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IDENTIFICATION OF FIBERS IN TEXTILES

BY

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ABSTRACT:

Identification of textile fibers could be assessed by making use of light microscopy. In essence, a solution was prepared consisting of $ZnCl_2$ (100 g), KI (32 g), distilled water (34 ml), and I_2 (till saturation). This solution was used as a swelling agent for tectile fibers during microscopic examination. Differences in longitudinal and cross-sectional views have been taken to identify fibers in textiles.

INTRODUCTION:

Fiber identification in textiles is made on the basis of morphological features observed in longitudinal and cross-sectional views, compared with standard samples of known origin or with photomicrographs published in literature/1/.

Identification of textile fibers is very important today because qualitative analysis of textile materials becomes more complex every year. This is a direct result of the variety of man-made fibers on the market and the increasing use of these fibers in blends with each other or with natural fibers.

Identification of textile fibers is usually assessed by several methods such as heat and flame test, stain test, solubility test, melting-point test, moisture regain test, specific gravity test, and refractive index test /2/.

Each one of these seven tests will help identify fibers. In fact these basic methods of fiber identification are not altogether new. There are some disadvantages of these tests. Flame and solubility tests do not provide precise distinction of the variety of fibers, they give only the chemical groups to which the fibers belong, Table 1. Moisture regain test gives the same value for two or more fibers e.g. Acetate, Nylon 6, and Nylon 66 are the same (4/5%), Table 2. Melting-point test can not give the melting temperature for many fibers such as cotton, flax, silk, and wool; such materials do not melt, Table 3. Using specific gravity test we find that cotton, flax, and rayon have the same value (1.52). Also Dacron, Tortrel, Terylene, and Toray-tetoron have the same value (1.38), Table 4. Using refractive index test, the value of light vibration parallel to fiber axis for cotton, flax, silk, wool, rayon, nylon, and acrylic are 1.56, 1.58, 1.59, 1.56, 1.54, 1.57 and 1.5, respectively. It is clear that differences between them are very small, Table 5. On the other hand, stain tests are usually applicable only to white and light colored fibers or to dyed fibers that can be stripped to a light shade.

Thus, it is obvious that a rapid and simple method for assessing identification of textile fibers is needed. The present work was undertaken fill this gap.

In essence, the method described here is based on immersion of the unknown fibers in a particular swelling agent, then examination of the swollen fibers using light microscope. This method covers procedures for the identification of the following textile fibers used commercially in Egypt.

1. Vegetable fibers:-
   - 1.1. Seed fibers: Cotton.
   - 1.2. Bast fibers: Flax, Hemp, Jute, and Ramie.
   - 1.3. Leaf fibers: Sisal, and Manila.

2. Man-made fibers (regenerated fibers):
Viscose rayon, super Cordenka, Meryl, Tyrex, Colcored.

Although Meryl, Super Cordenka, Tyrex, and Colcord are imported fibers, they are included because they may be encountered in Egypt.

Reagents:

Concentrated zinc chloride iodide solution used was prepared as follows; (100 g) zinc chloride and (32 g) potassium iodide were dissolved in (34 ml) distilled water, then iodine was added till saturation /3/.

Apparatus:

A light microscope with an attached camera and a heating disc was used. Adjustment of the temperature could be achieved through connection of the disc with Universal Incubator.

All the measurements were conducted at a constant slide temperature of 62° as given in /4/.

Test specimens:

In preparing test specimens for examination under the microscope, the method described in ASTM Designation: D 276 - 62 T was used.

Microscopic Study:

First you inspect the material carefully to obtain information about its distinctive characteristics. This way indicate:

1) Resins or other foreign matter on the material (Usually do not remove resins, but if you must, use ASTM Test D 629 - 59 T).

2) Different classes of fibers present in the material. Inspection will also help you select representative samples for subsequent testing.

3) Make the first microscopic examination with low magnification 50 X - 60 X.

