CHAPTER 6

Heat Transfer in a Rectangular Thin Surface

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6.1 INTRODUCTION

Heat is the form of energy that can neither be created nor destroyed and also can be transferred from one system to another as a result of temperature difference which is from the higher temperature to the lower temperature. There are three modes of heat transfer process which are heat conduction, heat convection, and heat radiation. Besides, heat transfer is also one of the important topics that have wide applications in industry and our daily life such as heat and power equipment, air-conditioner, generator, radiator, internal combustion engines, and others.

In this study, we will focus on analysing fin surface as one of the applications of heat transfer. Fin is an extended surface that is added onto a structure to increase the efficiency of the rate of heat removal from a base structure. There are two modes of heat transfer that take place while dissipating heat from fins to surrounding namely conduction and convection. Heat transfer insides the fin will due to conduction while on the surface of fin, convection will take place (Sunden, 2012). The finned surfaces are widely used in electrical appliances and electronics such as on computer processors known as heat sinks, cooling coils and condenser coils in refrigerator and air conditioners, radiators of automobiles, etc. as illustrated in Figure 6.1.

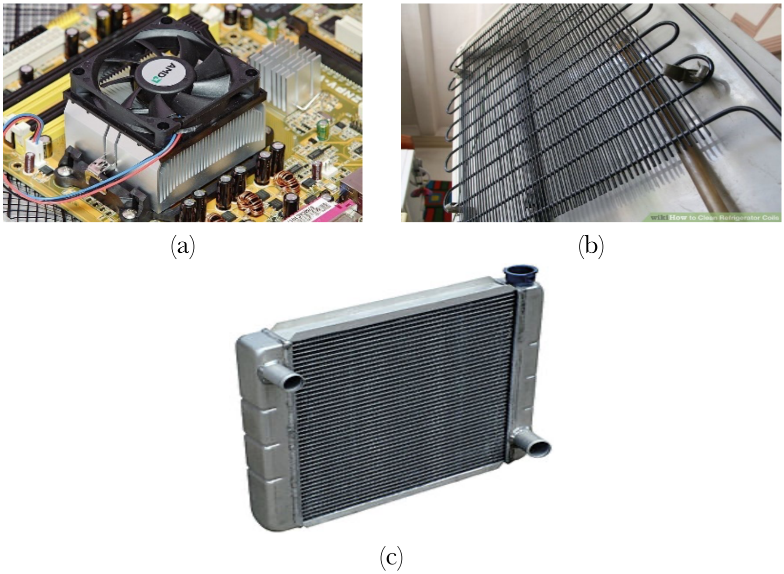

Figure 6.1 Example of extended surfaces using in real life (a) Computer processor (heat sink), (b) Condenser in refrigerator, and (c) Radiator in car (*Extended Surface Heat Transfer*, 2017)

An exact solution for thermal diffusion in a straight fin with varying exponential shape when the thermal conductivity and heat transfer coefficients are temperature dependent is investigated by Turkyilmazoglu (2012). Hamza Abdulsada (2015) presented an exact solution for temperature distribution caused by convection-radiation along a constant cross sectional area fin. Patel et al. (2016) stated that heat transfer between surface and gas is found to be rather low as a convective heat transfer coefficient in situations where finned surfaces are widely used.

The heat transfer can be increased by increasing the number of fins. This fin is used to maintain the system working at its recommended temperatures and operating efficiently and consistently (Nagarani et al., 2014). Therefore, it is very important to understand on how the temperature distribute which will be investigated in this chapter based on mathematical modelling, in particular, numerical method.

Numerical method is one of the well-known methods in mathematics. It is now become widely used in solving the problem with the advancement of computational technologies that we have now (Parmar & Chavda, 2000). Among the most widely used numerical methods in solving and simulating real-world heat transfer problems are: finite difference (FDM) and finite element method (FEM) (M*ü*ft*ü*, 2022).

According to Yeak (2013), the quality of the approximation between grid/element points is poor in FDM comparing to FEM. The most attractive feature in FEM is its ability to solve complex geometry and boundaries with relative ease while FDM is restricted to handle only on rectangular shape and simple iterations. Özişik (2017) stated that there are no best methods to solve a heat problem, but each method has its own advantages depending on the nature of the physical problem that has to be solved. FEM has become popular in past few decades due to the development of high-speed computer programs which the reason why most of engineers choose FEM over FDM (Pavlou, 2015).

This chapter will present on how the two different numerical methods which are FDM and FEM can be utilized to study the heat transfer in a rectangular fin. Also, to compare the accuracy of the solution between FDM and FEM.