(18.15) given: $\dot{Q} = 850W$ $L = 0.005\,m$ $\rho = 2770\,\frac{kg}{m^3}$

$c_p = 875\,\frac{J}{kgK}$ $\alpha = 7.3\times10^{-5}\,\frac{m^2}{s}$ $A = 0.03\,m^2$ $T_1 = 22°C = T_\infty$

$k = 12\,\frac{W}{m^2K}$

find: t @ $T_2 = 140°C$

$m = \rho L A$

$m = (2770\,\frac{kg}{m^3})(0.005\,m)(0.03\,m^2)$

$m = 0.4155\,kg$

$\dot{Q}_{in} \cdot t = m c_p (T_2 - T_1)$

$t = \frac{m c_p (T_2 - T_1)}{\dot{Q}_{in}} = \frac{0.4155\;875\,(140-22)}{850}$

$\boxed{t = 50.47\,s}$

(18.14) given: $L = 2\,cm$ $K = 21\,\frac{W}{mK}$ $\rho = 8000\,\frac{kg}{m^3}$ $c_p = 570\,\frac{J}{kgK}$

$T_i = 18°C$ $T_\infty = 950°C$ $h = 150\,\frac{W}{m^2K}$

find: Plot T_{exit} vs. Velocity

$$T_{exit} = e^{-bt}(T_i - T_\infty) + T_\infty$$

$$b = \frac{hA}{\rho V c_p} \qquad \frac{A}{V} = \frac{1}{L}$$

$$b = \frac{h}{\rho L c_p}$$

MATLAB

18.42 given: $L = 10\,cm$ $\rho = 2702\ \frac{kg}{m^3}$ $c_p = 903\ \frac{J}{kg\,K}$

$k = 237\ \frac{W}{mK}$ $\alpha = 97.1 \times 10^{-6}\ \frac{m^2}{s}$ $T_\infty = 500°C$ $T_i = 25°C$

find: T_0 @ $t = 15\,s$ if $T_s \approx T_\infty$ so $h \to \infty$

solution: $$\frac{T_0 - T_\infty}{T_i - T_\infty} = A_1 e^{-\lambda_1^2 \tau}$$ $Bi = \frac{hL}{k} = \infty$

$$T_0 = A_1 e^{-\lambda_1^2 \tau}(T_i - T_\infty) + T_\infty$$ $\lambda_1 = 1.5708$

$$T_0 = 1.2732 \cdot e^{(-1.5708^2 \cdot 0.5826)}(25 - 500) + 500$$ $A_1 = 1.2732$

$\tau = \frac{\alpha t}{\frac{L^2}{2}} = \frac{97.1 \times 10^{-6} \cdot 15}{0.05^2} = 0.5826$

$$\boxed{T_0 = 356.4°C}$$

(18.43) given: $L = 1.5\,cm$ $K = 110\,\frac{W}{mK}$ $\rho = 8530\,\frac{kg}{m^3}$ $c_p = 380\,\frac{J}{kgK}$

$\alpha = 33.9\times10^{-6}\,\frac{m^2}{s}$ $T_i = 25°C$ $T_\infty = 700°C$ $t = 10\,min$

$h = 80\,\frac{W}{m^2K}$

Find: T_c

$t = 10\cdot60 = 600$

Solution:

$$\frac{T_c - T_\infty}{T_i - T_\infty} = A_1 e^{-\lambda_1^2 \tau} \cos(\lambda_1 \frac{x}{L}),\ \tau > 0.2$$

$$\tau = \frac{\alpha t}{L^2} = \frac{33.9\times10^{-6}\cdot600}{0.015^2} = 90.4$$

