

## ABSTRAK

Tujuan penelitian ini adalah a) membuat program untuk menghitung distribusi suhu, laju aliran panas, efisiensi sirip dan efektivitas pada sirip lurus berpenampang kapsul yang tersusun atas dua bahan pada keadaan tak tunak. b) mengetahui pengaruh jenis material bahan sirip dan pengaruh berbagai variasi nilai koefisien perpindahan panas konveksi  $h$  terhadap distribusi suhu, laju aliran panas, efisiensi sirip dan efektivitas pada sirip lurus berpenampang kapsul yang tersusun atas dua bahan pada keadaan tak tunak. c) mengetahui nilai efisiensi dan efektivitas pada sirip lurus berpenampang kapsul yang tersusun atas dua bahan untuk berbagai variasi bahan sirip pada keadaan tak tunak dan untuk berbagai variasi nilai koefisien perpindahan panas konveksi  $h$  pada keadaan tak tunak.

Perhitungan pada penelitian ini dilakukan dengan menggunakan metode komputasi, dengan metode beda hingga cara eksplisit. Penampang sirip berbentuk kapsul. Sirip tersusun dari dua bahan logam yang berbeda. Perpindahan panas yang terjadi pada sirip hanya berlangsung dalam satu dimensi, yaitu dalam arah  $x$ , atau tegak lurus dasar sirip. Sirip diasumsikan mempunyai massa jenis ( $\rho$ ) dan panas jenis ( $c$ ) yang tidak berubah. Suhu dasar sirip,  $T_b = 100^\circ\text{C}$  dipertahankan tetap dari waktu ke waktu, pada saat  $t = 0$  s, suhu awal di setiap volume kontrol merata sebesar  $T = T_i = 100^\circ\text{C}$ , dan suhu fluida di sekitar sirip diasumsikan  $30^\circ\text{C}$ . Variasi penelitian adalah jenis material bahan sirip, dan koefisien perpindahan panas konveksi.

Hasil penelitian terhadap sirip lurus berpenampang kapsul yang tersusun atas dua bahan adalah a) program komputasi dengan metode beda-hingga cara eksplisit berhasil dibuat dan diterapkan untuk menentukan laju aliran panas, efisiensi, dan efektivitas sirip. b) Massa jenis, panas jenis, dan nilai koefisien perpindahan panas konduksi dari material bahan sirip mempengaruhi difusivitas termal. Semakin besar difusivitas termal suatu bahan, maka efisiensi dan efektivitas yang didapat sirip semakin besar. Distribusi suhu, laju aliran panas, efisiensi sirip, dan efektivitas sirip tertinggi dicapai komposisi material bahan sirip Besi dengan Tembaga. Jika hanya memperhatikan efisiensi dan efektivitas sirip tanpa memperhatikan faktor lain seperti biaya dan kekuatan, maka komposisi material bahan yang paling menguntungkan untuk dibuat sirip adalah Besi dengan Tembaga. Urutan komposisi bahan mulai dari yang menguntungkan jika dibuat sirip dengan penampang kapsul : Besi-Tembaga, Besi-Aluminium, Besi-Seng, Besi-Kuningan, Besi-Nikel c) Semakin besar nilai koefisien perpindahan panas konveksi  $h$ , nilai laju aliran kalornya semakin besar, namun nilai efisiensi dan efektivitasnya semakin rendah. Hal tersebut dibuktikan pada detik ke-80 dengan 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  $6,798 \text{ W}$ ;  $20,402 \text{ W}$ ;  $35,524 \text{ W}$ ;  $50,233 \text{ W}$ ;  $76,574 \text{ W}$  dan nilai efisiensi sebesar  $88,32\%$ ;  $66,26\%$ ;  $46,15\%$ ;  $32,63\%$ ;  $19,9\%$  serta nilai efektivitas sebesar  $15,111$ ;  $11,337$ ;  $7,896$ ;  $5,582$ ;  $3,404$ .

