMENTAL :

Three different fabrics-whose characteristis are illustrated in table (1)-were chosen for the exposure to the outdoor atmosphere in fertilizer factory mentioned above. One of them was made from pure cotton fibers, the second was made from pure polyester and the third was made from a blended cotton-polyester fibers 35-65%. Specimens exposed to ammonia gas in laboratory were made of cotton taken from different finishing processes as illustrated in table (1).

Table (1): Characterization of fabrics exposed to factory atmosphere and that exposed to ammonia

Fabric kind	Fiber content	Fabric construction	Yarn count (Ne)		Yarn density (per cm)		weight per unit area (gm/m²)
			warp	weft	warp	weft	
Fabrics exposed to factory atmosphere							
1) Cotton fabric	Pure cotton	twill 2/2 Z	14.7	14.4	28.3	12.7	188.5
2) Blend fabric	35-65% cotton polyester	plain	32.6/2	14.7	25.3	15.7	176.4
3) Polyester fabric	pure polyester	twill 2/2 Z	42.8/2	42.8/2	45	24.0	210.0
Fabrics exposed to ammonia in laboratory							
Grey fabric		Satin 5	44.1/2	16.1	41.9	18.5	210.2
Scoured fabric		Satin 5	44.1/2	16.1	44.3	19.7	226.4
Bleached fabric		Satin 5	44.1/2	16.1	43.3	20.5	227.8
Dyed fabric		Satin 5	44.1/2	16.1	45.0	20.5	240.7

Specimens exposed to factory atmosphere were during November to December 1985 according to the program illustrated in table (2). The exposure was by the aid of a Vertical racks as shown in Figure (1).

Table (2): Exposure time program in the factory atmosphere.

Sample No.	Exposure time (shifts)*	Exposure data
1	21	2 - 9 Nov .
2	42	2 - 16 Nov .
3	63	2 - 23 Nov .
4	84	2 - 30 Nov .
5	105	2 Nov . - 7 Dec .
6	126	2 Nov . - 14 Dec .
7	147	2 Nov . - 21 Dec .

* One shift = 8 hours

The average concentrations of air pollutants CO, CO_2, NO_2 and NH_3 gases in the factory atmosphere during exposure time are given in Table (3) as reported by the factory. Temperature and relative humidity were recorded during the exposure time and their average values were 26 ± 6°C for temperature and 71.8% for the relative humidity.

The laboratory work was performed using an experimental rig illustrated in Fig. (2). Ammonia gas concentration was adjusted by measurement of partial pressure to be within the limits of the values reported in the factory atmosphere. The program of the exposure time in the laboratory rig is given in table (4).

Table (3): Average concentrations of air pollutants in the factory atmosphere during the exposure time.

Pollutant	Concentration (ppm)
Ammonia gas, NH_3	150
Carbon monoxide, CO	6
Carbon dioxide, CO_2	200
Nitrogen dioxide NO_2	0.2

Table (4): Exposure time program in laboratory

Sample No.	Exposure time (shifts)	Exposure date
1	12	15 - 19 July
2	24	15 - 23 July
3	36	19 - 31 July
4	48	23 July - 8 Aug.
5	60	31 July - 20 Aug.
6	72	8 Aug. - 1 Sept.
7	84	20 Aug. - 17 Sept.

All the exposed samples in addition to a blank sample from each kind have been tested for the following properties-according to the method outlined in ASTM[5]: Fabric breaking strength, fabric tearing strength, fabric abrasion resistance, fabric air permeability, fabric bending length, fabric weight per unit area, fabric thickness, warp and weft density, warp and weft count, warp and weft crimp, fabric cover factor, flexural rigidity, and bending modulus.

3. RESULTS AND DISCUSSION :

Results obtained from the last mentioned properties, whether for specimens exposed to factory atmosphere or exposed to ammonia gas in laboratory are presented on a percentage basis according to the following equation:

$$R_i = \frac{P_i^{\circ} - P_i}{P_i^{\circ}} \times 100$$

where, R_i indicates the result presented for the property i, P_i° is the absolute value of the property i obtained for the blank specimen and P_i is that for the exposed specimens. All tests have been done for warp direction and weft direction. The results obtained from both warp and weft directions are calculated and presented for each property in Figs. (3 -12).

