Special Issue: Thermodynamic Optimization, Exergy Analysis, and Constructal Design

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Thermodynamic optimization is carried out to bring the design of a thermal system as closely as possible to the theoretical limit of performance. The theoretical limit of performance is determined by exergy analysis. In practice, the design and performance of a thermal system will not reach to their perfect theoretical limits because of the constraints related to size, time, cost and etc. Thermodynamic optimization aims at identifying the mechanisms and system components that are responsible for thermodynamic losses. In thermodynamic optimization the sizes of these thermodynamic losses are determined, and design of system components is carried out within the global constraints to minimize the losses. Further consideration is made to minimize the costs due to construction and operation of the energy system in the global thermodynamic optimization and the development of system architecture.

Exergy analysis is based on the laws of thermodynamics and is carried out to determine the theoretical limit of ideal operation for a thermal system and to find out the extent to which the operation of the actual system departs from that of the ideal. Exergy is the thermodynamic quantity that describes the “useful energy” content, or the “work producing potential” of a given thermodynamic system. According to the second law of thermodynamics, exergy is always destroyed, partially or totally, in real thermal systems during any process. The amount of exergy destruction is proportional to the entropy generation, and indicates the departure of the actual system performance from the ideal.

Exergy analysis has been used increasingly during the last several decades in performance analysis of thermal systems. Exergy analysis quantifies the types, causes, and locations of losses due to irreversibilities and therefore it is found to be a more meaningful approach for assessing the efficiencies of thermal systems. It has also shown to be an efficient tool for process optimization. Exergy analysis of an existing process

is a very efficient tool to critically examine the process energy use and to test for possible savings.

Thermodynamic optimization deals mainly with the minimization of exergy destruction or entropy generation. The relationships between the physical configuration and the destruction of exergy can be studied by the utilization of the principles of thermodynamics, fluid mechanics, heat and mass transfer, together with the constraints related to materials, and geometry.

The evolutionary design toward flow-system configurations that provide easier flowing (greater access) for their currents is covered by the Constructal law. Better and better configurations are pursued through changes in geometry. Greater access means not only less irreversibility in thermal and fluid flow systems but also less travel time in urban sign, less cost in a wide variety of flow designs, lighter mechanical structures for vehicles, more compact ways to communicate information, etc.

The present special issue of the *Arabian Journal for Science and Engineering (AJSE)* is devoted to present several applications of thermodynamic optimization, exergy analysis and constructal design. A number of well-known experts in the area of thermodynamics, optimization, exergy analysis and constructal design have contributed to this special issue. It is hoped that the papers presented in this issue would enhance the understanding and promote future developments in the area of thermodynamic optimization.

We thank the authors for their contributions and the guest editors for their support. We are grateful to the reviewers for their help in evaluating the papers. We also wish to express our deepest gratitude to the staff of the AJSE office for their efforts. This special issue would not have been possible without their expertise and continuous help.

The Editors