STUDY ON THE REGIAN OF PAKISTANI WOOL FIBRES

ARBAB ABDUL WAKIL AND AMIR MOHAMMAD

Wool Research Division, North Regional Laboratories, Pakistan Council of Scientific and Industrial Research, Peshawar

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The variation between time in minutes and loss in weight, time in minutes and percentage regain and the effect of the varying humidity on percentage regain of adsorption and desorption of unscoured Kaghani and Harnai wool fibres has been studied. It was found that Kaghani wool fibres take about 80 minutes to reach the dryness, while Harnai wool fibres take only about 60 minutes. The rate of both desorption and adsorption in Kaghani wool fibres is greater than in the Harnai variety while the rate of desorption in the Kaghani variety as well as the Harnai variety is greater than absorption.

Introduction

It is known that the hygroscopic[1] nature of textile fibres, i.e., their ability to absorb water, is of great importance from many stand-points, not the least of which is the comfort of the wear, when the textile material is used for clothing. The moisture relations of fibre have an important bearing on many of the technical processes which they undergo in the course of manufacturing yarns and fibres. Dyeing technique too is closely associated with the moisture relation of fibre, for those which do not wet with water are very difficult to dye. Hence, the measurement of regain is of great importance in the wool industry for controlling the standard weight and the numerous stages, in nearly all of which regain is a factor determining the quality or uniformity of the product or the efficiency of the process.

A study of the variation in the content of the hygroscopic moisture in worsted yarn has been made by Hartshone. This study led to the establishment of a standard for conditioning wool in the United States. The complexity of the behaviour of wool towards moisture has been clarified considerably by Speakman, Stott and Cooper. Speakman[2] was the first to show that a marked hysteresis exists in the moisture content of wool between adsorption and desorption. Measurements have been confined to 25 samples each of Kaghani and Harnai wool percentage regain and moisture content under different conditions of humidities and temperature and results evaluated.

Experimental

1. *Determination of Percentage Regain and Loss in Weight.*—The percentage regain and loss in the weight of wool fibres was determined using the oven method.[3] Firstly ,the empty bottle with round glass cover off was kept in the oven for a time till a constant weight was obtained. The bottle was cooled in a desiccator, and finally the weight of the empty bottle was noted.Ten g. of the wool were placed in the bottle and heated in the oven at a temperature of 105°C. for different lengths of time, and thus the loss in weight and percentage regain of the same wool fibres for different time was found out.

2. *Determination of Adsorption and Desorption Properties of Wool Fibres with Relative Humidity Chamber Method.*—(i) Desorption Using Humidity Chamber Method: A polymeter was placed in the chamber for sometime till it attained the relative humidity of the chamber. The percentage relative humidity on the polymeter was noted. As the increase in temperature decreases the percentage relative humidity, the heating of the humidity chamber containing the bottle with wool sample and glass cover off was started and the percentage regain of desorption for the values of 45, 35, 25 and 15% relative humidities were determined. (ii) Adsorption, using the Relative Humidity Chamber Method: In this method, the heating of the humidity chamber containing the sample was continued till a constant relative humidity of the polymeter was obtained, i.e., the relative humidity of the polymeter was found constant with the further increase in temperature. The percentage relative humidity and temperature was recorded. After weighing the wool sample at 15% relative humidity, the chamber was cooled gradually with desert cooler and blowers. Thus the percentage regain of adsorption was calculated for the values of 15, 25, 35, 45 and 60 percentage relative humidities.

Calculation

$$\text{Percentage regain } 4 = \frac{(a-b)}{b} 100,$$

where a is the weight of the sample with moisture, and b is the weight of sample after drying at the various intervals of time.

The percentage regain of adsorption and desorption can also be determined in the same manner.

Discussion

Transportation[5] of wool from one locality to another of different humidities and temperatures causes loss or gain in the apparent weight of the wool, as the moisture is picked up or absorbed by the hygroscopic material from the atmosphere, if the relative amount of moisture in the air is greater than that in the material. Conversely, the moisture will be given up by the material if the relative amount of moisture in the air is less than that in the material. These changes are due to differences between the vapour pressure of the atmosphere and that within the material, particularly when the vapour pressure approaches equilibrium, as indicated by the equalization of the rate of exchange. Then for practical purposes hygroscopic equilibrium has been attained. Under natural conditions the amount of moisture (in atmosphere) is continually changing. This results in varying amount of moisture contained by the hygroscopic material exposed to the atmosphere.