From the results obtained for breaking strength, tear strength, and abrasion resistance of the specimens exposed to factory atmosphere, it is obvious that pure polyester fabric has a higher resistance to the adverse effects of air pollutants mounting in the factory atmosphere, whereas the addition of polyester fibre to cotton fibre increase the durability of the fibre. Also, the dimensional stability of the pure polyester is greater than that of pure cotton, where as, the dimensional stability of cotton-polyester blend is in between, as indicated from the results of measuring crimp, mass per unit area, warp and weft density, fabric cover factor, and air permeability.

From the results of measuring mechanical properties of the specimens exposed to ammonia gas in the laboratory, it is found that, the more resistance to the adverse effect of ammonia gas is the grey cotton fabric followed by scoured, bleached and dyed cotton fabrics respectively. Also the grey cotton fabric has higher dimensional stability followed by scoured, bleached, and dyed cotton fabrics respectively.

It is obvious that the behaviour of the specimens exposed to ammonia gas in the static rig was similar to that in the factory atmosphere, indicating that ammonia is the predominant factor in the factory atmosphere.

The higher resistance to air pollutants obtained from polyester rather than from cotton may be attributed to the closeness of the structure of polyester and so the absence of swelling in aqueous media and the comparatively slow diffusion of reagents inside the fibre[6].

4. CONCLUSIONS :

From this investigation, it has been found that pure polyester fabric has higher resistance to the adverse effect of air pollutants than pure cotton, but due to the discomfortability of pure polyester fabric for human use in hot climates; it is, therefore, preferable to use fabrics composed from pure polyester warp yarns and pure cotton weft yarns to comply the strength and comfort requirements. The polyester warp yarns must appear with a great extent in the face of the fabric to give a higher resistance to the adverse effects of air pollutants and the cotton weft yarns must appear in the back of the fabric, to be in contact with the skin, to give a higher comfort for the user.

The fabric construction can be shosen from the following designs:

- Twill or satin weaves in which warp yarns appear with a great extent in the face of the fabric.
- Warp or weft backed cloth that have a face from polyester and backing from cotton yarns.
- A double cloth that have upper layer from pure polyester yarns and lower layer from pure cotton yarns.

Because of the use of cotton yarns as a weft in these fabrics, these yarns disappear in the back of the fabric, and because the finishing processes accelerate the adverse effects on these fabrics, grey cotton yarns must be chosen as a weft of these fabrics.

REFERENCES :

1- Race, E.; "Degradation of Cotton During Atmospheric Exposure, Particularly in Industrial Regions" ; J. Soc. Dyers Coloursts 65; 55 - 63;(1949).

2- Bogaty, H.; Campbell, K.S.; Appel, W.D. ; "The Oxidation of Cellulose by Ozone in Small Concentrations" Textile Res. J. 22; 81 - 83;(1952).

3- Brysson, R.J. ; Trask, B.J. ; Vpham, J.B., "The Effect of Air Pollution on Exposed Cotton Fabrics" J. Air Pollution Control Assoc., 17; 294 - 298; (1967).

4- Morris, M.A.; Young, M.A.; Moling, T.A., " The Effect of Air Pollutants on Cotton" Textile Res. J., 34, 563 - 564, (1964).

5- ASTM, (D 1175 - 64 T), (D 1388 - 64), (D 1424 - 63), (D 1682 - 64), (D 1777 - 64) and (D 1910-64); American Society for Testing Materials, Philadelphia, (1967).

6- Sadov, F.; Korchagin, M.; and Matetsky, A.; "Chemical Technology of Fibrous Materials" MIR Publishers, Moscow; (1978).

