

ABSTRAK

Tujuan penelitian ini adalah (1) membuat program untuk menghitung distribusi suhu sirip, laju perpindahan kalor sirip, efisiensi sirip, efektivitas pada sirip mengerucut berpenampang kapsul yang terdiri dari dua bahan pada kondisi tak tunak, (2) mengetahui pengaruh komposisi bahan sirip terhadap distribusi suhu, laju perpindahan kalor, efisiensi, efektivitas pada sirip mengerucut berpenampang kapsul pada keadaan tak tunak, (3) mengetahui pengaruh ukuran material bahan sirip terhadap laju perpindahan kalor, efisiensi, efektivitas sirip mengerucut berpenampang kapsul pada keadaan tak tunak, (4) mengetahui nilai efisiensi dan efektivitas pada sirip mengerucut yang terdiri dari dua bahan berpenampang kapsul dengan variasi nilai koefisien perpindahan kalor konveksi h pada keadaan tak tunak.

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

Hasil penelitian terhadap sirip mengerucut berpenampang kapsul yang terdiri dari dua bahan adalah (1) program komputasi dengan metode komputasi numerik berhasil dibuat dan dapat diterapkan untuk menghitung distribusi suhu, laju perpindahan kalor, efisiensi, dan efektivitas sirip, (2) komposisi bahan sirip mempengaruhi difusivitas termal. Semakin besar difusivitas termal suatu bahan, maka efisiensi dan efektivitas yang didapat sirip semakin besar. Distribusi suhu, laju aliran kalor, efisiensi sirip, dan efektivitas sirip tertinggi dicapai komposisi bahan sirip Besi dengan Tembaga, (3) ukuran sirip yang divariasi yaitu pada ukuran lebar sirip (a). Ukuran lebar sirip mempengaruhi laju perpindahan kalor, efisiensi sirip, dan efektivitas sirip. Pada variasi ini ada dua kondisi yang berbeda. Pada kondisi pertama, semakin besar ukuran lebar sirip maka efisiensi dan efektivitas yang didapat semakin kecil, sedangkan semakin besar ukuran lebar sirip laju perpindahan kalor yang didapat semakin besar. Pada kondisi dua, semakin besar ukuran lebar sirip maka nilai efisiensi semakin besar sedangkan nilai efektivitas yang didapat semakin kecil, kemudian untuk laju perpindahan kalor yang didapat sama seperti pada kondisi pertama yaitu, semakin besar ukuran sirip laju perpindahan kalor yang didapat semakin besar, (4) Semakin besar nilai koefisien perpindahan panas konveksi h , nilai laju perpindahan kalornya semakin besar, namun nilai efisiensi dan efektivitasnya semakin rendah. Hal tersebut dibuktikan pada detik ke-120 dengan komposisi bahan Besi – Alumunium ; suhu dasar, $T_b = 100^\circ\text{C}$; suhu awal, $T_i = 100^\circ\text{C}$; suhu fluida di sekitar sirip, $T_\infty = 30^\circ\text{C}$ untuk variasi koefisien perpindahan panas konveksi $50 \text{ W/m}^{20}\text{C}$, $200 \text{ W/m}^{20}\text{C}$, $500 \text{ W/m}^{20}\text{C}$, $1000 \text{ W/m}^{20}\text{C}$, $2500 \text{ W/m}^{20}\text{C}$ menghasilkan laju aliran panas berturut – turut sebesar $23,36 \text{ W}$; $53,20 \text{ W}$; $80,96 \text{ W}$; $115,169 \text{ W}$; $186,08 \text{ W}$ dan nilai efisiensi sebesar $76,03\%$; $43,29\%$; $26,35\%$; $18,75\%$; $12,11\%$ serta nilai efektivitas sebesar $17,63$; $10,04$; $6,11$; $4,35$; $2,81$.

Kata Kunci : efisiensi, efektivitas, metode beda hingga cara eksplisit, mengerucut, penampang kapsul, sirip.

ABSTRACT

The purpose of this research is (1) to make a program to calculate the distribution of temperature, heat transfer rate, efficiency, and effectiveness of a capsule cross-section conical fin consisting of two materials under unsteady conditions. (2) to determine the effect of the fin material composition on temperature distribution, heat transfer rate, efficiency, and effectiveness of conical fins with a capsule cross-section in unsteady conditions. (3) to know the material size effect heat transfer rate, efficiency, and effectiveness of conical fins with a capsule cross-section in unsteady conditions. (4) To know the efficiency, and effectiveness value of capsule cross-section fin formed by two materials with variations in the value of the convection heat transfer coefficient h at an 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, $T_b = 100^\circ\text{C}$ was maintained constant over time. At $t = 0$ s, the initial temperature of the fins is uniformly distributed at $T = T_i = 100^\circ\text{C}$, and the temperature of the fluid around the fins is assumed to be uniform and constant at 30°C .

The results of the research on conical fins with capsule cross-section that formed by two materials are as follows. (1) A computational program with numerical method has been completed and successfully calculated the temperature distribution, heat transfer rate, efficiency, and effectiveness of the fins. (2) The composition of the fin material affects the thermal diffusivity. The greater the thermal diffusivity of a material, the greater the efficiency and effectiveness of the fins. The distribution of temperature, heat flow rate, fin efficiency, and the highest fin effectiveness was achieved by the composition of the Iron and Copper fin material. (3) The size of the fins was varied, namely the size of the fin width (a). The size of the fin width affects the rate of heat transfer, fin efficiency, and fin effectiveness. In this variation there are two different conditions. In the first condition, the larger the size of the fin width, the lower the efficiency and effectiveness obtained, while the larger the size of the fin width, the higher the heat transfer rate obtained. In condition two, the larger the size of the fin width, the greater the efficiency value while the effectiveness value obtained is smaller, then the heat transfer rate obtained is the same as in the first condition, namely, the larger the fin size, the greater the heat transfer rate obtained. (4) The greater the value of the convection heat transfer coefficient h , the greater the value of the heat transfer rate, but the lower the efficiency and effectiveness. This is proved in the 120th second experience with the composition of Iron – Aluminum. The base temperature is $T_b = 100^\circ\text{C}$, with initial temperature $T_i = 100^\circ\text{C}$, with the temperature around the fins $T_\infty = 30^\circ\text{C}$, and for the variations of the convection heat transfer coefficient is $50 \text{ W/m}^2\text{ }^\circ\text{C}$, $200 \text{ W/m}^2\text{ }^\circ\text{C}$, $500 \text{ W/m}^2\text{ }^\circ\text{C}$, $1000 \text{ W/m}^2\text{ }^\circ\text{C}$, $2500 \text{ W/m}^2\text{ }^\circ\text{C}$. These condition resulted the heat flow rates are respectively as follows; 23,36 W; 53,20 W; 80,96 W; 115,169 W; 186,08 W and with an efficiency value of 76,03%; 43,29%; 26,35%; 18,75%; 12,11% and effectiveness value of 17,63; 10,04; 6,11; 4,35; 2,81.

Keywords : capsule cross-section, conical, efficiency, effectiveness, explicit finite difference method, fins.