

## Preface Second Edition

A lot of cryogenic development has occurred in the 25+ years since the first edition of *Helium Cryogenics* (1986) was published. The field has seen the completion of the Large Hadron Collider (LHC) in Geneva, Switzerland with its associated enormous helium cryogenic refrigeration system. Numerous superconducting fusion engineering projects have been completed and the International Thermonuclear Experimental Reactor (ITER) is under development. Also, a variety of space-based cryogenic instruments have been successfully launched, many of which have contained hundreds of liters of liquid helium in a near zero-g environment. On a different plane, one of the most notable related developments has been the discovery of and now applications for high temperature superconductors (HTS). This field has impacted cryogenics in a fundamental way encouraging the development of cryogenic systems in the intermediate temperature regime (20–80 K). This along with other applications such as space-based instruments has brought about a broad and sustained effort at small scale cryocooler R&D with the most prominent being that of pulse tube coolers.

The author has also aged over this period with the associated gains of experience and somewhat different perspective on the subject. Given these changes and the opportunity to incorporate them into a new edition, it seemed a good time to undertake such a project. Before you is the result of this effort. Hopefully, it will be viewed to be a significant improvement over the first edition and a useful addition to the library of scientists and engineers interested in the field of low temperature science and technology.

This edition of *Helium Cryogenics* has undergone considerable revision and updating. Since the first edition was written prior to the widespread availability of word processing, the first task was to convert the available hard copy to electronic form. This task was ably assisted at FSU by Ms. Lindsay Hardy. Once the author had access to a revisable document, the real work began. Much of the updating was accomplished during the author's sabbatical leave from FSU, which was spent as a Visiting Erskine Fellow in the Mechanical Engineering Department at the University of Canterbury in Christchurch, New Zealand in fall (spring in the southern

hemisphere) 2010. Without that opportunity it would have been very difficult to carry out the project. Also, the author received help and suggestions from a number of colleagues. Valuable suggestions and comments on the first draft were provided by Dr. Dogan Celik, Dr. David Hilton, Ernesto Bosque and Mark Vanderlaan of FSU, Prof. John Weisend II of Michigan State University, Dr. Ting Xu of Oak Ridge National Laboratory, Prof. Andrew Rowe of the University of Victoria and Prof. John Pfothenhauer of the University of Wisconsin.

The resulting second edition has been reorganized with several additions and a few deletions. Chapters 1 through 3 have been revised to include a few new sections and updated data. After that the book has undergone a major reorganization. Since Chap. 3 concerns helium as a classical fluid it seemed appropriate to move the classical transport properties of fluid mechanics and heat transfer to occupy the next two chapters, Chaps. 4 and 5. Chapter 6 (formerly Chap. 4) then concerns helium as a quantum fluid. This is followed by Chap. 7 (He II Heat and Mass Transfer). For those familiar with the first edition, a most notable change is in the expanded and enhanced discussion of He II heat and mass transfer owing to the considerable research advances in the interim. Chapter 8 is again about liquefaction and refrigeration of helium and has been updated considerably from the first edition including more discussions on cryocoolers and He II refrigeration technology. Chapter 9, now titled “ $\text{He}^3$  and Refrigeration Below 1 K”, concentrates on the properties and applications for the rare isotope of helium. Finally, a new Chap. 10 has been created that incorporates a few special topics that do not fit easily within the content of the first nine chapters. These include cryogenic insulation, helium adsorption and magnetic refrigeration. The other generally noticeable enhancement is that the questions and problems at the end of each chapter have been expanded and revised. Also, within each chapter there are more short examples to illustrate the theory for the reader.

This text has been used in a course primarily taught for graduate students in the Mechanical Engineering Department at the FAMU-FSU College of Engineering. It has also been used as a supplement to numerous short courses taught by the author at various locations around the world. Through this process, many of the detailed explanations have been clarified and supplemented. It is my hope that you will find *Helium Cryogenics, Second Edition* to be a worthy improvement and a valuable asset for your research and development activities.

Tallahassee, FL, USA

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