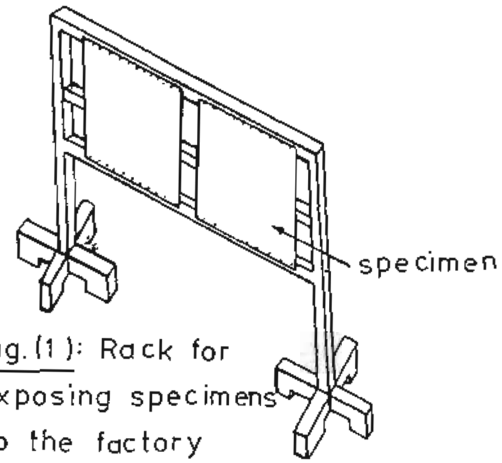

Fig.(1): Rack for exposing specimens to the factory atmosphere

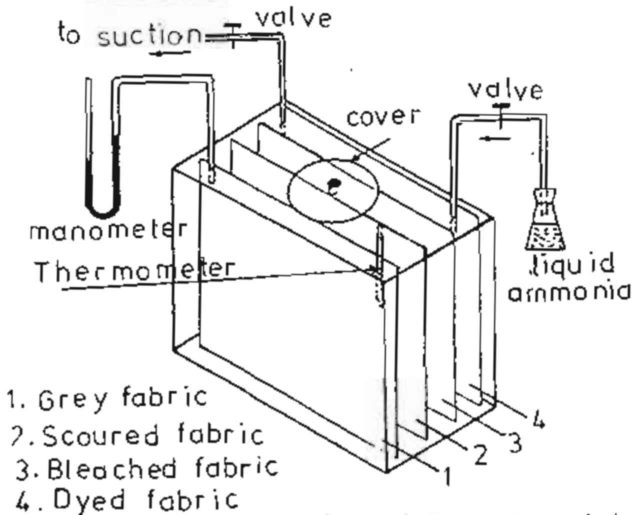

Fig.(2): Experimental rig

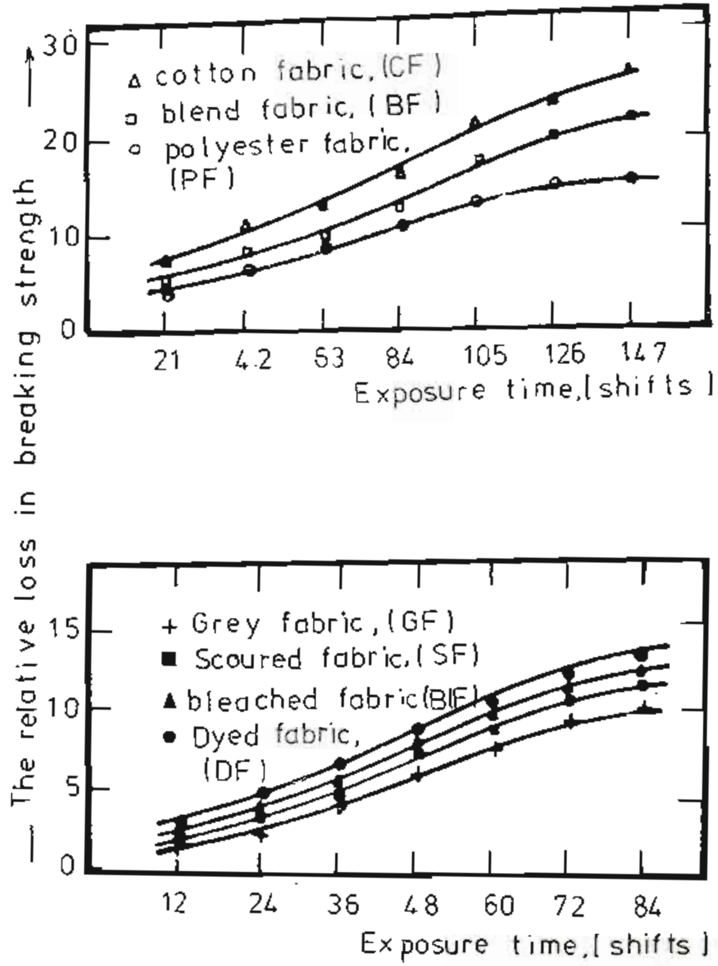

Fig.(3): Relation between exposure time & relative loss in breaking strength.