4) If more microscopic work is needed, you select groups of fibers from the material, mount them and examine them (ASTM Test D 276 - 60 T) at higher magnification (250 to 500 X).

5) Note the longitudinal appearance of individual fibers and compare them with those of known fibers. If more careful examination is needed, you should determine the cross-sections as well as short fiber appearance.

You can often obtain other useful informations by using a heat and flame test as part of the preliminary inspection. You will note the effects of heat, the burning characteristics, and the burning odour of the specimen and use them to determine the subsequent course of your testing.

Result:

Longitudinal, cross-sectional, and short fiber length photomicrographs for many fibers are shown on figures 1 - 14.

Fig. 1 Swelling of mature raw cotton fibers:

a) Primary wall shrinkage in lengthwise direction forming spiral shape.

b) Secondary-wall swelling in a direction perpendiculer to axis of fiber forming beads shape.

c) Mixture of types (a) and (b).

Fig. 2 Mature and immature swelled cotton fibers (immature fiber like screw).

Fig. 3. Short length of swellen cotton fibers where the secondry wall appear from the end of fiber (like dog bone), because cellulose did not find any resistance to swell at the ends.

Fig. 4. At the end of the swelling short length of super mature cotton fiber, the depositing layer of secondry wall can be easily shown.

Fig. 5. Short length of swellen mature cotton fiber, but treated chemically (damage due to bleaching effect).

Fig. 6. Shows that short length of mature cotton fibers swellen, and primary wall appears like ring in dark tone, where secondry wall is represented by the internal and external areas in light tone. All these figures can be obtained by making cross section view of cotton fibers and very short length and using swelling agent.

Fig. 7. Short fibers of regenerated cellulose fibers under the action of swelling agent:

a) Note that the begining and ending of cut point appear in a very dark tone.

b) Another type of swelling like sun rays shape.

c) One swelling fiber is divided into two parts (upper part and lower part).

Fig. 8. Rayon Viscose:

a) and b) Note the sharp cut of the swelling ends of the fibers.

c) Note the swelling shape like veined marble.

Fig. 9. Colcord 1687/20 den.

a),b) and c) Its swelling shape is quite different from the others.

Fig. 10. Meryl 1650/04 den. Appear like lattice form.

Fig. 11. Tyrex
Little swelling in perpendicular direction in the fiber axis and also it is clear that there is something like chanal on length wise direction.

Fig. 12. Mixing of swelling cotton and polyester fibers. Note that cotton swelling is normal, but polyester does not swell at all because polyester has high resistence to swelling.

Fig. 13.a) and b) Sisal fiber, after swelling it can be seen as an indvidual unit.

Fig. 14. Flax fiber:
a and b) Short fiber, it is clear that individual units in length wise direction having knops.

Table (1)

SOLUBILITY

Chemical agent:	Concentration % b.w.	Density at 75 °F.	Temperature °F	Acetate: Secondary	Acetate: Triacetate	Acrylic: Acrilon, Acrilon 6, Dralon	Nylon: Nylon 6, Nylon 6-6	Polyester: Dacron, Terylene, Portrel, Taray-Teralon	Cotton and Flax	Silk	Wool
Acetic Acid	65		75	S	S	1	1	1	1	1	1
Acetone				S	P	1	1	1	1	1	1
Acetonitrile				S	1	1	1	1	1	1	1
Ammonium Thiocyanate	70		200	1		S	1	1	1	1	1
Benzyl alcohol				S	1	1	1	1	1	1	1
Carbon tetra-chloride			170	1	1	1	1	1	1	1	1
Chloroform			75	1	S	1	1	1	1	1	1
Cresol				S	S	1	S	1	1	1	1
Cyclohexanone				1	1	1	1	1	1	1	1
Dimethyl acetamide				S	S	1_4	1	1	1	1	1
Dimethyl sulfoxide				S	S	P	1	1	1	1	1
Formic acid	85			S	S	1	S	1	1	1	1
Hydro chloric acid	37-38	1,09		S	P	1	S	1	1	S	1
Nitric acid	70	1,4		S	S	S	S	1	1	P	P
Sodium hydroxide	40		At Boil	P	P	1	1	S	1	S	S
Sulfric acid	75	1,6		S	S	-	S	1	S	S	1

S = Fiber soluble or completely disintegrated.