$$Bi = \frac{hL}{k} = \frac{80\cdot0.015}{110} = 0.011$$

$$\lambda_1 = 0.0998 + (0.1410 - 0.0998)\frac{(0.011-0.01)}{(0.02-0.01)}$$

$$\lambda_1 = 0.10392$$

$$A_1 = 1.0017 + (1.0033 - 1.0017)\frac{(0.11-0.01)}{(0.02-0.01)}$$

$$A_1 = 1.00186$$

$$T_L = (T_i - T_\infty)A_1 e^{-\lambda_1^2\tau}\cos(\lambda_1) + T_\infty = (25-700)\,1.00186\,e^{-(0.10392)^2\,90.4}\cos(0.10392) + 700$$

$$\boxed{T_L = 446.6°C}$$

ASEN 3113 - Assignment 07 - Main

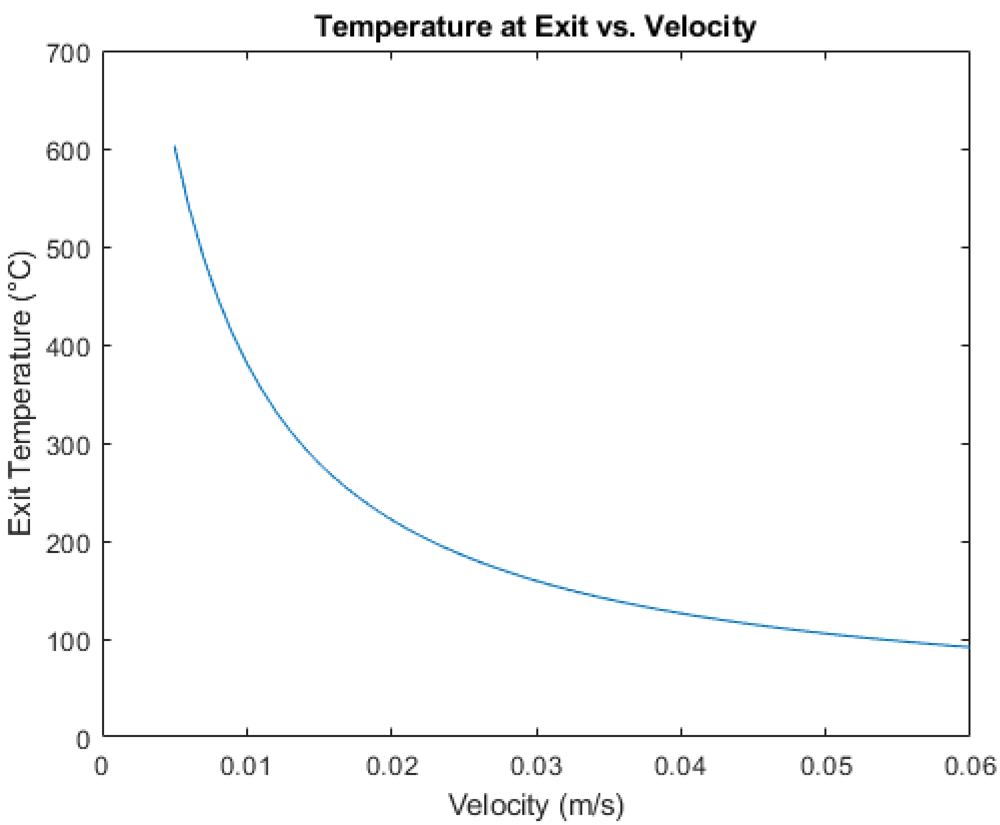
```
Author: Samuel Razumovskiy
Collaborators: None
Date: 11/1/2019 (last revised: 11/1/2019)

clear,clc,close all

h = 150; %W/m^2k
rho = 8000; %kg/m^3
L = 0.02; %m
Cp = 570; %J/kgK
b = h/(rho*L*Cp);
Ti = 18;
Tinf = 950;

v = 0.005:.001:.06; %m/s
t = 3./v; %s
Te = exp(-b.*t).*(Ti-Tinf)+Tinf;

plot(v,Te)
title('Temperature at Exit vs. Velocity')
xlabel('Velocity (m/s)')
ylabel(['Exit Temperature (',char(176),'C)'])
```



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