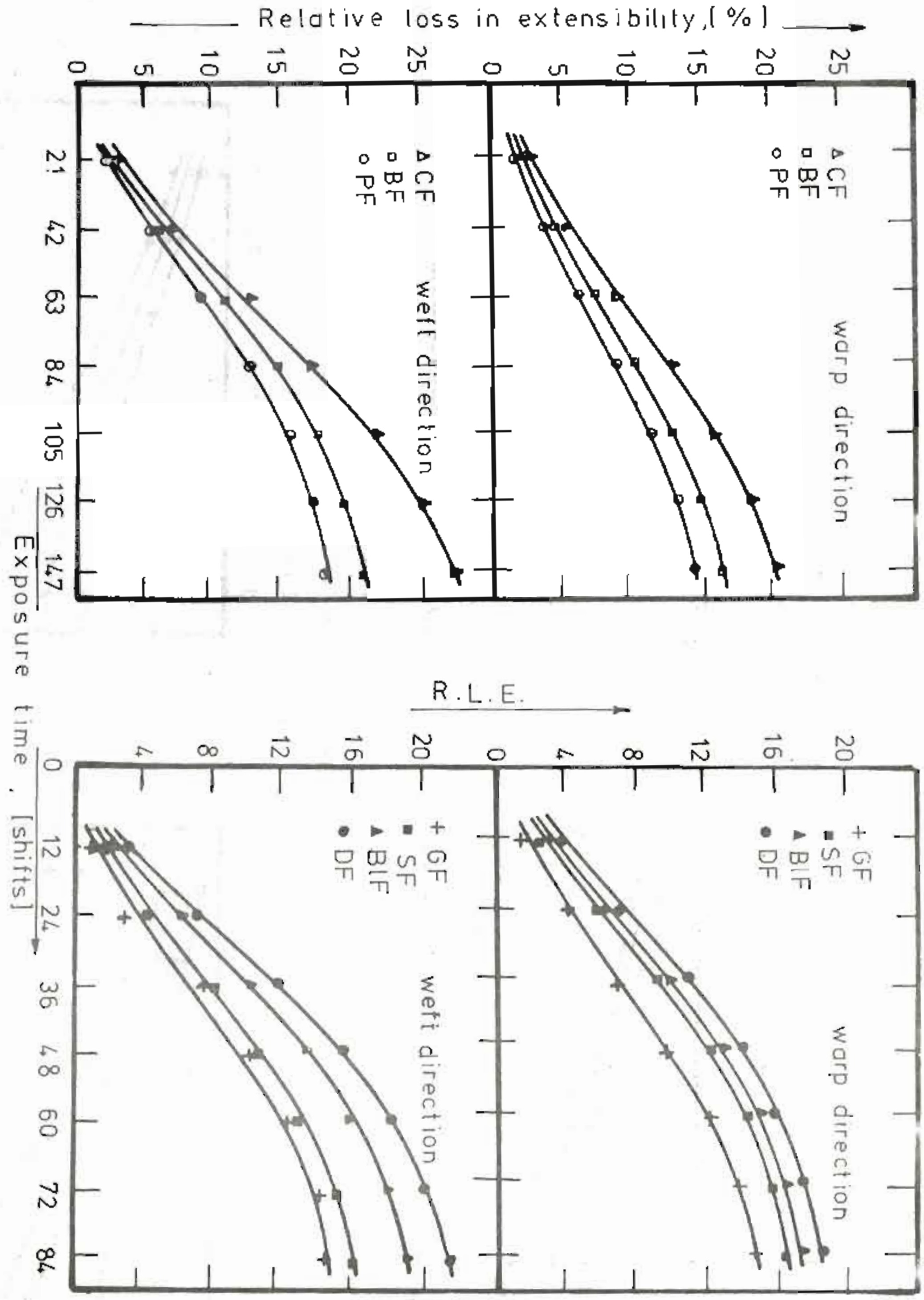

Fig.(4): Relation between exposure time and relative loss in extensibility

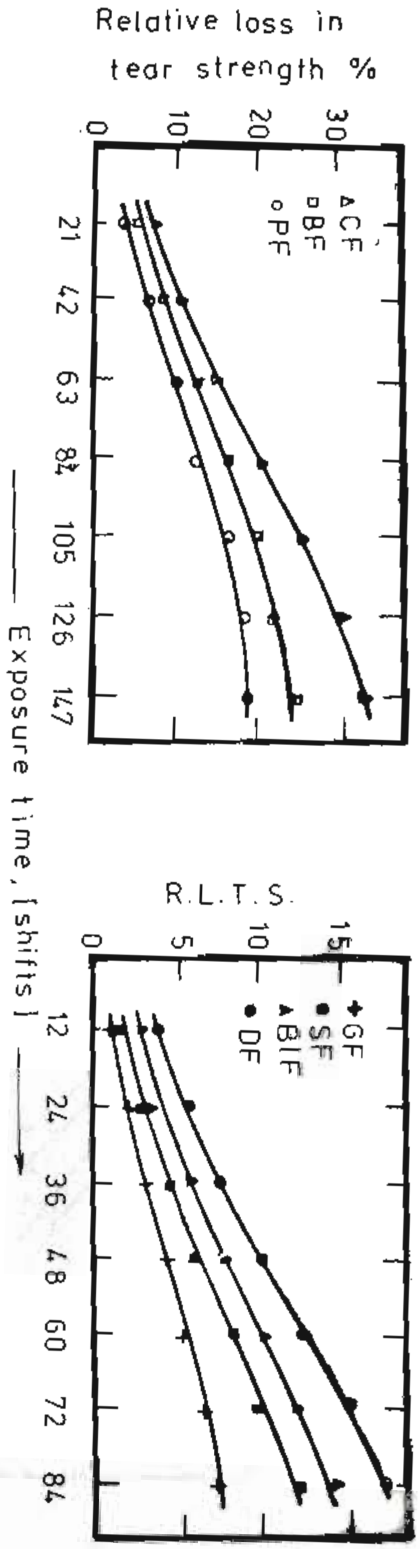

