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Introductory Chapter: Heat Transfer

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1. Introduction

Heat transfer is the field in Thermodynamics in charge of the study of the generation, conversion, exchange and use of energy in form of heat (thermal energy) between different systems. Heat can be transferred using several mechanisms such as conduction, convection, and radiation. The proper understanding of these modes of heat transfer leads to a successful design of any device in which thermal energy is involved. That is why it is so important to study and to analyze heat transfer in any application.

Thermal energy is present in any aspect of our lives. We can daily experiment heat transfer phenomena at home, when cooking or taking food out of the fridge [1], when using a vehicle to go to work [2] or turning the heating or air-conditioning system on in our office [3]. Sometimes this thermal management is not evident but it is essential for our comfort and lifestyle [4]. Besides, heat transfer is of vital importance in all the electric power plants. Whether some fuel is being burnt to get steam or if we want to maintain a PV panel temperature to a certain level, again a proper management of thermal energy is crucial to the operation of the system [5, 6].

And nowadays it is even more important to perfectly control thermal transfer when designing renewable energy systems where every unit of energy requires to be used; or when installing an efficiency measure in a process to prevent thermal losses [7, 8].

2. Heat transfer analysis

Thermal energy analysis is a complex task that usually requires the use of large theoretical equations and mathematical models that can predict the behavior of a certain system. It is not easy to simplify natural or forced convection, phase change phenomena, or radiation heat transfer, considering their interactions with other parts of the system under study. Therefore, most of the engineers and researchers in the thermal field turn to computational models and test benches that help them understand all these processes [9].

2.1 Computational simulations

A very common approach to heat transfer study is to develop a computational model making several assumptions prior to the simulations. These models use thermodynamic equations and energy balances to represent what we can expect to happen in real conditions. These computational tools are really useful since they allow us to perform tons of simulations and analyze many cases in a cost-effective manner. You can use them to optimize a certain design and be sure that it will work

properly once it has been built. Besides, by using these models a sensitive analysis can be performed to check which parameter is affecting more to the results of the system. There are many ways to develop these models, using different solving techniques. It is essential to understand the heat transfer phenomena you want to study and then check for the best method to model it.

2.2 Experimental analysis

Another approach to study heat transfer problems is to design and build an experimental test bench. Sometimes it is so difficult to theoretically model a thermal energy system that it is more convenient to analyze the problem experimentally. Therefore, an experimental rig is employed to obtain useful results of the cases under study. Often, all these rigs allow the researcher to modify the boundary conditions affecting the system, so the problem can be tested under different circumstances. These test benches are also useful to validate the computational models and check if they can properly predict the behavior of the system.

3. Applications

As it has been mentioned in the introduction of this chapter heat transfer appears in many daily activities. Therefore, there is a wide range of fields in which thermal energy is studied.

It is mandatory to perform a thermal analysis when developing heat exchangers designed to transport heat from one point to another. For that, it is vital to identify which kind of heat sink best fits the application (can natural convection be used, or it should include some forced convection? For example). This analysis is also useful because the conditions under which heat is being transferred will determine the material of the systems that is being used, requirements about auxiliary consumption, limit of maximum temperatures of operation, and so on.

Heat transfer analysis is also crucial in electronic applications that are continuously growing with higher consumptions, and therefore, higher thermal management requirements. As Murshed explains, power electronics are facing a huge challenge in removing high heat fluxes maintaining a low temperature in the device [10].

Conventional heat transfer approaches are still being used, but there are some other new technologies that are being included in these applications such as: nanofluids, phase change devices, and so on.

4. Conclusions

The chapters included in this book are a good example of how scientists, researchers and engineers from the industry are solving heat transfer issues that appear in many fields. You will find computational models, the use of nanofluids in heat transfer devices, an optimization of a bunch of heat exchangers, and several samples of thermal management in different applications.

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