rate shown by BA. During the constant rate period water is being evaporated from the surface of the material at a rate comparable to that of a free water surface and moisture is being supplied by diffusion or capillarity to the surface at a rate equal to or greater than the evaporative rate. During this period the material is generally considered to assume the wet bulb temperature of the air, although this is not strictly true as, in many cases, radiant heat is absorbed or some heat is supplied by conduction.

AD represents the first stage of the falling rate period and when this portion of the curve is linear it is assumed that the surface, although still wet, is gradually drying out. The moisture content corresponding to point A is termed the *critical* moisture content and it is reached when the moisture reaches the surface at a rate less than the potential evaporative rate. The portion of the rate curve corresponding to DE represents the period of drying where the outer surface has become dry and subsurface

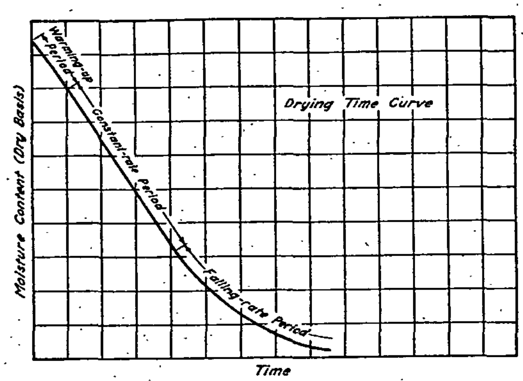

FIG. 1. MOISTURE CONTENT VS. DRYING TIME[1]

evaporation is taking place. During the period A to E, the temperature of the material gradually increases and tends to approach the dry bulb temperature of the air.

Finally, all drying stops at the *equilibrium moisture content* (point E on the curve) where the vapor pressure of water in the air is equal to the vapor pressure of water in the material. The equilibrium moisture content varies with the humidity of the air and the hygroscopic properties of the material as explained in Chapter 45, Industrial Air Conditioning.

The drying rate during the constant rate period is subject to mathematical analysis and can be predicted with some degree of accuracy but calculations involving the falling rate period are seldom satisfactory because of the number of variables involved. The flow of water within the material may be caused by a combination of many factors some of which are capillarity, pressure due to shrinkage, true diffusion of liquid moisture, the force of gravity and a sequence of vaporizations and condensations within the solid. Because of this complexity of internal moisture flow and the tremendous number of solid materials with different internal structures, no satisfactory theory has yet been developed for predicting the rate of this flow and hence the rate of drying. As a result, the fundamentals of a practical approach to drying have been based on the

external drying conditions; i.e. the temperature, humidity and velocity of the drying air, and the physical conditions of the material being dried. Prediction of drying rates may be based on past experience but are preferably obtained from experiments employing the conditions which are expected in commercial large-scale practice.[1]

Omissions in Drying Cycle

Many solids, such as lumber, are so dry at the beginning of the drying operation that the constant rate period of free surface evaporation does not occur. Frequently the surface of the material is dry enough so that no surface drying can take place, in which case only the final stage of sub-surface drying is involved. In other instances, the critical moisture content of a wet solid is sufficiently low that sub-surface drying starts almost immediately after the conclusion of the constant rate period. Thus the

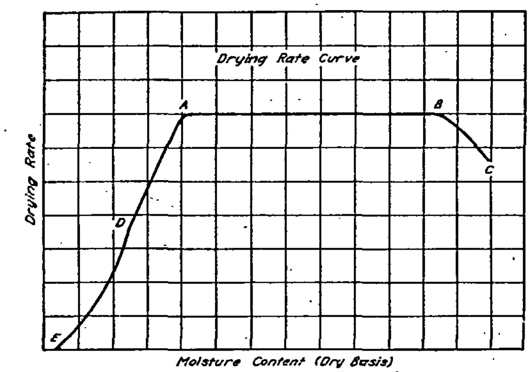

FIG. 2. RATE OF DRYING VS. MOISTURE CONTENT[1]

intermediate state of unsaturated surface drying does not occur and the drying is of the sub-surface type during practically the whole of the falling rate period. With other kinds of material, particularly thin sheets, such as newsprint paper, sub-surface drying may occur at such a low moisture content that it is not encountered in commercial work, the falling rate period being confined in practice to unsaturated surface drying.

MOISTURE CONTENT

The moisture content of solid materials can be expressed in terms of per cent on *wet* or *dry* basis. The per cent moisture on a wet basis is the ratio of the weight of moisture in the sample to the total weight of the sample whereas on a dry basis it is the ratio of the weight of moisture in the sample to the weight of solids in the sample. A vegetable, for example, having 80 per cent moisture on a wet basis would have 80 grams of moisture and 20 grams of bone dry solids in a 100 gram sample. On a dry basis, the moisture content would be 4.0 (400 per cent).

In drying calculations the dry basis is usually preferred because small variations in initial moisture content expressed on a wet basis can lead to serious errors. For example, if a quantity of 100 lb of material is to