Fig.(5): Relation between exposure time and relative loss in tear strength.

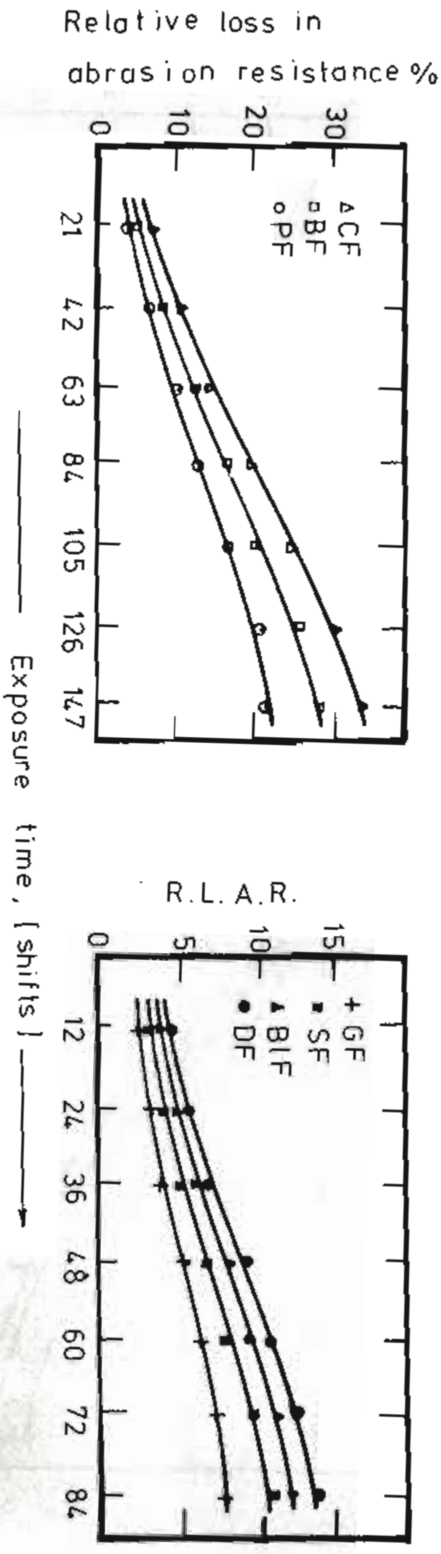

Fig.(6): Relation between exposure time and relative loss in abrasion resistance.

