

TABLE 2. REGAIN OF HYGROSCOPIC MATERIALS  
 Moisture Content Expressed in Per Cent of Dry Weight of the Substance at  
 Various Relative Humidities—Temperature, 75 F

| CLASSIFICATION            | MATERIAL                           | DESCRIPTION                    | RELATIVE HUMIDITY—PER CENT |      |      |      |      |      |      |      |      | AUTHORITY      |
|---------------------------|------------------------------------|--------------------------------|----------------------------|------|------|------|------|------|------|------|------|----------------|
|                           |                                    |                                | 10                         | 20   | 30   | 40   | 50   | 60   | 70   | 80   | 90   |                |
| Natural Textile Fibers    | Cotton                             | Sea island—roving              | 2.5                        | 3.7  | 4.6  | 5.5  | 6.6  | 7.9  | 9.5  | 11.5 | 14.1 | Hartshorne     |
|                           | Cotton                             | American—cloth                 | 2.6                        | 3.7  | 4.4  | 5.2  | 5.9  | 6.8  | 8.1  | 10.0 | 14.3 | Schloesing     |
|                           | Cotton                             | Absorbent                      | 4.8                        | 9.0  | 12.5 | 15.7 | 18.5 | 20.8 | 22.8 | 24.3 | 25.8 | Fuwa           |
|                           | Wool                               | Australian merino—skein        | 4.7                        | 7.0  | 8.9  | 10.8 | 12.8 | 14.9 | 17.2 | 19.9 | 23.4 | Hartshorne     |
|                           | Silk                               | Raw chevennes—skein            | 3.2                        | 5.5  | 6.9  | 8.0  | 8.9  | 10.2 | 11.9 | 14.3 | 18.8 | Schloesing     |
|                           | Linen                              | Table cloth                    | 1.9                        | 2.9  | 3.6  | 4.3  | 5.1  | 6.1  | 7.0  | 8.4  | 10.2 | Atkinson       |
|                           | Linen                              | Dry spun—yarn                  | 3.6                        | 5.4  | 6.5  | 7.3  | 8.1  | 8.9  | 9.8  | 11.2 | 13.8 | Sommer         |
|                           | Jute                               | Average of several grades      | 3.1                        | 5.2  | 6.9  | 8.5  | 10.2 | 12.2 | 14.4 | 17.1 | 20.2 | Storch         |
| Rayons                    | Hemp                               | Manila and sisal—rope          | 2.7                        | 4.7  | 6.0  | 7.2  | 8.5  | 9.9  | 11.6 | 13.6 | 15.7 | Fuwa           |
|                           | Viscose Nitrocellulose Cupramonium | Average skein                  | 4.0                        | 5.7  | 6.8  | 7.9  | 9.2  | 10.8 | 12.4 | 14.2 | 16.0 | Robertson      |
|                           | Cellulose Acetate                  | Fibre                          | 0.8                        | 1.1  | 1.4  | 1.9  | 2.4  | 3.0  | 3.6  | 4.3  | 5.3  | Robertson      |
| Paper                     | M. F. Newsprint                    | Wood pulp—24% ash              | 2.1                        | 3.2  | 4.0  | 4.7  | 5.3  | 6.1  | 7.2  | 8.7  | 10.6 | U. S. B. of S. |
|                           | H. M. F. Writing                   | Wood pulp—3% ash               | 3.0                        | 4.2  | 5.2  | 6.2  | 7.2  | 8.3  | 9.9  | 11.9 | 14.2 | U. S. B. of S. |
|                           | White Bond                         | Rag—1% ash                     | 2.4                        | 3.7  | 4.7  | 5.5  | 6.5  | 7.5  | 8.8  | 10.8 | 13.2 | U. S. B. of S. |
|                           | Com. Ledger                        | 75% rag—1% ash                 | 3.2                        | 4.2  | 5.0  | 5.6  | 6.2  | 6.9  | 8.1  | 10.3 | 13.9 | U. S. B. of S. |
| Misc. Organic Materials   | Kraft Wrapping                     | Coniferous                     | 3.2                        | 4.6  | 5.7  | 6.6  | 7.6  | 8.9  | 10.5 | 12.6 | 14.9 | U. S. B. of S. |
|                           | Leather                            | Sole oak—tanned                | 5.0                        | 8.5  | 11.2 | 13.6 | 16.0 | 18.3 | 20.6 | 24.0 | 29.2 | Phelps         |
|                           | Catgut                             | Racquet strings                | 4.6                        | 7.2  | 8.6  | 10.2 | 12.0 | 14.3 | 17.3 | 19.8 | 21.7 | Fuwa           |
|                           | Glue                               | Hide                           | 3.4                        | 4.8  | 5.8  | 6.6  | 7.6  | 9.0  | 10.7 | 11.8 | 12.5 | Fuwa           |
|                           | Rubber                             | Solid tire                     | 0.11                       | 0.21 | 0.32 | 0.44 | 0.54 | 0.66 | 0.76 | 0.88 | 0.99 | Fuwa           |
|                           | Wood                               | Timber (average)               | 3.0                        | 4.4  | 5.9  | 7.6  | 9.3  | 11.3 | 14.0 | 17.5 | 22.0 | Forest P. Lab. |
|                           | Soap                               | White                          | 1.9                        | 3.8  | 5.7  | 7.6  | 10.0 | 12.9 | 16.1 | 19.8 | 23.8 | Fuwa           |
|                           | Tobacco                            | Cigarette                      | 5.4                        | 8.6  | 11.0 | 13.3 | 16.0 | 19.5 | 25.0 | 33.5 | 50.0 | Ford           |
| Food-stuffs               | White Bread                        |                                | 0.5                        | 1.7  | 3.1  | 4.5  | 6.2  | 8.5  | 11.1 | 14.5 | 19.0 | Atkinson       |
|                           | Crackers                           |                                | 2.1                        | 2.8  | 3.3  | 3.9  | 5.0  | 6.5  | 8.3  | 10.9 | 14.9 | Atkinson       |
|                           | Macaroni                           |                                | 5.1                        | 7.4  | 8.8  | 10.2 | 11.7 | 13.7 | 16.2 | 19.0 | 22.1 | Atkinson       |
|                           | Flour                              |                                | 2.6                        | 4.1  | 5.3  | 6.5  | 8.0  | 9.9  | 12.4 | 15.4 | 19.1 | Bailey         |
|                           | Starch                             |                                | 2.2                        | 3.8  | 5.2  | 6.4  | 7.4  | 8.3  | 9.2  | 10.6 | 12.7 | Atkinson       |
|                           | Gelatin                            |                                | 0.7                        | 1.6  | 2.8  | 3.8  | 4.9  | 6.1  | 7.6  | 9.3  | 11.4 | Atkinson       |
| Misc. Inorganic Materials | Asbestos Fiber                     | Finely divided                 | 0.16                       | 0.24 | 0.26 | 0.32 | 0.41 | 0.51 | 0.62 | 0.73 | 0.84 | Fuwa           |
|                           | Silica Gel                         |                                | 5.7                        | 9.8  | 12.7 | 15.2 | 17.2 | 18.8 | 20.2 | 21.5 | 22.6 | Fuwa           |
|                           | Domestic Coke                      |                                | 0.20                       | 0.40 | 0.61 | 0.81 | 1.03 | 1.24 | 1.46 | 1.67 | 1.89 | Selvig         |
|                           | Activated Charcoal                 | Steam activated                | 7.1                        | 14.3 | 22.8 | 26.2 | 28.3 | 29.2 | 30.0 | 31.1 | 32.7 | Fuwa           |
|                           | Sulphuric Acid                     | H <sub>2</sub> SO <sub>4</sub> | 33.0                       | 41.0 | 47.5 | 52.5 | 57.0 | 61.5 | 67.0 | 73.5 | 82.5 | Mason          |