It is well-known[6] that the weight of wool, as is that of many other textile fibres is profoundly affected by the humidity of the atmosphere in which it is stored. This dependence arises because, though water can be abosrbed by the wool substance, it is not very tightly bound to it. Thus the absorbed water is always trying to escape from the same way as it is from the surface of liquid water. At the same time wool is always being bombarded by the water molecules in the atmosphere and equilibrium is attained when the rate of escape of molecules is equal to the rate of bombardment. Now, while the rate of escape from both a liquid surface and from wool increases rapidly with rise in temperature, for wool fibres the rate of escape also increase, according to the amount of abosrbed water already present in the wool. The amount of water vapours in the atmosphere, which is required to bring it into equilibrium with a wool fibre will, therefore, depend both on the temperature and the amount of water absorbed by the wool.

Using the high temperature oven, the time required to reach dryness varies with the type of fibre and the weight of the fabric; the light fabric takes less time than heavy one. So far as the Kaghani and Harnai wools are concerned, their timing to reach dryness are about 80 and 60 minutes, respectively. Drying curves for Kaghani and Harnai are shown in Figs. 1 and 2, which show that the most of the moisture is lost very rapidly, but that the lost particles are held tenaciously by the fibre. Moreover, during the first 20 minutes of drying, the Kaghani wool looses more weight than Harnai, but finally, the loss in weight in Harnai is greater than in Kaghani.

Dealing with the regain in Kaghani and Harnai wools, it is observed that during first 20 minutes of heating at 105°C., Kaghani wool looses more weight, and on the other hand Harnai wool looses less weight, so the percentage regain of Kaghani wool is greater than Harnai's, but for the next 20 minutes of drying, the regain in Harnai and Kaghani is the same as the loss in weight in both

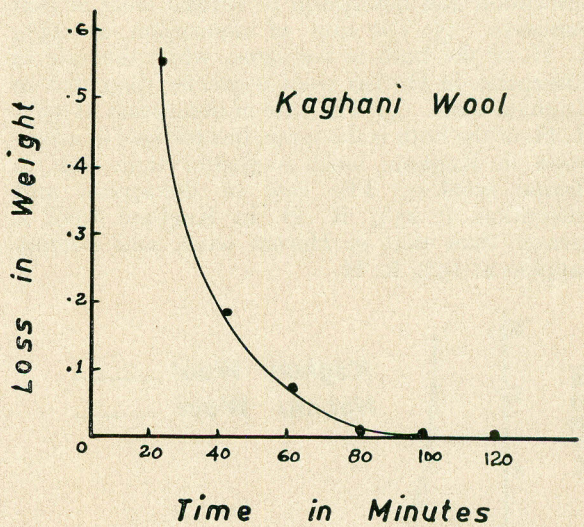

Fig. 1.—Relation between loss in weight and time in minutes.

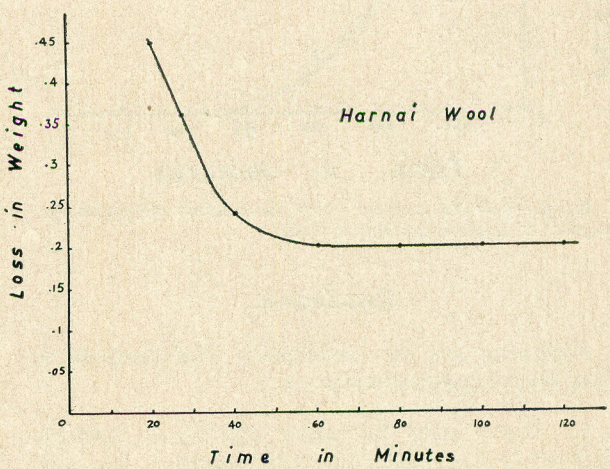

Fig. 2.—Relation between loss in weight and time in minutes.

cases is the same, and afterwards Harnai wool looses more weight than Kaghani wool, so its regain is greater than Kaghani wool. On the whole the loss in weight as well as the regain in Harnai wool is greater than in the Kaghani wool (Fig. 4, top).

Effects of Relative Humidity

(1) The rate of desorption in Kaghani wool at each and every humidity is greater than the rate of adsorption and same is the case in Harnai wool (Figs. 3 and 4, bottom). (2) The rate of desorption and adsorption at 55% R. H. in Kaghani wool is greater than the rate of adsorption and desorption in Harnai wool at that humidity. (3) The rate of desorption at 45% R. H. of the both is the same, while the rate of adsorption in Harnai wool is greater than that in Kaghani wool. (4) The rate of desorption at 35% R. H. of the both is the same, but the rate of adsorption in Kaghani wool is greater than that in Harnai wool. (5) The rate of desorption and adsorption at 25% R. H. in Kaghani wool is greater than that in Harnai wool, and nothing happens at 15% R. H.

