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Study on Heat and Mass Transfer in Convective Drying Process of Moving Porous Solid

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Recently in the different fields of the national economy drying process is being widely used in manufacturing the products. Especially in various fields such as the production of roofing tile and foodstuff, it is necessary to establish the process of convective drying of moving moist object. This article aims to analyze the heat and mass transfer of moving moist object in the convective drying process which can put the production on the scientific base.

To make the model of convective drying of moving porous solid, the tunnel dryer is selected, and the assumptions are as follows;

First, the moving velocity of object is uniform, and its temperature and moisture are steady.

Second, air and water vapor are considered as perfect gases.

Third, the hot air flow is incompressible and turbulent with the low Reynolds number

Fourth, the object is a porous solid with uniform shape and pores;

Geometric region for simulation of drying process of moving porous solid is divided into porous region including objects and the region of hot air. Drying kinetic equations of moving porous solid in porous region can be expressed as;

Heat transfer energy equation

$$(C_{P,\,s}+wC_{p,\,1})(1-\gamma_P)\rho_s u_0\frac{\partial T_S}{\partial x}=\{\xi\alpha_{as}(b_1+b_2T_r+b_3T_r^2)(T-T_s)-\dot{m}[h_s+C_{P,\,v}(T-T_s)]\}$$

Moisture transfer energy equation

$$\dot{m}=-(1-\gamma_P)\rho u_0\frac{\partial w}{\partial x}=(1-\gamma_P)\rho_s\xi\beta_{as}(Y_{sat}(T_s)-Y_a)(a_1+a_2w_r+a_3w_r^2)$$

By coupling the continuity equation, energy equation, vapor moisture equation, k–ɜ equation of hot air and turbulent energy dissipation of hot air, we have presented the mathematical model for the numerical analysis of the heat and mass transfer in convective drying of moving porous solid.

On this basis, we calculated the temperature and the moisture of moving solid in tunnel dryer verse the various velocities using the CFD simulation analysis program FLUENT6.3.26.

Through the simulation we determined the coefficients which are used in drying kinetic equations as a_1=2*e*–9, a_2=*e*–5, a_3=–4.465*e*–6, b_1=0.18, b_2=0.064 8, b_3=–0.234.

To verify the model we compared the results with experimental data, and the deviation is 4%.

The result of research can be used to determine the reasonable operational parameter which guarantees the moisture of the product in the outlet of dryer verse the various velocities of the moving object.