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Corso di Termofluidodinamica Computazionale

Homework No. 2
AA 2018/2019

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1 Problems

1. Following *Homework 1 - AA. 2018-19*, consider a longitudinal, plain fin of rectangular profile, as shown in figure 1. It has a thermal conductivity value of $k = 50$ W/(m K), a thickness $t = 20$ mm, a length $L = 200$ mm and it extends indefinitely along the third direction. The convective heat transfer coefficient is h =500 W/(m^2 K) and the temperature of the surrounding fluid is $T_\infty = 25$ °C. The temperature of the base of the fin can be assumed equal to $T_b = 200$ °C, and it should be taken into account that also the tip of the fin contributes to heat transfer to the fluid.

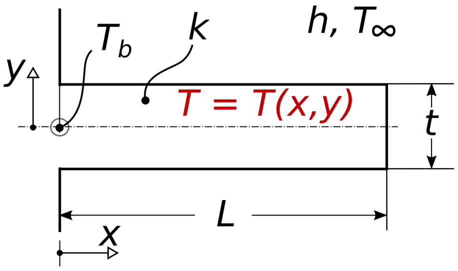

Figure 1: Two-dimensional longitudinal fin of rectangular profile.

In this case, disregard the usual assumption of 1D temperature distribution (see [1, 2]), i.e.

$$T \approx T(x)$$

and consider a full 2D temperature distribution [3]:

$$T = T(x, y)$$

Using the Finite Volume method, develop a 2D steady numerical model for the fin and, using an *adequate* number of cells, compute the heat transfer for unit width of the fin q'_{num2D} [W/m]. Compare the result with that obtained with the 1D model of *Homework 1*. What is the $\%$ error using the 1D assumption ?

2. Repeat the same analysis of problem 1, but considering the lower aspect-ratio L/t fin of *Homework 1*, e.g. thickness $t = 100$ mm and length $L = 200$ mm and again compare the results with the 1D model. What is the $\%$ error using the 1D assumption in this second case? It is lower or higher ? Why ?

References

[1] G. Comini, G. Cortella, *Fondamenti di trasmissione del calore*, 4a Ed., S.G.E. Editore, (2013).

[2] F. P. Incropera, D. P. Dewitt, T. L. Bergman, A. S. Lavine, *Fundamentals of Heat and Mass Transfer*, 6th Ed., Wiley, (2007).

[3] A D. Kraus, A. Aziz, J. Welty, *Extended Surface Heat Transfer*, Wiley, (2001).