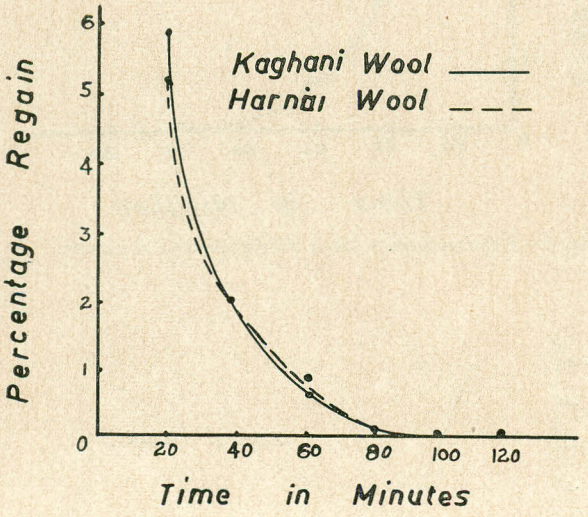

Fig. 3.—Relation between "time in minutes and percentage regain" of Kaghani and Harnai wools.

Conclusion

Following are the conclusions while keeping in view the foregoing discussion:

1. The affinity for water appears to increase slightly as the wool becomes coarser.7 In view of the alterations in the adsorption and desorption undergone by wool in the usual processing, it is

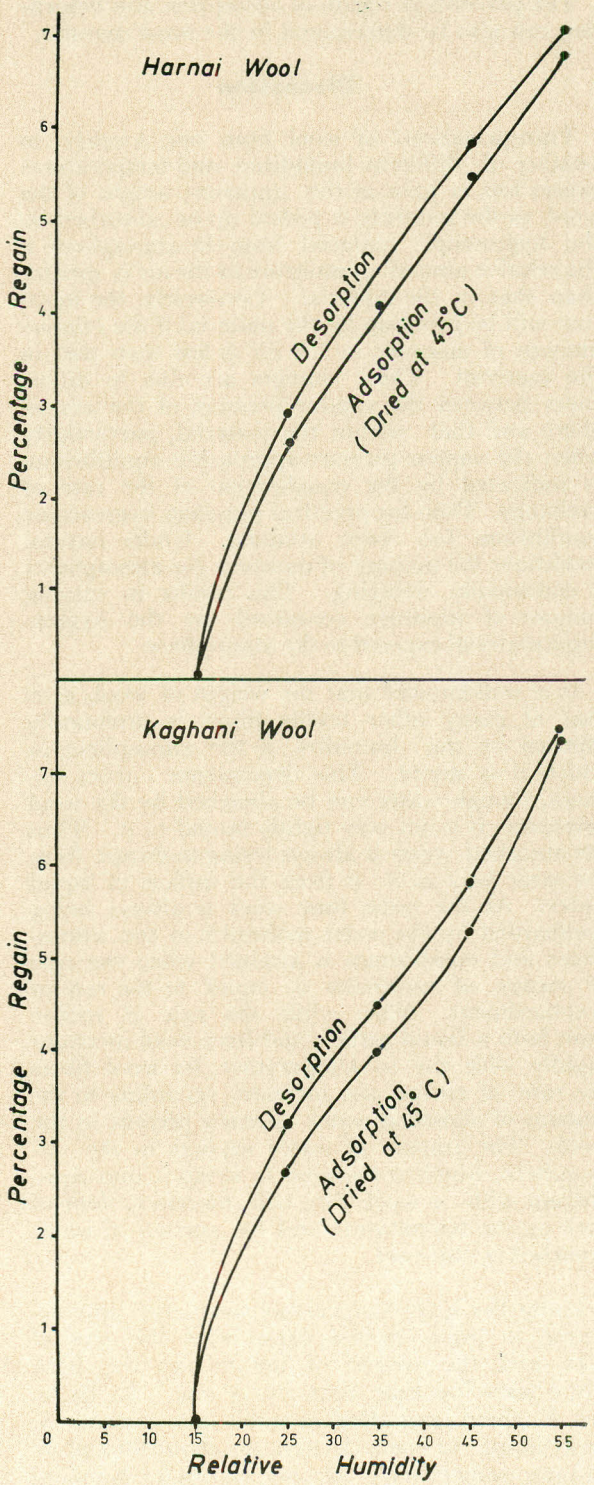

Fig. 4.(top).—Relation between "relative humidity and percentage regain" (desorption and adsorption curves of Harnai wool); (bottom), Relation between "relative humidity and percentage regain" (desorption and adsorption curves of Kaghani wool).

important to know the range of humidity over which wool must be dried, in order to pass from the hygroscopic stage to the stage of desorption.

