

Preface

This text covers the fundamentals of thermodynamics required to understand electrical power generation systems. It then covers the application of these principles to nuclear reactor power systems. It is not a general thermodynamics text, but is a thermodynamics text aimed at explaining the fundamentals and applying them to the challenges facing actual nuclear power systems. It is written at an undergraduate level, but should also be useful to practicing engineers.

It starts with the fundamental definitions of thermodynamic variables such as temperature, pressure and specific volume. It defines the Zeroth Law of Thermodynamics. It then explains open and closed systems. The Ideal Gas law is introduced along with some of its limitations for real gases. Gas kinetic theory is then introduced to provide a background for the Ideal Gas Law and a foundation for understanding for the theory of specific heats. Then it moves on to the First Law of Thermodynamics and its realization in the internal energy and enthalpy potentials. After addressing several applications, it moves on to the Second Law of Thermodynamics and the concept of entropy. It then approaches entropy from the statistical mechanics viewpoint to validate that it truly is a measurable physical quantity. It concludes the fundamental theory portion of the book by discussing irreversibility, availability, and the Maxwell relations, touching slightly on the Third Law of Thermodynamics.

The second portion of the book is devoted to specific applications of the fundamentals to Brayton and Rankine cycles for power generation. Brayton cycle compressors, turbines, and recuperators are covered, along with the fundamentals of heat exchanger design. Rankine steam generators, turbines, condensers, and pumps are discussed. Reheaters and feed water heaters are also covered. Ultimate heat rejections by circulating water systems are also discussed.

The third part of the book covers current and projected reactor systems and how the thermodynamic principles are applied to their design, operation and safety analyses.

Detailed appendices cover metric and English system units and conversions, detailed steam and gas tables, heat transfer properties, and nuclear reactor system descriptions.

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