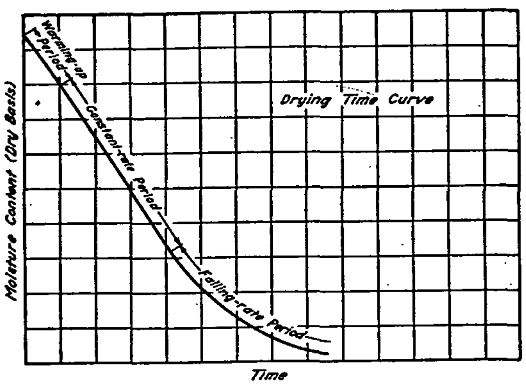


FIG. 2. MOISTURE CONTENT $W$ VS. DRYING TIME $\theta$[2]

## Periods of Drying[1]

A typical drying time curve for a wet solid is shown in Fig. 2. This curve is a plot of the moisture content at any time in a solid undergoing drying. It is the usual method of presenting experimental drying data. Although Fig. 2 shows that the moisture content is subject to a continuous variation with time, a more precise illustration of the nature of this variation can be obtained by differentiating the curve and plotting the drying rate (pounds of water per hour per pound of dry material) against the moisture content (pounds of water per pound of dry material) as shown in Fig. 3, or plotting the rate of drying against time as shown in Fig. 4. These *rate curves* show that the drying process is not a smooth, continuous one in which a single mechanism controls throughout. The rate curve in Fig. 4 has the advantage of showing how long each drying period predominates.

Section AB on each curve represents a *constant-rate period*. In Fig. 2, it is shown by a straight line of constant slope $dW/d\theta$, which becomes a horizontal line on the rate curves in Figs. 3 and 4.

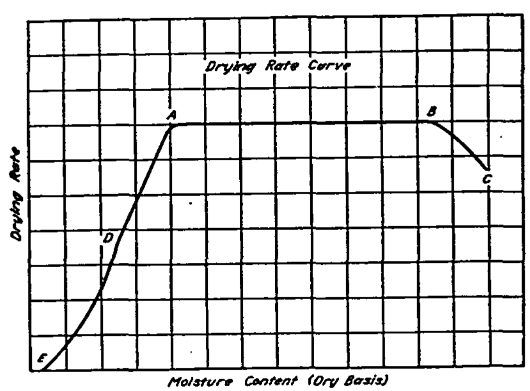


FIG. 3. RATE OF DRYING $\frac{dW}{d\theta}$ VS. MOISTURE CONTENT $W$[1]



The curved portion of Fig. 2 is termed the falling-rate period, and, as shown in Figs. 3 and 4, it is typified by a continuously changing rate. Point A, where the constant rate ends and the drying rate begins to decrease, is termed the *critical moisture content.*

The portion of the curves designated by CB represents a warming-up period, and it may, or may not, be a significant item depending on the total time involved.

*Constant-Rate Period.* Drying during the constant-rate period is equivalent to evaporation from a free-water surface on the surface of the solid. The rate of drying in this period is determined by the rate of diffusion of water vapor through an air film at the wet surface of the solid. A constant rate of evaporation on the surface of the solid maintains the surface at a constant temperature, which, in the absence of other heat effects, is very nearly the wet-bulb temperature of the air. If heat flows to the surface of evaporation by radiation and conduction, or both, in addition

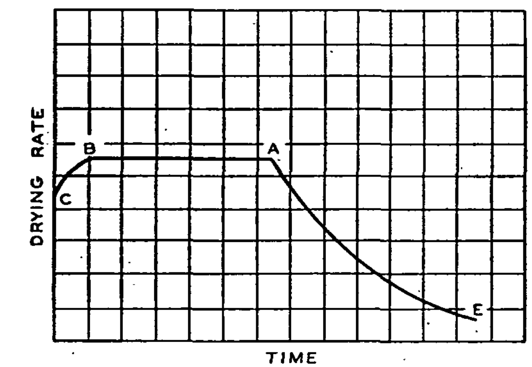


FIG. 4. RATE OF DRYING, $\frac{dW}{d\theta}$ VS. TIME $\theta$

to convection, the surface temperature will be constant at some value between the air temperature and the wet-bulb temperature. This higher temperature in turn produces a higher constant rate of evaporation.

In those dryers in which heat is transferred to a wet solid by conduction through hot surfaces, and heat transfer by convection is not a factor, the wet surfaces approach the boiling point temperature rather than a wet-bulb temperature.

When all the heat for evaporation in the constant-rate period is supplied by a hot gas, a dynamic equilibrium is established between the rate of heat transfer to the material and the rate of vapor removal from the surface. This equilibrium between heat and mass transfer rates can be expressed as follows:

$$\frac{dw}{d\theta} = \frac{h_t A \Delta t}{\lambda} = k_g A \Delta p \quad (1)$$

*where*

$\frac{dw}{d\theta}$ = drying rate, pounds of water per hour.