2. The hygroscopic quality of wool is of considerable importance in commerce, because the weight of any given lot of wool in any form will vary within large limits according to climatic conditions.[8] Shipping wool from one locality to another of different humidities and temperature will cause a loss or gain in the apparent weight of the wool. As the importation of wool involves duty consideration, the true weight should be based on a standard percentage of moisture, or regain. The physical characteristics of the textile fibre are also effected by the moisture content in a most remarkable manner, (specially strength, extensibility, rigidity and swelling etc., so that it is important to know the percentage moisture content or regain at the various temperatures and relative humidities.

3. It was proved from experimental work, that the percentage moisture regain is not the sure test for the determination of wool quality, i. e., fineness, breed etc. The appreciable difference of increase or decrease in percentage moisture content may be due to some processing of wool already undertaken, e. g., scouring, combing etc. which effects the moisture content appreciably; other-

TABLE 1.—RELATION BETWEEN MEAN LOSS IN WEIGHT AND TIME IN MINUTES OF KAGHANI WOOL FIBRES. WEIGHT OF SAMPLE TAKEN 10 G. TEMP.; 105°C.

No. of observation	Time in min.	Loss in wt. in g.
1	20	·53
2	40	.2
3	60	.08
4	80	.01
5	100	.01
6	120	.01

TABLE 2.—RELATION BETWEEN MEAN LOSS IN WEIGHT AND TIME IN MINUTES OF HARNAI WOOL FIBRES. WEIGHT OF SAMPLE TAKEN, 10 G. TEMP. 105°C.

No. of obsrvation	Time in min.	Loss in wt. in g.
1	20	·45
2	40	.24
3	60	.2
4	80	.2
5	100	.2
6	120	.2

TABLE 3.—RELATION BETWEEN MEAN PERCENTAGE OF REGAIN AND TIME IN MINUTES OF KAGHANI WOOL FIBRES. WEIGHT OF SAMPLE TAKEN 10 G. TEMP. 105°C.

No. of observation	Time in min.	Percentage regain
1	20	5·93
2	40	2.05
3	60	0.6
4	80	0.1
5	100	Nil
6	120	Nil

TABLE 4.—RELATION BETWEEN PERCENTAGE REGAIN AND TIME IN MINUTES OF HARNAI WOOL FIBRES. WEIGHT OF SAMPLE 10 G. TEMP., 105°C.

No. of observations	Time in minute	Percentage Regain
1	20	5.2
2	40	2.05
3	60	0.9
4	80	0.13
5	100	Nil
6	120	Nil

TABLE 5.—EFFECT OF RELATIVE HUMIDITY ON MEAN PERCENTAGE REGAIN SHOWING ADSORPTION AND DESORPTION PROPERTIES OF KAGHANI WOOL FIBRES.

No. of observation	Relative humidity	Desorption % regain	Adsorption % regain
1	55	7·5	7·4
2	45	5·8	5·3
3	35	4·5	4·05
4	25	3.20	2.7
5	15	Nil	Nil

TABLE 6.—EFFECT OF RELATIVE HUMIDITY ON MEAN PERCENTAGE REGAIN, SHOWING ADSORPTION AND DESORPTION PROPERTIES OF HARNAI WOOL FIBRES.

No. of observation	Relative humidity	Desorption % regain	Adsorption % regain
1	55	7.1	6.78
2	45	5.8	5·5
3	35	4·5	3.6
4	25	2.9	2.6
5	15	Nil	Nil

wise different types of wool under same conditions of temperature and relative humidity show little difference for the same.

4. An appreciable difference in percentage moisture content between the packed and loose wool fibres was also detected.

5. From the results and discussion it is also clear that Harnai wool is heavier than Kaghani wool.

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References

1. J. T. Marsh. Textile Science (Chapman and Hall Ltd., 37, Essex St. W.E. 2, London), p. 87 (1958).
2. W. V. Bergen and H. R. Maursbargen American Wool Hand-book (Textile book Publisher Inc., New York, 16 N. Y.), p. 153, (1948).
3. Wool Science Review (The Int. Wool Secretariat, Scientific and Technical Deptt. 18—20 Regent St. London, S. W. 1, Jan. 1961), p. 21 No. 19.
4. John H. Skinkle, Textile Testing (Chem. Publishing Co. Inc., Brooklyn N. Y., 1949), p. 19.
5. Elliot B. Grover D. S. Hamby, Hand-book of of Textile Testing and Quality Control (Textile Book Publishers Inc., New York, 1961,) p. 141.
6. Wool Science Review (The Int. Wool Secretariat, Scientific and Tech. Deptt., 18—20 Regent St., London., S. W. 1., Nov. 1956). No. 13.
7. W. V. Bergen and H. R. Maursbergen. American Wool Hand-book (Textile Book Publishers Inc., New York, 1948), p. 154.
8. Ibid, (1948), p. 156