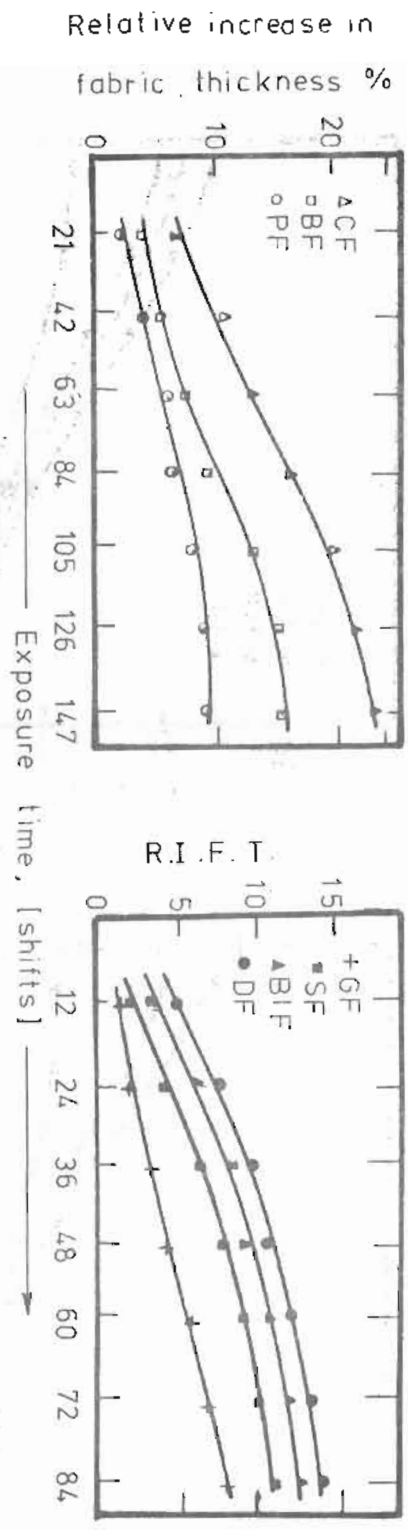

Fig. (7): Relation between exposure time and relative increase in fabric thickness

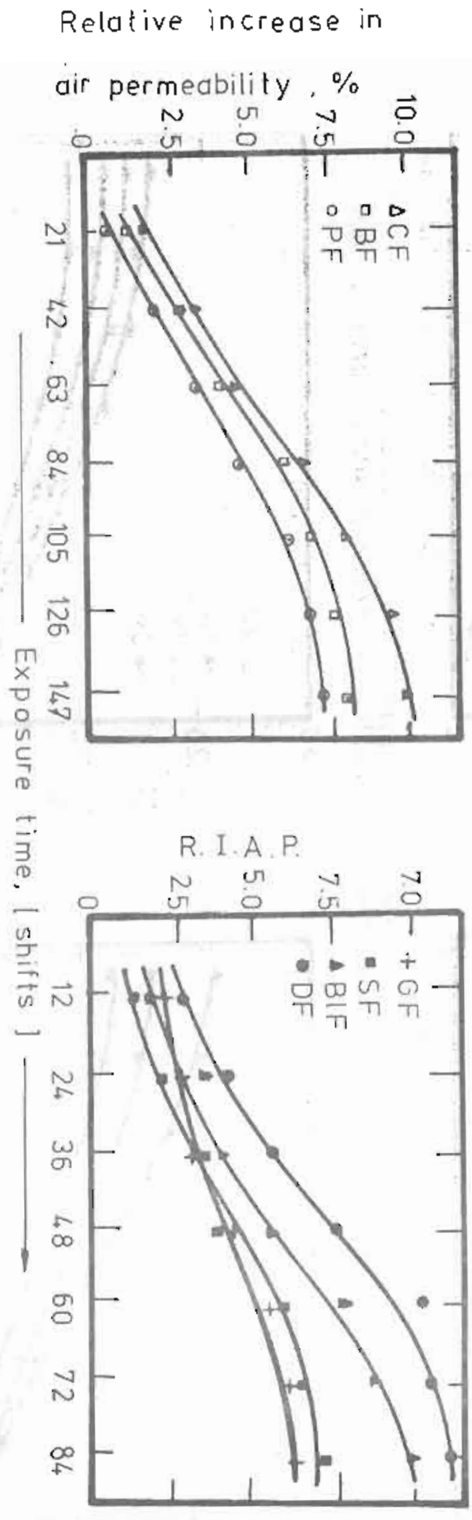

Fig.(8): Relation between exposure time and relative increase in air permeability

