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Evaluation of convective mass transfer coefficient during drying of jaggery

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Abstract

In this paper an attempt is made to evaluate the convective mass transfer coefficient during drying of jaggery in a controlled environment. In this method, different masses of jaggery were used. The jaggery was dried in the roof type even span greenhouse with a floor area of 1.2×0.8 m^2 in natural and forced convection mode at atmospheric pressure till it attained almost no variation in mass. The experimental data of mass evaporated, temperatures of jaggery, greenhouse room air and relative humidity were measured and the data used to evaluate the convective mass transfer coefficient by regression analysis. It was found that the convective mass transfer coefficient is a strong function of mass of jaggery, temperatures and relative humidity for a given size of greenhouse.

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Greenhouse

A_t

area of jaggery tray (m^2)

C

experimental constant

C_v

specific heat of humid air (J/kg °C)

g

acceleration due to gravity (m/s^2)

Gr

Grashof number$=g\beta X^3\rho_v{}^2\Delta T'/\mu_v{}^2$

h_c

convective heat transfer coefficient (W/m^2 °C)

K_v

thermal conductivity of humid air (W/m °C)

M_j

mass of the jaggery (kg)

$\dot{m}_{ev}$

moisture evaporated (kg)

n

experimental constant

Nu

Nusselt number$=h_c X/K_v$

Pr

Prandtl number of humid air$=\mu_v C_v/K_v$

$P(T)$

Partial vapor pressure at temperature T (N/m^2)

$\dot{Q}_e$

rate of heat utilized to evaporate moisture (J/m^2 s)

Re

Reynolds number$=\rho_v vd/\mu_v$

t

time (s)

T_{c1}

greenhouse temperature (in upper side), (°C)

T_{c2}

above jaggery surface temperature in greenhouse (°C)

T_j

temperature of jaggery (°C)

$\Delta T'$

effective temperature difference (°C)

X

characteristic dimension (m)

β

coefficient of volumetric expansion (1/°C)

γ

relative humidity (dec.)

σ

surface tension of liquid–vapor interface (N/m)

λ

latent heat of vaporization (J/kg)

μ_v

dynamic viscosity (kg/m sec)

ρ_v

density (kg/m^3)

Article Outline

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