Heat Transfer Questions & Answers

Question by Student 201527118

I have a question about #1 of assignment 7.

$Given$

: 10 rows deep and 50 tubes high.

$$S_{\rm p} = S_{\rm n} = 1.9cm,\ D = 6.33mm$$

$$T_{\rm s} = 90^\circ C$$

$$T_\infty = 20^\circ C,\ u_\infty = 4.5m/s,\ p = 1atm$$

$Wanted : q/L,\ T_2$

$Assumptions$

: S-S, No radiation, No V.D., $T_\infty = T_1,\ \rho = const$

$Sol)$

$$u_{\rm max} = u_\infty \frac{S_{\rm n}}{S_{\rm n} - D} = 6.75m/s$$

$$T_{\rm f} = \frac{T_\infty + T_{\rm s}}{2} = 328K$$

Table : Properties of air with $T_{\rm f} = 328K$

$\rightarrow \rho_{\rm f} = 1.08\ kg/m^3,\ \mu_{\rm f} = 1.96 \times 10^{-5} kg/m \cdot s,\ Pr = 0.702,$
$k = 0.028\ W/m \cdot^\circ C$

Then,

$$Re_{\rm D} = \frac{\rho_{\rm f} u_{\rm max} D}{\mu_{\rm f}} = 2354$$

From table, $Nu_{\rm D} = CRe_{\rm D}{}^n Pr^{1/3}$

and $S_{\rm N}/D = S_{\rm P}/D = 3 \rightarrow C = 0.317,\ n = 0.608$

Then,

$$Nu_{\rm D} = CRe_{\rm D}{}^n Pr^{1/3} = 31.6$$

$$h = \frac{k}{D} Nu_{\rm D} = 140\ W/m^2 \cdot^\circ C$$

and, $A_{\rm s} = 49 \times 10 \times \pi D \times L$

$$\therefore q/L = h\frac{A_{\rm s}}{L}(T_{\rm s} - T_\infty) = h \times 490 \times \pi D \times (T_{\rm s} - T_\infty) = 95.5kW/m$$

So, I think the answer 54.9 kW/m is wrong.

You are right that there was a mistake. But it is not in the answer but in the question formulation: it should be 6 rows deep, not 10 rows deep. I fixed the mistake in the assignment: please check the latest version. 2 points bonus.

Question by Student 201427132

I have a question that why modification is made at convective heat transfer equation at 5/23 class. $q'' = h(T_W - T_\infty)$ *into* $q'' = h(T_W - T_{aw})$
When you teach fully developed flow, starting with Energy equation, you made a assumption that Viscous dissipation can be negligible.
I think that modification " $q'' = h(T_W - T_\infty)$ *into* $q'' = h(T_W - T_{aw})$ *" should be made when V.D can not be negligible.*
But in this case, why modification should be made?

Before tackling internal flow in a pipe, I mentioned about external flow over a plate with and without VD as a reference point. But don't confuse the latter with flow in a pipe/duct. 1 point bonus.

Question by Student 201427102

When calculate RE_D *for tube banks, you used fin Temperature, But you assumed flow is incompressible and you said* $\rho_f = \rho_{inf}$ *for incompressible(liquid). Then, why I use fin Temperature???*

Hm, incompressible flow doesn't mean constant density flow. You can have an incompressible flow with a density change.. If the flow is a liquid, then yes you can assume the density to be constant, but not if the flow is a gas. I'm not sure if this answers your question..

Question by Student 201700043

Dear professor, I have a question about #1 assignment 7. I think you found the total heat Transfer per unit length thanks to this formula :

$$\frac{q}{L} = h_{\text{6rows}} \cdot AS \cdot \pi \cdot D \cdot (T\text{s} - T1)$$

which gives :

$$\frac{q}{L} = h_{\text{6rows}} \cdot rows_{\text{deep}} \cdot tubes_{\text{high}} \cdot \pi \cdot D \cdot (T\text{s} - T1)$$

I found thanks to this formula :

$$\frac{q}{L} = 54.9kw/m(thecorrectanswer)$$

But I think,if we consider the air inside the bank,the air doesn't touch the half of the first and last rank of tube, so why don't we choose in that formula :

$$tubes_{\text{high}} - 1$$

that leads to that formula :

$$\frac{q}{L} = h_{\text{6rows}} \cdot rows_{\text{deep}} \cdot (tubes_{\text{high}} - 1) \cdot \pi \cdot D \cdot (T\text{s} - T1)$$

and finally :

$$\frac{q}{L} = 53.8 kw/m$$

The air flows around all exposed surfaces of the cylinders as this is external flow on a tube bank. So, you can't cut a cylinder in half, this wouldn't make sense. I'll give you 1.5 point bonus boost. I would have given more if your typesetting would be better (you should have written n_{row} instead of $rows_{\text{deep}}$ and n_{tubes} instead of $tubes_{\text{high}}$ and define n_{row} and n_{tubes} after their first use.

Question by Student 201427132

First of all, i understand T_f as approximate temperature in the thermal layer when we consider the thermal layer.
In recent lecture, you find the Nusslet number,the Reynolds number considering thermal layer when we want to find some numbers at some shapes.
But, lecture before the midterm exam, we did not consider the film temperature and some problems, from recent Assignments, did not consider film temperature by assuming $T_\infty = T_f$.
I wonder when we can assume T_∞ is equal to T_f.

I don't understand.. Before the midterm, we didn't compute the Nusselt numbers (because h was given) so there was no need to compute the film temperatures. Is this what you mean?

Question by Student 201327107

Professor, I have a question about the lecture today. When you calculating Re_D about LMTD EG, you used the properties of T_{b1}. But from the tables about Fully-developed turbulent flow(rough tubes), the Prandtl number and friction factor are based on properties evaluated at the film temperature. So is it correct to use the properties of T_f when find f and Pr?

Yes, exactly. I went quickly in class because of lack of time but when doing the assignments you need to follow the intructions in the tables carefully. Thus, when using the correlation for fully-developed flow in rough tubes, you have to evaluate the Stanton number at the mean bulk temperature and the Prandtl number and the friction factor at the film temperature. Because the mean bulk temperature and film temperature are not known apriori, you need to iterate. 2 points bonus.