P = Fiber partly soluble or partly disintegrated.

1 = Fiber insoluble.

CAUTION: All liquids mentioned above are hazardous liquids and should be handled with care. Use chemical laboratory exhaust hoods, gloves, aprons and goggles.

Table (2): Moisture Regain (Percent)[x]

Fibers		Moisture regain at 20°C., 65% R.H.
Acetate	Secondary (Acele)	6
	Triacetate (Arnel)	4
Acrylic	All	1.5 to 2.5
Modacrylic	Dynel	0.4
	Verel	...
Nylon	Nylon 6 and nylon 6-6	4 to 5
Nytril	Darvan	2 to 3
Olefin	Polyethylene, polypropylene	none
Polyester	All	0.2 to 0.8
Rayon	All	11 to 14
Saran	All	none
Spandex	Lycra	1.3
	Vyrene	...
Cotton	All	7 to 11
Flax	Bleached	8
Silk	Boiled-off	10 to 11
Wool	Cashmere, mohair, and regular (Merino)	about 15

Notes:

- In general, this test in not suitable for yarns spun from a blend of fibers or for fabrics made from such yarns.

x These are actual regains and in many cases are different from commercial regains.

Table (3): Melting Point.

Fibers		Melting Point (°C.)	Melting Point (°F.)
Acetate	Secondary (Acele)	260	500
	Triacetate (Arnel)	288	550
Acrylic	All(including orlon and orlon sayelle)	Indeterminate	
Modacrylic	Dynel	188[x]	371[x]
	Verel	210[x]	410[x]
Nylon	Nylon 6	213	415
	Nylon 6-6 (including Antron)	250	482
Nytril	Darvan	218[x]	424[x]
Olefini	Polyethylene	135	275
	Polypropylene	170	338
Polyester	Dacron, Fortrel, Terylene, Toray-Tetoron	250	482
	Kodel	282	540
	Vycron	232	450
Rayon	All	Indeterminate	
Saran	All	168	335
Spandex	Lycra, Vyrene	230[x]	446[x]
Cotton	All (including mercerized and not mercerized)	Indeterminate	
Flax	Bleached	"	
Silk	Boiled - off	"	
Woll	Cashmere, mohair, regular (Merino)	"	

Notes:

x Approximate value.

- Fiber softens at a somewhat lower temperature, and reproducible melting point values are difficult to obtain.

Table (4): Specific gravity

	Fibermaterials and their specific gravity							
	Saran	Cotton Flax Rayon	Dacron Fortrel Terylene Toray- Tetoron	Acetate Wool	Silk.	Nylon	Acrylic	Olefin
	1.70	1.52	1.38	1.32	1.25	1.14	1.14 1.19	0.92
0.87	S*	S	S	S	S	S	S	
1.00	S	S	S	S	S	M**	M	
1.15	S	S	S	S	M			
1.30	S	S						
1.45	S							
1.60	S							

* S: Sure to sink.
** M: May sink.

Table (5): Refractive Index.

Materials	Refractive Index Light vibration parallel to fibre axis (N//)	Light vibration per pendicular to fibre axis (N)	Birefringence (N//minus N) N
Acetate	1.47 - 1.48	1.47 - 1.48	Less than 0.01
Acrylic	1.50 - 1.53	1.50 - 1.53	Little or none
Modacrylic	about 1.54	about 1.53	Less than 0.01
Nylon	1.57 - 1.59	1.51 - 1.53	0.06
Nytril	about 1.48	about 1.48	Little or none
Olefin	about 1.56	about 1.51	0.05
Polyester	1.71 - 1.73	1.53 - 1.54	0.18
Kodel	.....	....	....
Rayon	1.54 - 1.56	1.51 - 1.53	0.03
Saran	1.61	1.61	Little or none
Spandex	.....	....	....
Cotton	1.56 - 1.59	1.52 - 1.54	0.05
Flax	1.58 - 1.60	1.52 - 1.53	0.06
Silk	1.59	1.54	0.05
Wool	1.56	1.55	0.01