Table 2 shows the regain or hygroscopic moisture content of several organic and inorganic materials when in equilibrium at a dry-bulb temperature of 75 F and various relative humidities. The effect of relative humidity on regain of hygroscopic substances is clearly indicated. The effect of temperature is comparatively unimportant. In the case of cotton, for instance, an increase in temperature of 10 deg has the same effect on regain as a decrease in relative humidity of one per cent. Changes in temperature do, however, affect the rate of absorption or drying. Sudden changes in temperature cause temporary fluctuations in regain even when the relative humidity remains stationary.

The regain or moisture content affects the physical properties of textiles to a marked degree, changing the strength, pliability and elasticity.

The fact that the regain of textiles will come into equilibrium with the conditions of the surrounding air and vary with its temperature and relative humidity is the fundamental basis for the control of physical qualities during manufacture. During the preparation processes in a cotton mill, the cotton fibers should be in a condition to be easily carded.

These preliminary processes are carried out best in a relative humidity of 50 to 55 per cent. As the cotton fiber comes to the spinning operation, more flexibility is needed and the relative humidity is increased in this department. For many years, 65 per cent relative humidity was considered the optimum. To offset the extra work performed on the fiber as the spindle speed is increased, many cotton mills now carry 70 per cent relative humidity in the spinning rooms.<sup>1</sup> Winding, warping and weaving are all processes calling for great flexibility and a consequent need for higher humidity.

Other textile fibers, due to their different natural characteristics, are processed under relative humidities and temperatures applicable to each.

Rayons, on account of great loss of strength with the higher regains, should be processed in a relative humidity of 55 to 70 per cent. Acetate silk, another chemical fiber, with approximately 50 per cent of the regain of rayon, may be processed between 60 and 65 per cent relative humidity.

All hygroscopic materials release sensible heat equivalent to the latent heat of the moisture absorbed by the material, all of which may account for a small percentage of the total heat load.

## CONDITIONING AND DRYING

In general, the exposure of materials to desirable conditions for treatment may be coincidental with the manufacture or processing of the materials, or they may be treated separately in special enclosures. This latter treatment may be classified as conditioning or drying. The purpose of conditioning or drying is usually to establish a desired condition of moisture content and to regulate the physical properties of the material.

When the final moisture content is lower than the initial one, the term *drying* is applied. If the final moisture content is to be higher, the process is termed *conditioning*. In the case of some textile products and tobacco,

<sup>1</sup>The Present Status of Textile Regain Data, by A. E. Stacey, Jr. (National Association of Cotton Manufacturers, 1927).