UNSTEADY HEAT AND MASS TRANSFER DURING COMBINED CONDUCTIVE-CONVECTIVE DRYING OF COLLOIDAL CAPILLARY-POROUS MATERIALS

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Ph.D. Thesis, Mechanical Engineering Faculty,
University of Belgrade, February 1999
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Analyzed is the problem of unsteady heat and mass transfer inside the moist colloidal capillary-porous body during the process of combined conductive-convective drying. Observed is the case when the layer of moist material is placed on the heated surface of constant temperature, while over the opposite free surface of the material, air of certain temperature, relative humidity and velocity is blown. Heat is supplied to the material primarily conductively, and removed convectively. The water vapor, evaporated inside the material, as well as on its free surface, is removed convectively.

The mathematical model of the process is formed following the principles of thermodynamics of irreversible processes. The equations describing combined heat and mass transfer in the layer of moist material, as well as the corresponding equations for the initial conditions and the boundary conditions at contact and free surface, are formed considering all thermophysical properties of the material to be fully dependent on local temperature and moisture content inside the body during the process.

The proposed mathematical model is solved numerically by use of nonlinear finite difference explicit scheme. Simultaneously, the model with constant thermophysical coefficients in governing equations, formed for the same initial and boundary conditions, is solved. Significant differences between the results of these two models are obtained both for temperature and moisture content distributions. Of importance is that the proposed model with variable coefficients allows reaching physically acceptable non-parabolic moisture content profiles

Experimental part of the investigation is performed on the laboratory facility, capable to maintain the required boundary conditions. Utilized is the representative colloidal capillary-porous material with previously defined dependencies of relevant thermophysical properties on temperature and moisture content. Through the analysis and comparison of numerical and experimental results, the applied concept is verified and the new information on the process assembled.