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Longitudinal View Of Fibers Identification

Fig. (1-a)

Fig. (1-b)

Fig. (1-c)

Fig. (2)

Fig. (3)

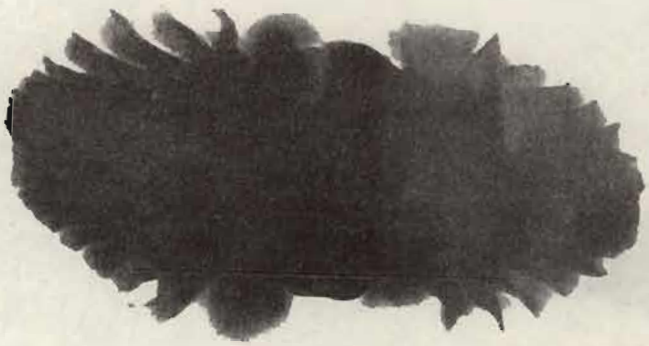

Fig (4)

Fig. (5)

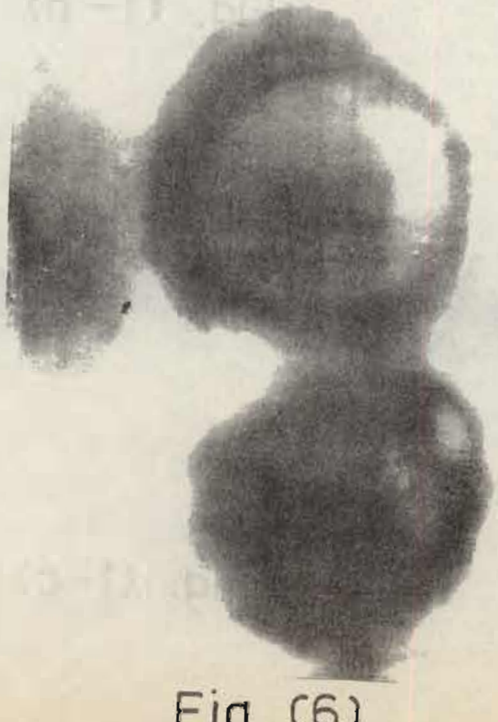

Fig. (6)

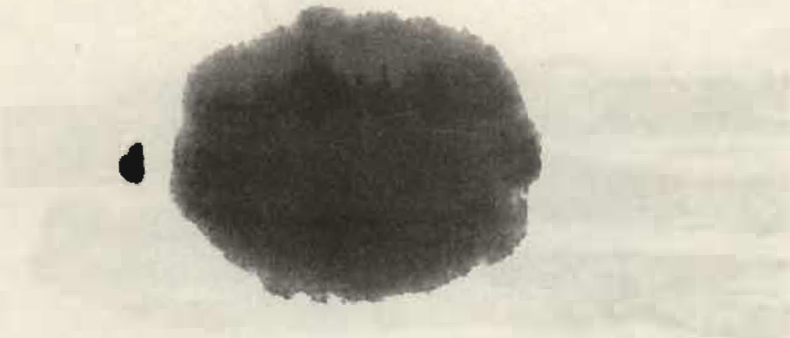

Fig. (7-a)

Fig. (7-b)

