Heat Transfer Questions & Answers

Question by Student 201427103

Dear Professor. I am writing to ask you a question while solving Question # 5 in Assignment 7. The condition given is Constant Heat Flux. So I referred to the given table. According to this table, I see "Constant heat flux, local h " . So I did the process as the attached picture to prove the assumption that h is also constant. (The reason for this is that if h is the constant, the average value is the same value h.) The results show satisfaction when the

$$m = \frac{1}{4}$$

*However, if Gr **

$$10^5 < Gr^* < 10^{11} \tag{1}$$

then the last equation attached to the picture will not be adapt. because according to Table this condition,

$$m = \frac{1}{5}$$

so How do I interpret this?

KakaoTalk_20180609_155626471.jpg

Again, all the math should be written in LaTeX. Don't attach a picture with mathematics. If there's a derivation you wish to discuss, then write it all here using LaTeX.

Question by Student 201427103

I'm sorry, but I've got the exact meaning now. Let's recreate the attached expression.I am writing to ask you a question while solving Question 5 in Assignment 7. The condition given is Constant Heat Flux. So I referred to the given table. According to this table, I see "Constant heat flux, local h " . So I did the process to prove the assumption that h is also constant.(The reason for this is that if h is the constant, the average value is the same value h.) first

$$Gr^* = \frac{g\rho^2\beta q_w x^4}{k\mu^2} \tag{2}$$

$$Nu_x = \frac{hx}{k} = C(Gr^* Pr)^m = C(\frac{g\rho^2\beta q_w x^4}{k\mu^2} Pr)^m$$

In reference to this equation (1) . The following is a summary of h.

$$h = \frac{Ck}{x}(Gr^* Pr)^m = Ck(\frac{g\rho^2\beta q_w}{k\mu^2}Pr)^m(x^{4m-1}) \tag{3}$$

Let's now measure the average value of h.

$$\bar{h} = \frac{\int_0^L h\,\mathrm{d}x}{L} = \frac{\int_0^L Ck(\frac{g\rho^2\beta q_w}{k\mu^2}Pr)^m(x^{4m-1})\,\mathrm{d}x}{L} = \frac{Ck(\frac{g\rho^2\beta q_w}{k\mu^2}Pr)^m}{L}\frac{1}{4m}x^{4m} \tag{4}$$
$$= \frac{k(C(\frac{g\rho^2\beta q_w x^4}{k\mu^2}Pr)^m)}{4mL}$$

Therefore, the average value of the final Nu :

$$N\bar{u}_L = \frac{\bar{h}L}{k} = \frac{1}{4m}C(\frac{g\rho^2\beta q_w x^4}{k\mu^2}Pr)^m \tag{5}$$

To satisfy the first assumption here , m value have to be

$$m = \frac{1}{4}$$

but If you look at the table, when the Gr value are:

$$10^5 < Gr_x^* < 10^{11} \tag{6}$$

The m value is

$$m = \frac{1}{5}$$

Therefore, under (5) conditions, we were able to confirm that we were not satisfied. Why is this so? I want to know.
Thank you for your patience Professor.

Hmm, I am not sure if I am following you correctly. Why do you say the value for m is $1/4$ to satisfy assumption (1) for an average h? This doesn't make sense. The value for m is $1/5$ if $\mathrm{Gr}_x^* \lessapprox 10^{12}$ and $1/4$ otherwise. If you wish to integrate h over a large Grashoff number range with a lower limit less than 10^{11} and an upper limit greater than 10^{13}, then you need to split the integral in 2 and use two different ms. 0.5 point bonus for the effort.

Question by Student 201527143

Professor, I dont know how to choose differential form eqn or integral form eq for the volume. I understand integral form from the notebook eg. However, I dont understand when I should use differential form. Please let me konw.

You have to use the differential form when the integral form can not give you the answer. For instance, you may need it when trying to find q'' just near the surface for a solid with a non-constant thermal conductivity.

Question by Jaehyuk

Professor, I have a question about A1Q6. If h_1 (heat transfer coefficient on the left wall) is not given, there are two equations(heat equation and convection-radiation balance) with three unkowns, so that it is impossible to solve. Is there other ways to find h_1 ?

Hint: you don't need the data left of the block or within the block to find (a) or (b). You only need the temperature on the right side of the block. Think about it more.

Question by Jaehyuk

Professor, again I have question about A1Q6. Last time, you told me that h_1 is not needed to solve (a) and (b). However, does this also applied to (c) and (d)?

Because h_1 is not given in the question statement, it is not needed to solve the problem. Once (a), (b), (c), and (d) are found, you can find h_1 if you wish, but that is not necessary.

Question by Jaehyuk

Professor, I have a question about contact resistance. As far as I know, when there is a difference in temperature between two surfaces, convection occurs due to circulation of fluid between surfaces. Here starts my question. In the previous class, we did not deal with the convective heat transfer due to filling fluid. Does this convective heat transfer negligible or am I missing any concept?

You can assume the convective heat transfer within the filler fluid to be included within the contact resistance itself (the contact resistance will be smaller in case there is more convective heat transfer).