Abstract: The process of coupled heat and mass transfer that occurs in a rotary dehumidifier used in air conditioning systems was made subject to analysis, and the results obtained (the mass transfer process occurs in the direction opposite to the positive water vapor partial pressure difference) have justified the application of the chemical potential to the description of the nonsteady-state processes of mass transfer in the dehumidifier matrix. It has been demonstrated that an image of the so-called combined wave arises in the rotary dehumidifier of air, and that the image is characterized by the formation of two active zones of heat and mass transfer. Within the framework of the assumptions made, the relevant mathematical model (α-model) was developed and substantiated, and the calculated values of the thermal and adsorption waves obtained with the model were presented. It has been found that the analysis of the processes arising in the active zones of heat and mass transfer made it possible to assess the range of changes in the optimal operating parameters of the dehumidifier, as well as the range of rational uses where the dehumidifier could be applied.