International Journal of Numerical Methods for Heat & Fluid Flow, vol. 15(1), 2005, pages 96-115

Steady and unsteady thermal analysis of a triple stack cold plate with heat losses

Abstract

Purpose - To provide some new and additional data for the design of a triple stack cold plate. Design/methodology/approach - A detailed finite element formulation for the triple stack cold plate with and without heat losses from the top and bottom surfaces of the stack is presented to determine its performance under steady as well as unsteady conditions. The effects of the number of unit cells, different heat losses as well as the governing dimensionless parameter, M (involving stack dimension, properties of the stack material and the variation in the heat transfer coefficient) on the performance of the stack are investigated. The detailed formulation of the asymptotic waveform evaluation scheme is also given and applied to determine the transient performance of the stack. Findings - The methods of analysis described are quite simple to use to determine the steady and unsteady performance of the triple stack cold plate under different operating conditions. The heat losses from the top and bottom surfaces of the stack do affect the maximum temperature of the stack and in such case, the assembled stack should be analysed. Research limitations/implications - The analysis is limited to an incompressible fluid. The effect of varying mass flow rate of the fluid in the stack passages is also not considered. Practical implications - New and additional generated data will be helpful in the design of cold plates used in the cooling of electronic components. Originality/value - The asymptotic waveform evaluation scheme is used for the first time to determine the transient performance of the triple stack cold plate under different operating conditions. The results thus obtained are compared well with those found from the finite element analysis (FEM), but the computational effort and time required in the analysis is much small as compared to those required in the FEM analysis.

Keywords — Cooling, electronic equipment and components, finite element analysis, heat loss