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A DISCRETE MODEL OF THE HEAT EXCHANGE PROCESS IN ROTATING REGENERATIVE AIR PREHEATERS

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We propose a mathematical model of the heat transfer process in a rotating regenerative air preheater of a thermal power plant. The model is obtained by discretizing the process as a result of averaging both temporal and spatial variables. Making a number of simplifying assumptions, we write a linear discrete system $z(n+1) = Az(n) + r(n)$ of order $2m$ with a monomial $2m \times 2m$ matrix $A = (a_{ij})$ in which $a_{ij} = \alpha_i$ for $i = 1$, $j = 2m$ and for $i = 2, \ldots, 2m$, $j = i - 1$, whereas all the other elements are zero. Using the relation $A^{2m} = \left(\prod_{i=1}^{2m} \alpha_i\right) E$ and the Cauchy formula, we study the stability, periodicity, and convergence of the Cesàro means and other properties. We also consider the identification problem consisting in finding unknown coefficients α_i, $i = 1, 2, \ldots, 2m$, from the values $z(1), z(2), \ldots, z(2m)$ of the trajectory. Under the assumption $r(n) = r = \mathrm{const}$ for $n = 1, 2, \ldots, 2m$, we transform the problem to the matrix equation $AY = B$, where the square matrix Y is composed of the columns $y_1 = t = r - (E - A)z_0$, $y_2 = Ay_1 + t$, …, $y_{2m} = Ay_{2m-1} + t$ and $B = [t - y_2, t - y_3, \ldots, t - y_{2m-1}]$. A recurrence relation is derived for $\det Y$. It is proved that, if $\Delta = \alpha_1\alpha_2 \ldots \alpha_m - \alpha_{m+1}\alpha m + 2 \ldots \alpha_{2m} \neq 0$, then $\det Y \neq 0$ and $A = BY^{-1}$.

Keywords: heat transfer process, cyclic process, monomial matrix, averaging, linear discrete equation, Cauchy formula, steady state behavior, periodic mode, Cesáro mean, identification.

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