Kata kunci : perpindahan panas, efisiensi sirip, efektivitas sirip, metode beda – hingga, eksplisit

## ABSTRACT

The purpose of this study is a) to create a program to calculate the temperature distribution, the heat flow rate, the fin efficiency, and the effectiveness of a capsule-shaped-straight fin composed of two materials in the unsteady state. b) To discover the effect of the fin material types and the effect of different variations value of convection heat transfer coefficient-h of the temperature distribution, the heat flow rate, the fin efficiency, and the effectiveness of a capsule-shaped-straight fin composed of two materials in the unsteady state. c) To find out the value of efficiency and effectiveness of a capsule-shaped-straight fin composed of two materials in the unsteady state by using different variations of the fin materials and different variations of the value of the heat transfer coefficient-h convection in the unsteady state.

In this study, the calculation uses numerical computational methods. The method uses the explicit finite difference method. The cross-section of the fin is a capsule-shaped. The fin is composed of two different metal materials. The heat transfer that occurs in the fin takes place only in one-dimensional cross-section, in the x-direction, or perpendicular to the fin base. The fin is assumed to have an unchanging density ( $\rho$ ) and specific heat (c). The base temperature of the fin  $T_b = 100^\circ\text{C}$  is maintained in constant over time, at  $t = 0$  s, the initial temperature in each control volume is equal to  $T = T_i = 100^\circ\text{C}$ , and the temperature of the fluid around the fin is assumed to be  $30^\circ\text{C}$ . This research uses different variations of fin materials type and convection heat transfer coefficient.

The results of the research on capsule-shaped straight fin composed of two materials are a) The computational programs by using the explicit finite difference method has been successfully created and applied to determine the heat flow rate, the efficiency, and the effectiveness of the fin. b) The density, the specific heat, and the conduction heat transfer coefficient values of the fin material affect the thermal diffusivity. The greater the thermal diffusivity of a material, the greater the efficiency and effectiveness of the fin. Moreover, compounding the material composition of iron and copper is needed to achieve the highest temperature distribution, heat flow rate, efficiency, and effectiveness of the fin. Furthermore, if the attention is only focused on the efficiency and effectiveness of the fin regardless of other factors such as cost and power, then compounding the mixture of iron and copper is the most advantageous material composition to make the fin. Started from the advantageous material composition, these are the material composition order to make the cross-section fin: Iron-Copper, Iron-Aluminum, Iron-Zinc, Iron-Brass, Iron-Nickel. c) When the value of the convection heat transfer coefficient-h is greater, then the value of the heat flow rate will also be getting greater. However, the value of its efficiency and effectiveness will be getting lower. This was proven in the 80th second with a base temperature,  $T_b = 100^\circ\text{C}$ ; the initial temperature,  $T_i = 100^\circ\text{C}$ ; the temperature of the fluid around the fin,  $T_\infty = 30^\circ\text{C}$  for variations of convection heat transfer coefficient of  $50 \text{ W} / \text{m}^{20}\text{C}$ ,  $200 \text{ W} / \text{m}^{20}\text{C}$ ,  $500 \text{ W} / \text{m}^{20}\text{C}$ ,  $1000 \text{ W} / \text{m}^{20}\text{C}$ ,  $2500 \text{ W} / \text{m}^{20}\text{C}$  has respectively generated the heat flow rate of  $6,798 \text{ W}$ ;  $20,402 \text{ W}$ ;  $35,524 \text{ W}$ ;  $50,233 \text{ W}$ ;  $76,574 \text{ W}$  and the efficiency value of  $88.32\%$ ;  $66.26\%$ ;  $46.15\%$ ;  $32.63\%$ ;  $19.9\%$  and the effectiveness value of  $15.111$ ;  $11.337$ ;  $7.896$ ;  $5.582$ ;  $3.404$ .

Keywords: heat transfer, fin efficiency, fin effectiveness, an explicit finite-difference method