```
"Problem 2.9"
P_infinity=101330.
T_infinity=300.
T_s=325.
U_infinity=2.1
x_1=0.42
x_2=1.5
q_dd_1=107.
q_dd_2=57
M_air=29
M_H2O=18
"Properties"
T_film=0.5*(T_s+T_infinity)
rho=density (air, P=P_infinity, T=T_film)
C_P=CP(air, T=T_film)
k=conductivity (air, T=T_film)
mu=viscosity(air, T=T_film)
Pr=Prandtl(air, T=T_film)
"Find Re_x at the two locations"
Re_x1=rho*U_infinity*x_1/mu
Re_x2=rho*U_infinity*x_2/mu
"At both locations we deal with laminar regime. Therefore assume Nu_x=cRe_x^n8Pr^(1/3) nad calculate c and n"
h_x1*x_1/k=C*Re_x1^n*Pr^(1/3)
h_x2*x_2/k=C*Re_x2^n*Pr^(1/3)
q_dd_1=h_x1*(T_s-T_infinity)
q_dd_2=h_x2*(T_s-T_infinity)
"Knowing n, we can find the mas fluxes by using analogy between heat and mass transfer"
"From Table in Appendix H"
D_12=(0.26e-4)*(T_infinity/298)^(3/2)
Sc=(mu/rho)/D_12
P_s=P_sat(water, T=T_infinity)
"Find mass fraction of water vapor at s surface"
X_s=P_s/P_infinity
m_1s=X_s*M_H2O/(X_s*M_H2O+(1.-X_s)*M_air)
K_x1*x_1/(rho*D_12)=C*Re_x1^n*Sc^(1/3)
m_dd_x1=K_x1*(m_1s-0.0)
K_x2*x_2/(rho*D_12)=C*Re_x2^n*Sc^(1/3)
m_dd_x2=K_x2*(m_1s-0.0)
"Mass flux is small enough to justify the application of low mass transfer method."
```

Problem 2.9

$P_{\infty} = 101330$

$T_{\infty} = 300$

$T_s = 325$

$U_{\infty} = 2.1$

$x_1 = 0.42$

$x_2 = 1.5$

$q_{dd,1} = 107$

$q_{dd,2} = 57$

$M_{air} = 29$

$M_{H2O} = 18$

Properties

$T_{film} = 0.5 \cdot [T_s + T_\infty]$

$\rho = \rho['Air', P = P_\infty, T = T_{film}]$

$C_P = \mathbf{Cp}['Air', T = T_{film}]$

$k = \mathbf{k}['Air', T = T_{film}]$

$\mu = \mathbf{Visc}['Air', T = T_{film}]$

$Pr = \mathbf{Pr}['Air', T = T_{film}]$

Find Re_x at the two locations

$$Re_{x1} = \rho \cdot U_\infty \cdot \frac{x_1}{\mu}$$

$$Re_{x2} = \rho \cdot U_\infty \cdot \frac{x_2}{\mu}$$

At both locations we deal with laminar regime. Therefore assume Nu_x=$cRe_{xn8Pr,(1/3)}$ nad calculate c and n

$$h_{x1} \cdot \frac{x_1}{k} = C \cdot Re_{x1}^{\;n} \cdot Pr^{[1/3]}$$

$$h_{x2} \cdot \frac{x_2}{k} = C \cdot Re_{x2}^{\;n} \cdot Pr^{[1/3]}$$

$q_{dd,1} = h_{x1} \cdot [T_s - T_\infty]$

$q_{dd,2} = h_{x2} \cdot [T_s - T_\infty]$

Knowing n, we can find the mas fluxes by using analogy between heat and mass transfer

From Table in Appendix H

$$D_{12} = 0.000026 \cdot \left[\frac{T_\infty}{298}\right]^{[3/2]}$$

$$Sc = \frac{\mu}{\rho \cdot D_{12}}$$

$P_s = \mathbf{P}_{sat}['Water', T = T_\infty]$

Find mass fraction of water vapor at s surface

$$X_s = \frac{P_s}{P_\infty}$$

$$m_{1s} = X_s \cdot \left[\frac{M_{H2O}}{X_s \cdot M_{H2O} + (1 - X_s) \cdot M_{air}} \right]$$

$$K_{x1} \cdot \frac{x_1}{\rho \cdot D_{12}} = C \cdot Re_{x1}{}^{n} \cdot Sc^{[1/3]}$$

$$m_{dd,x1} = K_{x1} \cdot [m_{1s} - 0]$$

$$K_{x2} \cdot \frac{x_2}{\rho \cdot D_{12}} = C \cdot Re_{x2}{}^{n} \cdot Sc^{[1/3]}$$

$$m_{dd,x2} = K_{x2} \cdot [m_{1s} - 0]$$

Mass flux is small enough to justify the application of low mass transfer method.

SOLUTION

Unit Settings: SI K Pa J mass deg

$C = 0.3118$	$C_P = 1005$	$D_{12} = 0.00002626$
$h_{x1} = 4.28$	$h_{x2} = 2.28$	$k = 0.02657$
$K_{x1} = 0.004598$	$K_{x2} = 0.002449$	$\mu = 0.00001915$
$m_{1s} = 0.02195$	$M_{air} = 29$	$m_{dd,x1} = 0.0001009$
$m_{dd,x2} = 0.00005376$	$M_{H2O} = 18$	$n = 0.5053$
$Pr = 0.7246$	$P_{\infty} = 101330$	$P_s = 3536$
$q_{dd,1} = 107$	$q_{dd,2} = 57$	$Re_{x1} = 52027$
$Re_{x2} = 185811$	$\rho = 1.13$	$Sc = 0.6455$
$T_{film} = 312.5$	$T_{\infty} = 300$	$T_s = 325$
$U_{\infty} = 2.1$	$x_1 = 0.42$	$x_2 = 1.5$
$X_s = 0.03489$		

5 potential unit problems were detected.