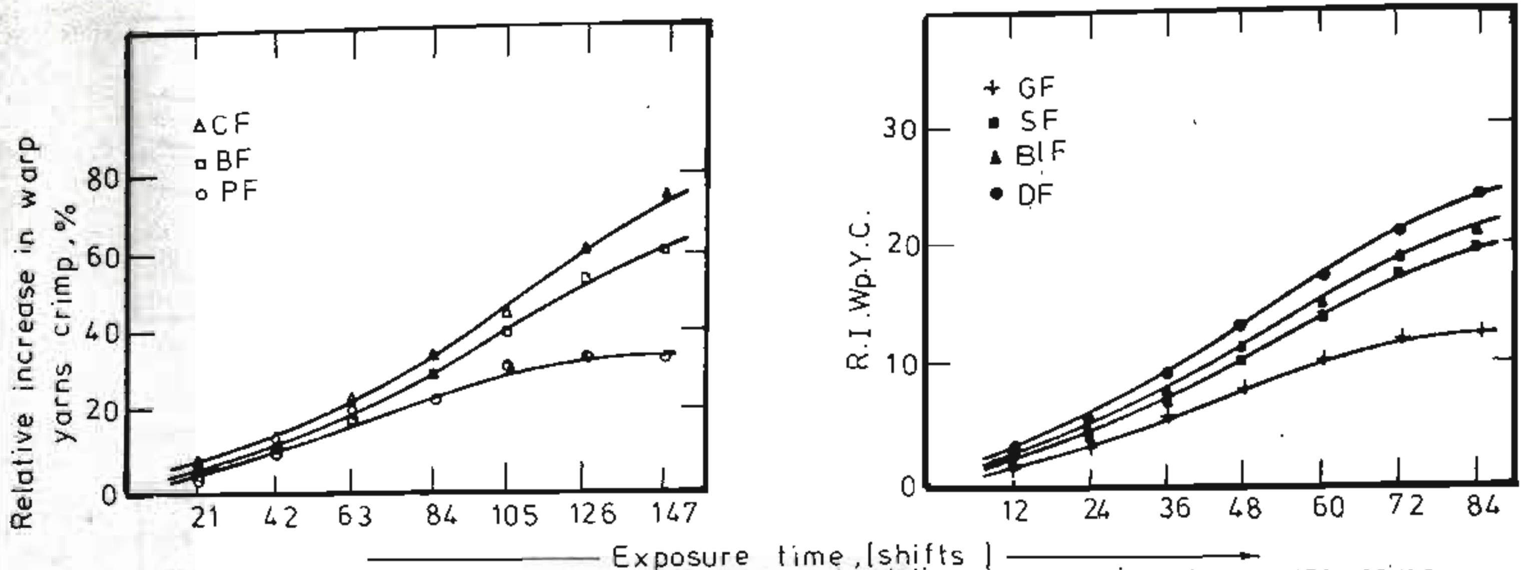

Fig (9): Relation between exposure time and relative increase in warp yarns crimp .

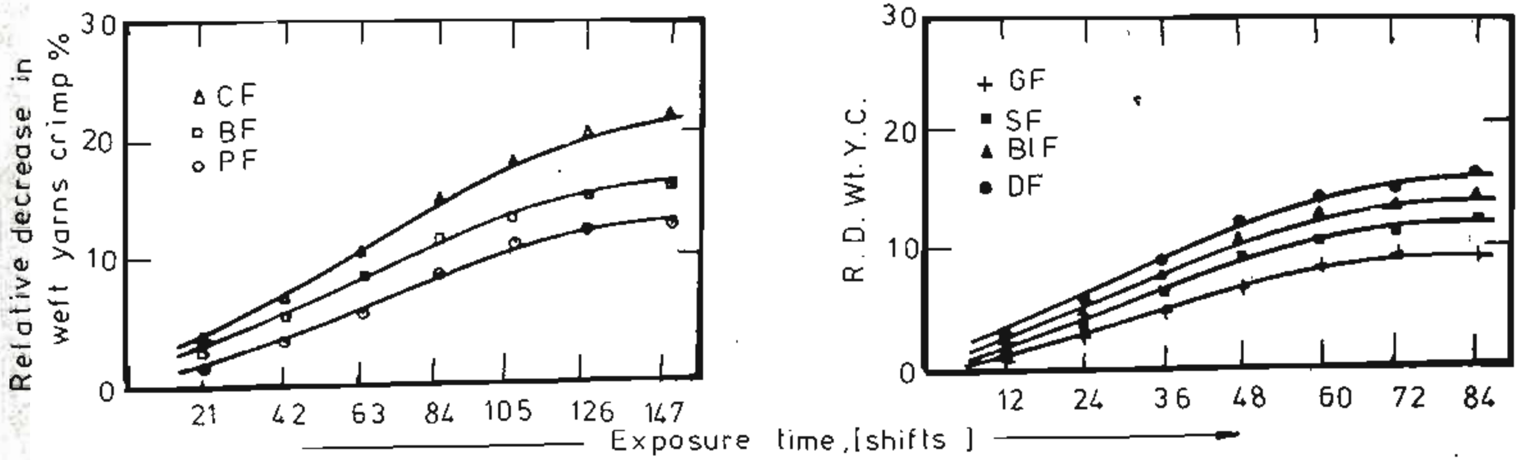

Fig. (10): Relation between exposure time and relative decrease in weft yarns crimp.

