King Abdulaziz University
Faculty of Engineering
Mechanical Engineering

MEP 460
Heat Exchanger Design
Spring 2022
HW. # 02 Answers

Homework on boiling and condensation, Ch. 10 of Incropera 7th Edition textbook

Problem	Modification	Answers
10.12	Change T_s from 115 to **117.0** °C	Power=12022 W, $\dot{m} = 5.327 * 10^{-3}\ kg/s$, ratio=q/$q_{max}$= 0.5396
10.14a	Change q_s'' to be **85%** of q_{max}'' instead of 50%	$q^{"} = 2.393 * 10^5\ W/m^2$, T_s=-18.0 ºC
10.30	Change T_s to **600 °C**	
	10.30 a Calculate the minimum film pool boiling heat flux (at Leidenfrost point) **10.30 b** What will be the surface temperature T_s at Leidenfrost point when considering only convective film boiling **10.30 c** What will be the corresponding surface temperature and the excess temperature if one assumes the heat flux at Leidenfrost point is operating in the nucleate pool boiling region.	h_{conv}=167.6 W/m^{2}K, h_{rad}=57.31 W.m^2.K, q=1323 W. **10.30 a** $q_{min}^{"} = 19007\ \frac{W}{m^2}.K$, **10.30 b** T_s=196.1 ºC **10.30 c** T_s=105.2 ºC

Additional problem
Starting with equation $\bar{h}_L$ for laminar film condensation on vertical plate (as given by Eq. 10.31), drive equation 10.38 which is

$$\overline{Nu}_L = \frac{\bar{h}_L (\nu_l^2/g)^{1/3}}{k_l} = 1.47 Re_\delta^{-1/3}$$

Where Re_δ is given by

$$Re_\delta = \frac{4g\rho_l(\rho_l - \rho_v)\delta^3}{3\mu_l^2}$$

Notice that from Eq. (10.26), one can write

$$\delta^4 = \frac{4k_l\mu_l(T_{sat} - T_s)\ L}{g\ \rho_l(\rho_l - \rho_v)\ h'_{fg}}$$

Also use the approximation

$$\rho_l(\rho_l - \rho_v) \approx \rho_l^2$$