ABSTRAK

Tujuan dari penelitian ini adalah (a) membuat program komputasi menggunakan metode beda-hingga (*finite-difference*) cara eksplisit untuk menentukan distribusi suhu, laju aliran kalor, efisiensi, dan efektivitas pada sirip mengerucut berpenampang segi empat yang tersusun atas dua bahan pada keadaan tak tunak. (b) mengetahui pengaruh komposisi bahan sirip terhadap distribusi suhu, laju aliran kalor pada sirip mengerucut berpenampang segi empat yang tersusun atas dua bahan pada keadaan tak tunak. (c) mengetahui nilai efisiensi dan efektivitas pada sirip mengerucut berpenampang segi empat yang tersusun atas dua bahan untuk berbagai variasi komposisi bahan sirip pada keadaan tak tunak dan untuk berbagai variasi nilai koefisien perpindahan kalor konveksi h pada keadaan tak tunak. (d) mengetahui pengaruh variasi ukuran sisi dasar terhadap distribusi suhu, laju perpindahan kalor, efisiensi, efektivitas pada sirip mengerucut berpenampang segi empat pada keadaan tak tunak.

Penelitian diselesaikan dengan metode komputasi numerik, dengan menggunakan cara beda hingga cara eksplisit. Variasi penelitian dilakukan terhadap komposisi bahan penyusun sirip, nilai koefisien perpindahan kalor konveksi, dan ukuran sirip. Setiap bahan penyusun sirip diasumsikan mempunyai massa jenis (ρ) dan kalor jenis (c), dan konduktivitas termal bahan (k) yang tidak berubah terhadap perubahan suhu. Suhu dasar sirip, $T_b = 100^oC$ dipertahankan tetap dari waktu ke waktu. Pada saat t = 0 s, suhu awal sirip merata sebesar $T = T_i = 100^oC$, dan suhu fluida di sekitar sirip diasumsikan merata dan tetap yaitu 30^oC.

Hasil penelitian terhadap sirip mengerucut berpenampang segi empat yang terdiri dari dua bahan adalah (a) program komputasi dengan metode numerik untuk menghitung distribusi suhu, laju perpindahan kalor, efisiensi, dan efektivitas sirip. (b) nilai distribusi suhu, laju perpindahan kalor, efisiensi, efektivitas sirip mengerucut berpenampang segi empat pada keadaan tak tunak pada variasi komposisi bahan dan nilai koefisien perpindahan kalor konveksi h. (c) Semakin besar nilai koefisien perpindahan kalor konveksi h, nilai laju aliran kalornya akan semakin besar, namun nilai efisiensi dan efektivitasnya semakin rendah. Hal tersebut dapat dibuktikan pada detik ke-100 dengan komposisi bahan Besi-Tembaga ; suhu dasar, $T_b = 100^oC$, suhu awal, $T_i = 100^oC$; suhu fluida di sekitas sirip; $T_\infty = 30^oC$ untuk variasi koefisien perpindahan kalor konveksi 50 $W/m^{2o}C$, 100 $W/m^{2o}C$, 500 $W/m^{2o}C$, 1000 $W/m^{2o}C$, 2500 $W/m^{2o}C$, 5000 $W/m^{2o}C$ menghasilkan laju aliran kalor berturut-turut sebesar 3,470 W; 5,637 W; 16,063 W; 23,558 W; 38,786 W; 57,321 W dan nilai efisiensinya sebesar 43,8 %; 35,6 %; 20,3 %; 14,9 %; 9,8 %; 7,2 % serta nilai efektivitasnya sebesar 19,831; 16,105; 9,179; 6,732; 4,433; 3,276. (d) ukuran sirip yang divariasikan adalah ukuran sisi dasar sirip (a_1 dan b_1). Semakin besar variasi ukuran sisi dasar sirip (a_1 dan b_1), maka nilai laju perpindahan kalor dan efisiensi sirip semakin besar, sedangkan nilai efektivitas sirip semakin kecil.

Kata Kunci : Efisiensi sirip, efektivitas sirip, mengerucut, metode beda-hingga, sirip.

ABSTRACT

The purpose of this research is (a) to make a computational program using finite-difference method to determine the distribution of temperature, heat transfer rate, efficiency, and effectiveness of a rectangular cross-section conical fin consisting of two materials under unsteady conditions. (b) to determine the effect of the fin material composition on temperature distribution, heat transfer rate, efficiency, and effectiveness of conical fins with a rectangular cross-section in unsteady conditions. (c) to know the efficiency and effectiveness value of a conical fin from two materials with a hexagon cross-section with variations in the value of the convection heat transfer coefficient h at an unsteady state, and (d) to know the effect of the base part size variations on temperature distribution, heat transfer rate, efficiency, and effectiveness of the conical fin with a rectangular cross-section at unsteady conditions.

This research was carried out with numerical computation using the finite difference method in an explicit way. The research on variations was carried out on the materials that formed the fins, the value of the convection heat transfer coefficient, and the size of the base cross-section. The fins were assumed to have a density (ρ), a specific heat (c), and a thermal conductivity (k) which do not change as the temperature changes. The base fin temperature, T_b = 100 ^oC was maintained constant over time. At t = 0 s, the initial temperature of the fins is uniformly distributed at T = T_i = 100 ^oC, and the temperature of the fluid around the fins is assumed to be uniform and constant at 30 ^oC.

The results of the research on conical fins with rectangular cross-section that formed by two materials are as follows. (a) A computational program with numerical method has been completed and successfully calculated the temperature distribution, heat transfer rate, efficiency, and effectiveness of the fins. (b) The value of temperature distribution, heat transfer rate, efficiency, effectiveness of the rectangular cross-sectional conical fin in an unsteady state on variations in the composition of the material and the value of the convection-heat transfer coefficient h is determined. (c) The greater the value of the convection-heat transfer coefficient h, the value of the heat flow rate will be higher, but the efficiency and effectiveness value is lower. This proved at the 100th second with the composition of Iron-Copper material. The base temperature is T_b = 100 ^oC, with initial temperature T_i = 100 ^oC, with the temperature around the fins T_∞ = 30^o C, and for the variations of the convection heat transfer coefficient is 50 W/m^2 ^oC, 100 W/m^2 ^oC, 500 W/m^2 ^oC, 1000 W/m^2 ^oC, 5000 W/m^2 ^oC. These condition resulted the heat flow rates are respectively as follows; 3,470 W; 5,637 W; 16,063 W; 23,558 W; 38,786 W; 57,321 W and with an efficiency value of 43,8 %; 35,6 %; 20,3 %; 14,9 %; 9,8 %; 7,2 %and effectiveness value of 19,831; 16,105; 9,179; 6,732; 4,433; 3,276. (d) The size of the fin variations is the base section of the fin (a_1 and b_1). The larger the fin base section size (a_1 and b_1), the higher the heat flow rate and efficiency, while the lower the effectiveness value.

Keywords: Conical, fin, fin effectiveness, fin efficiency, finite difference method.