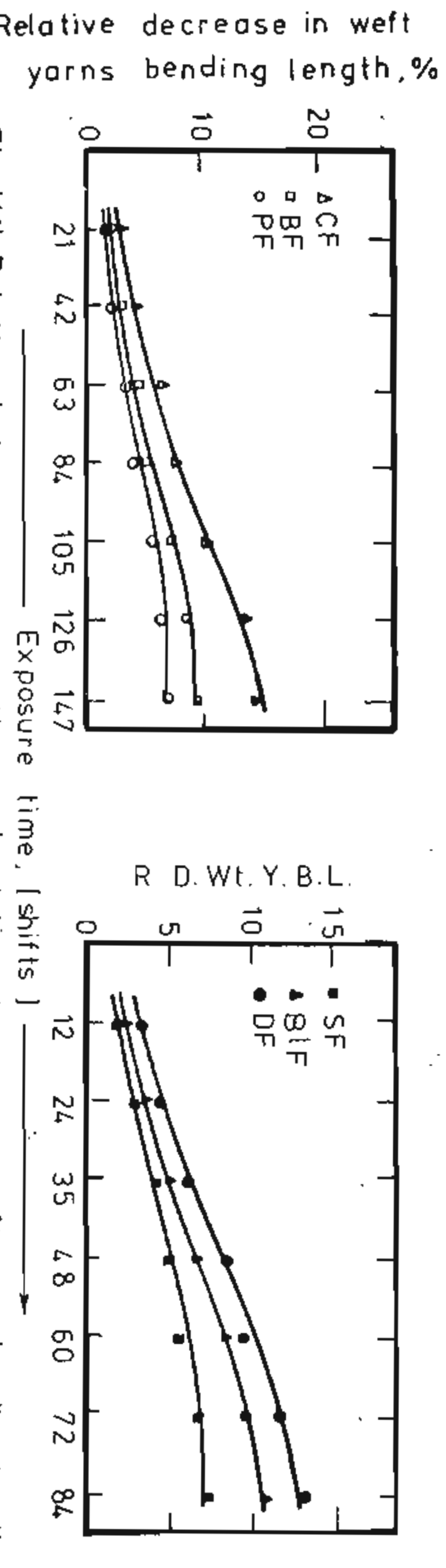

Fig.(11): Relation between exposure time and relative decrease in weft yarns bending length.

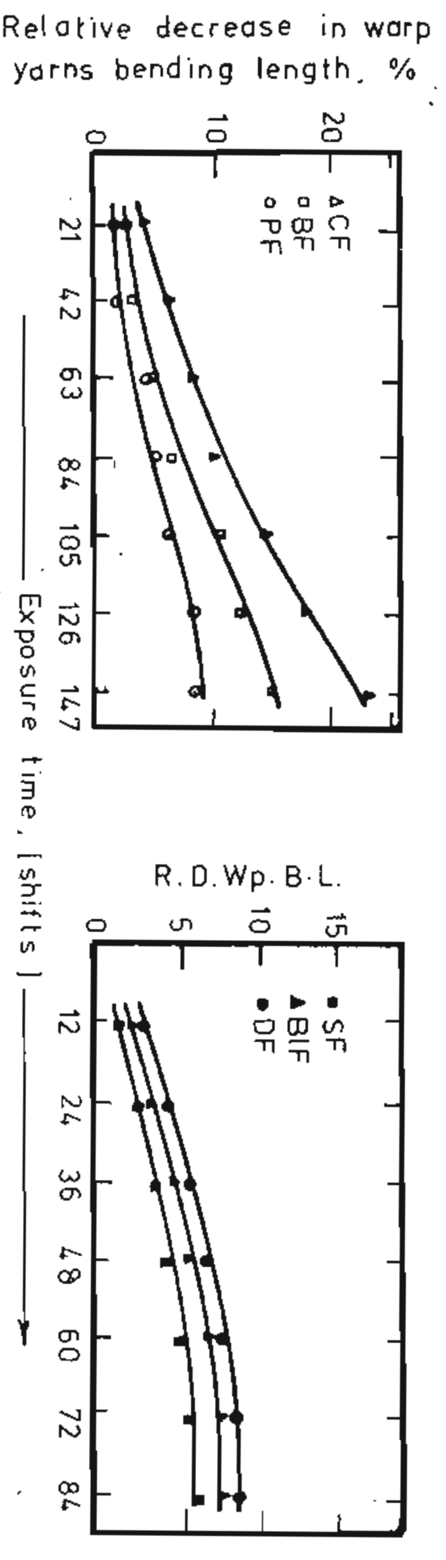

Fig.(12): Relation between exposure time and relative decrease in warp yarns bending length.