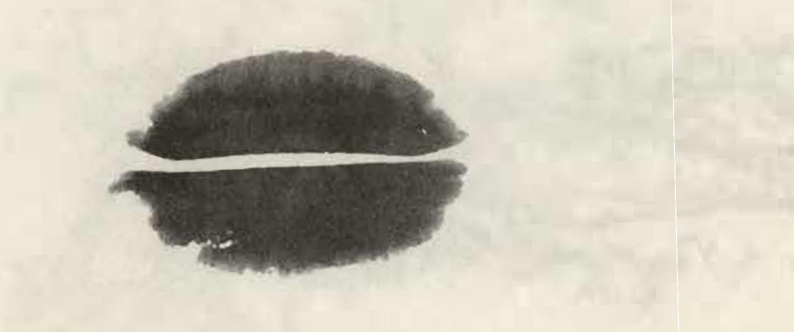

Fig. (7-c)

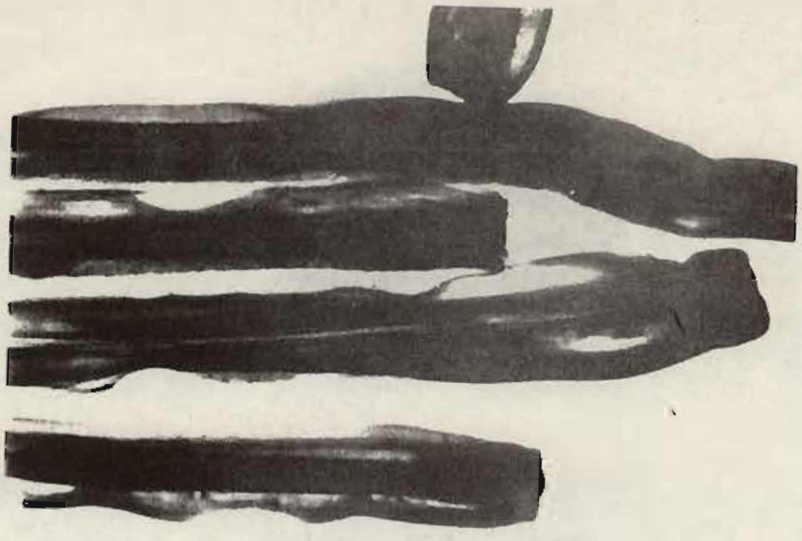

Fig. (8-a)

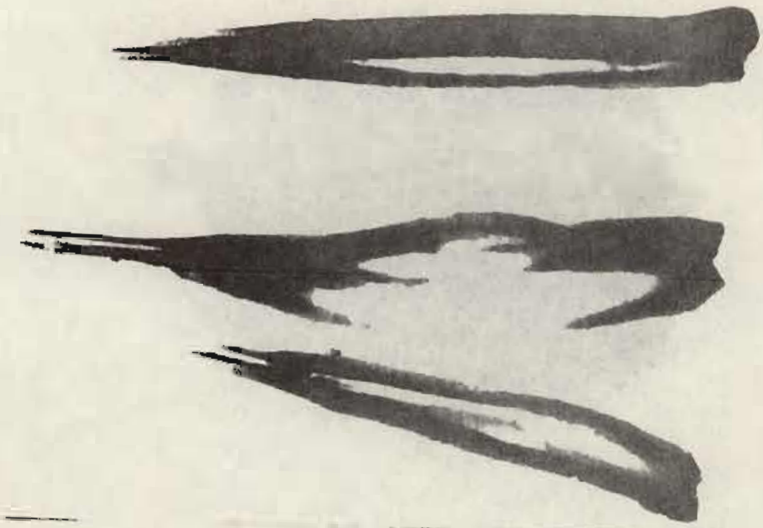

Fig. (8-b)

Fig. (8-c)

Fig. (9 - a)

Fig (9 - b)

Fig. (9 - c)

