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# Rate of drying- constant and falling rate, Effect of Shrinkage

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# Outline

- Introduction
- Rate and time of drying
- Constant drying rate period
- First falling drying rate period
- Second falling drying rate period
- Estimation of drying time



## Introduction

### Rate and time of drying

Drying process can be divided in to three periods

- (i) constant drying rate period and
- (ii) first falling drying rate period and
- (iii) second falling rate period.

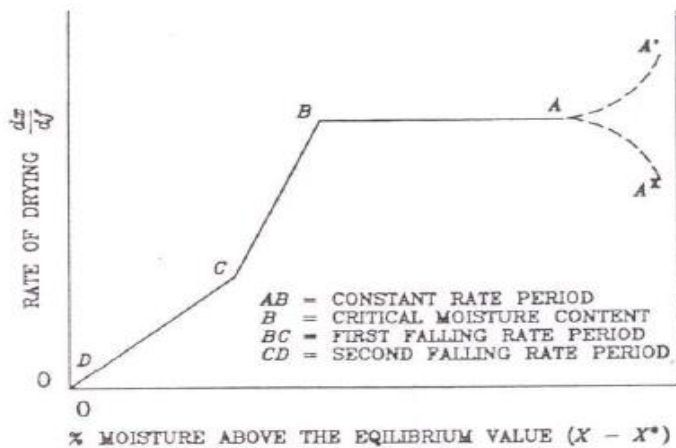


Fig. General rate of drying curve for solid material



- 1) Constant drying rate period
  - 1) Wet bulb temperature

$$q = M_w N_w \lambda_w A \text{----- (i)}$$

$$N_w = k_y (y_w - y)$$

$$\frac{dw}{d\theta} = \frac{h \cdot A (t_a - t_s)}{\Delta H_v} = k_a \cdot A \cdot (H_s - H_a)$$

Where,

w = kg of moisture

$\theta$  = time

h = heat transfer coefficient between air and moisture kcal/ kg hr °C

$t_a$  = dry bulb temperature of air, °C

$t_s$  = surface temperature, °C

A = area, m<sup>2</sup>

$\Delta H_v$  = heat of vapourisation at  $t_s$ , Kcal/ kg

$k_a$  = mass transfer coefficient (kg/ hr m)

$H_s$  = humidity of saturated air at the surface temperature



## First Falling drying rate period

## Second falling drying rate period

## Estimation of Drying Time

For constant rate drying period the following general expression would apply:

$$R_c = \frac{dw}{dt} = \frac{w_0 - w_c}{t_c} \text{-----(1)}$$

Where,

$w_c$  = Critical moisture content (kg water / kg dry solid ) and

$t_c$  = Time for constant rate drying

During falling rate drying, the following analysis would apply.

$$- \frac{dw}{dt} = R_c / w_c (w) \text{ or}$$

$$w_c / R_c \square - \frac{dw}{w} = \square dt$$

Where the limits of integration are between critical moisture content  $w_c$  or end of constant rate drying,  $t_c$  and some desired final moisture content,  $w$ .



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# Thank you