TABLE 1. TEMPERATURES AND HUMIDITIES APPLICABLE TO INDUSTRIAL AIR CONDITIONING—(Concluded)

TEXTILES (Continued)

Worsteds: Top storage temperature depends on whether cellar long period conditioning at low temperature or quick conditioning at high temperature is used. Weaving relative humidity depends upon staple, quality and construction.

Filtration of air is essential.

Rayon manufacture: The steeping room, where sheets of raw material are dipped in caustic soda then broken into a fine matted crumb, is held at 70 F and 55 percent relative humidity. Relative humidity is held down to prevent condensation on cold pipes and jackets.

In churn room, where sodium cellulose is converted into cellulose xanthate, temperatures of 75 to 80 F are maintained while humidity control is not important. Room temperatures are held below 85 F during the summer months.

The crumb is dumped into aging tanks located in a room held at 73 F with no humidity control.

For spinning operations it is desirable to limit the temperature to 90 F with a minimum relative humidity of 70 percent for the summer, while 70 percent and 75 F are desirable for the winter months.

The storage room, where the material is held for later processing design conditions, are 85 F and 100 percent relative humidity.

The material is washed, desulfurized, bleached and then washed again. It is then placed in a drier where controlled conditions of 100 deg and 65 percent relative humidity are required to bring the rayon back to the proper regain.

In the coning room, where winding machines place the rayon yarn on cones, temperature is held at a maximum of 80 F. Relative humidity is held at 55 percent.

PROCESS	TEMP. F	R.H. %
TOBACCO		
Cigar and cigarette making	70 to 75	55 to 65
Softening	90	85 to 88
Stemming and stripping	75 to 85	70 to 75
Packing and shipping	74 to 76	65
Filler tobacco casing and conditioning	75	75
Filler tobacco storage and preparation	78	70
Wrapper tobacco storage and conditioning	75	75

In preparation for stripping, the tobacco undergoes a softening operation, whereby it is automatically heated, moistened and then cooled.

Control of moisture regain, and of chemical and biological reactions is required in tobacco processing.

Exact temperature and humidity conditions maintained are usually trade secrets as they affect the finished product.

6. Control of dew-point for protection of highly polished surfaces.
7. Control of humidity for static electricity elimination.
8. Control of conditions for material test laboratories.

Moisture Content and Regain

In the manufacture or processing of hygroscopic materials such as textiles, paper, wood, leather, tobacco and foodstuffs, the temperature and relative humidity of the air have a marked influence upon the rate of production and upon the weight, strength, appearance, and general quality of the product. The moisture content of materials having a vegetable or animal origin, and to a lesser extent minerals in certain forms, comes to equilibrium with the moisture of the surrounding air. This moisture content is known as *regain*. Standards of *regain* are fixed in the trade, and are the fundamental basis for the control of certain physical qualities of the material during manufacture.

Manufacturing economy requires that the moisture content be maintained at a level favorable to rapid and satisfactory manipulation, and to a minimum loss of material through breakage. A uniform condition is desirable in order that high speed machinery may be adjusted permanently for the desired production with a minimum loss from delays, wastage of raw material, and defective product. *Moisture content* refers to free moisture (as in a sponge) and to hygroscopic moisture (which varies with atmospheric conditions). It is usually expressed as a percentage of the total weight of material. *Regain* is more specific and refers only to hygroscopic moisture. It is expressed as a percentage of the *bone-dry* weight of material. For example, if a sample of cloth weighing 100.0 g is dried to a bone-dry weight of 93.0 g, the loss in weight, or 7.0 g, represents the weight of moisture originally contained. This expressed as a percentage of the total weight (100.0 g) gives the moisture content of 7 percent. The regain, which is expressed as a percentage of the bone-dry weight, is $(7.0/93.0) \times 100 = 7.5$ percent.

The use of the term *regain* does not imply that the material as a whole has been completely dried out and has re-absorbed moisture.

A basis for calculating the regain of textiles is obtained by drying, under standard conditions, a sample from the lot, and the dry weight thus obtained is used in the calculations to determine the regain.

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 temperature as compared to the relative humidity is comparatively unimportant, although sudden changes in temperature cause a slight change in regain even when the relative humidity remains stationary. Changes in temperature do, however, affect the rate of absorption or drying, although this property generally varies with the nature of the material, its thickness and density.

When hygroscopic materials absorb moisture from the surrounding air, they deliver to the air sensible heat equivalent to the latent heat released by the moisture to the material. This amount of heat should be included in the load estimate.

Conditioning and Drying

In general, the materials may be exposed to desirable humidities for treatment coincidentally 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 usual purpose of conditioning or drying is 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 (See Chapter 47). If the final moisture content is to be higher, the process is termed *conditioning*. In the case of some textile products and tobacco, for example, drying and conditioning may be combined in one process for the dual purpose of removing undesirable moisture, and accurately regulating the final moisture content. Frequently, conditioning or drying is made a continuous process in which the material is conveyed through an elongated compartment by suitable means, and subjected to various controlled atmospheric conditions.

Control of Rate of Chemical Reactions

A typical example of control of the rate of chemical reactions occurs in the manufacture of rayon. The pulp sheets are conditioned, cut to size, and passed through a mercerizing process. It is essential that, during this process, close control of both temperature and relative humidity should be maintained. The temperature controls the rate of reaction directly, while the relative humidity maintains a constant rate of evaporation from the surface of the solution, and maintains a solution of known strength throughout the mercerizing period.

Another well-known example in this class is the *drying* of varnish which