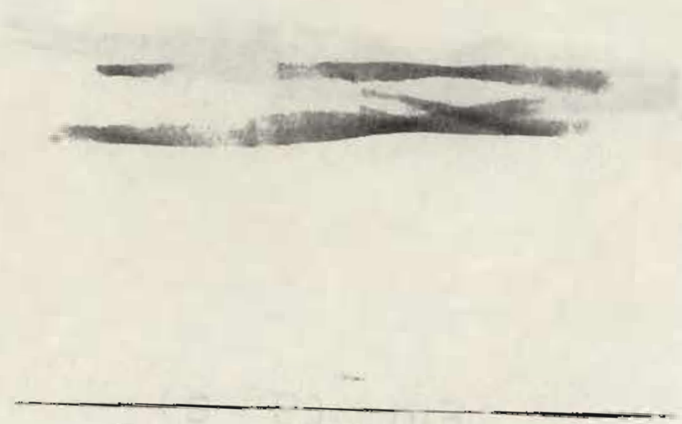

Fig. (10)

Fig. (11)

Fig. (12)

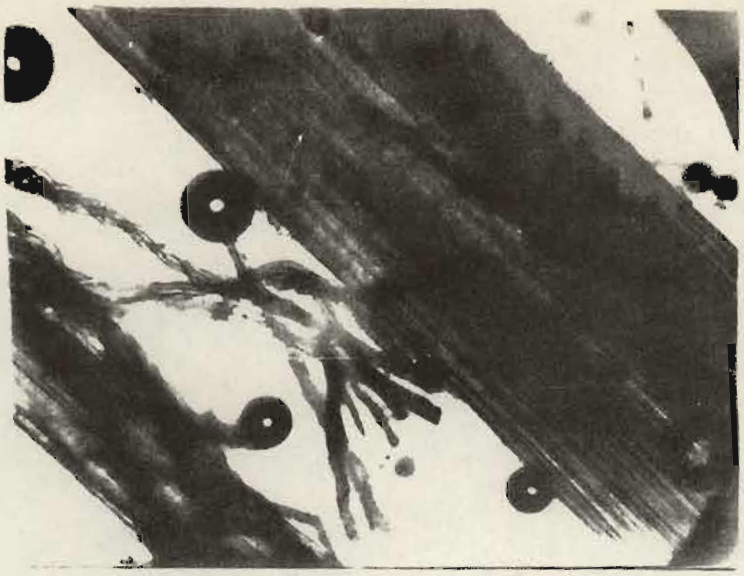

Fig. (13-a)

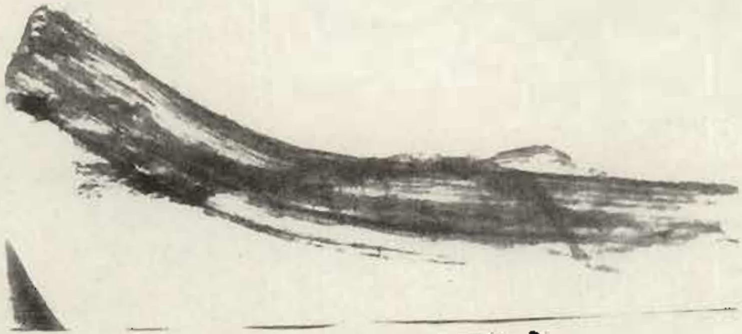

Fig. (13-b).

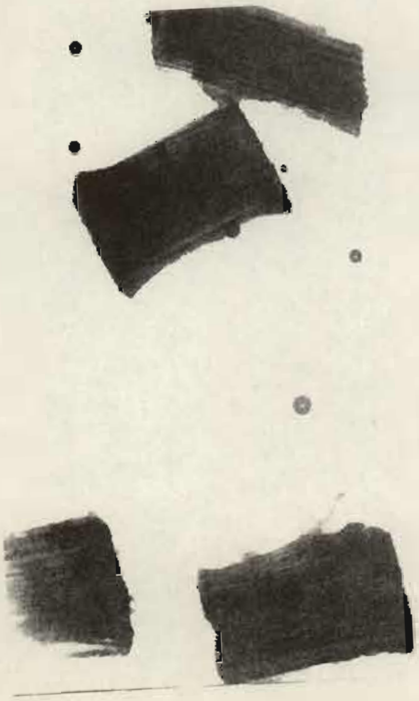

Fig (14-a)

Fig. (14-b)