Heat Transfer Questions & Answers

Question by Student 201800128

Dear Professor
I have a question regarding the equations used for the friction number f in pipes. In this course we are using the Moody diagram which in the turbulent region is based on Colebrook's equation:

$$\frac{1}{\sqrt{f}} = -2.0log_{10}(\frac{\frac{\varepsilon}{D}}{3.7} + \frac{2.51}{Re\sqrt{f}})$$

I am aware of another equation to find the friction number in the turbulent region which is Haaland's equation:

$$\frac{1}{\sqrt{f}} = -1.8log_{10}[(\frac{\frac{\varepsilon}{D}}{3.7})^{1.11} + \frac{6.9}{Re}]$$

As I recall Haaland's equation has an error of about 10% from Colebrook's, but considering that Colebrook's is already off by around 30% from exact values the error from Haaland's is slim. And when taking into consideration the vast human error when reading the Moody diagram this error would be negligable or even more accurate. So, to the question: Is there any reason why the Haaland's formula is not used in this course?
Cheers

This is a very good question, very well researched. But one issue I have with your question is that the 30% error you outline is not the difference between the correlation and the exact solution but rather the difference between the correlation and some average friction factor obtained from lots of experiments of turbulent flows in pipes. An error of 10-30% is not bad at all (and on target) when dealing with turbulent flows. An error of 3-5 times would be considered off. Thus, you can think of Haaland's and Colebook's correlations as being essentially the same: both will yield an error of 30% or so when compared with experiments. 2 points bonus.

Question by Student 201227125

I have question of shape factors from heat transfer tables. At Isothermal cylinder of radius r buried in semi-infinite medium having isothermal surface. There are three shape factors that

$$\frac{2\pi L}{cosh^{-1}(D/r)}, \frac{2\pi L}{ln(2D/r)}, \frac{2\pi L}{ln\frac{L}{r}[1-\frac{ln(L/2D}{ln(L/r)}]}.$$

Each shape factor has restrictions. But restrictions are overlapped. at assignment

8 - #3, L>>r, D>3r. I can use both $\frac{2\pi L}{cosh^{-1}(D/r)}$ *and* $\frac{2\pi L}{ln(2D/r)}$. *What should I use in this case? I got the correct answer using* $\frac{2\pi L}{cosh^{-1}(D/r)}$. *but, at assignment 8 - #3, Should* $\frac{2\pi L}{ln(2D/r)}$ *be used to obtain more accurate values?*

And I have another question. A>>B means that is A is 10times larger than B? or 100times? I'm not clear that how much larger or lower value makes the sign << or >> .

I don't think switching from one shape factor formula to another will make much of a difference — you should get a very similar result. Just make sure that the restrictions are applicable to your case. I'm not sure what $A \gg B$ means exactly. This is highly case dependent. But I would guess at least 5-10 times larger. 1 point bonus.

Question by Student 201427111

Professor i have a question for Heat treansfer over flat plate EG. ρ_∞ *is used to distinguish between laminar flow and turbulent flow. And if* $5 * 10^5 < Re_x < 10^7$ *so we can use* $st_x Pr^{\frac{2}{3}} = 0.0296Re^{-0.2}$ *but this time we use* ρ_f*, we know* $\rho_f = \frac{\rho_\infty * T_\infty}{T_f}$. *However assignment #6 Question1* ρ_∞ *is used to distinguish between laminar flow and turbulent flow. And we choose* $\overline{Nu_L} = Pr^{\frac{1}{3}}(0.037Re_L^{0.8} - 871)$. *This time just use* ρ_∞. *What's the difference between using* ρ_∞*,*ρ_f

It's better to use ρ_∞ to distinguish between laminar and turbulent flow. This is because what triggers the turbulence are disturbances happening on the edge of the boundary layer (where $\rho = \rho_\infty$). This has little to do with the density midway through the boundary layer. Thus you should also use ρ_∞, not ρ_f, to determine whether $5 \cdot 10^5 < \mathrm{Re}_x < 10^7$ because the lower limit of this Reynolds number range is related to laminar to turbulence transition. This applies also to other correlations for external flow over flat plates. But for external flow around cylinders and spheres and for natural convection, the Reynolds/Rayleigh number ranges are not related to laminar-to-turbulence transition. Thus, for these correlations, use ρ_f not ρ_∞. 1 point bonus.

Question by Student 201327132

Dear professor, I have a question about assignment 7, #5. In (b), I use this relation: ... = ... And we know Left hand side value.$q''_{radin} = 700W/m^2$. *Then I put the* $h = 2.7\frac{W}{m^2K}$ *and* $T_s = 319K$ *in right hand side. But that is not same* q''_{radin}. *Should I consider about additional term? I want to know what I missed. Thank you.*

There is no mistake in the answers provided. You're missing out on an important aspect of radiation heat transfer. You should think about this more.

Question by Student 201427115

I have question about high speed flow. For high speed flow we use T_{aw} *. To get* T_{aw} *, I need Pr and* C_p *. Here which temperature should I use to get Pr,* C_p *?*

Good question. You can use the free stream values. Pr and c_p don't change too much with temperature so it won't make much of a difference.

Question by Student 201427103

Hello, professor I have a question while studying Prandtl number.

Here's the first question. If there is a flow of fluid in motion of Pr $>$ *1, the point at which the separation occurs will increase the heat dissipation locally?*

I am not sure what you mean by the point at which separation occurs. Separation of what? Why would this dissipate the heat? I don't understand. Rephrase your question better. Please write one question per post. I deleted the others.