Heat Treatment of Gears

A Practical Guide for Engineers

A.K. Rakhit
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Preface

At the beginning of my career in gear design and manufacturing, I experienced a great deal of difficulty learning the art of gear heat treatment. I struggled a lot, attended a number of seminars on the subject, and spent a great deal of time experimenting with gear heat treatment. Over the last 50 years, a great deal of research has been carried out and published in the disciplines. Unfortunately, very little has been published on heat treatment of gears that is both easy to understand and useful to the gear engineer. This book has been specially written for the benefit of gear engineers engaged in design and manufacturing because I thought it would be beneficial to share my experience with the gear engineers of the future. I believe the information presented in this book will give them a good start in their careers.

Gears have been in existence for a long time. Before the invention of steel, gears were made of materials that were readily available and easily machinable, such as wood. Obviously, these gears did not last long and required frequent replacement. Cost was not as important as it is now.

Today there is continual demand for gear designs that transmit more power through smaller, lighter, quieter, and more reliable packages that must operate over a wide range of service conditions, with an increased emphasis on cost containment. The average life requirement for a gear in industrial service is now measured in millions of cycles. These requirements have accelerated the development and use of high-strength materials. Gears made of certain steels are found to meet these demands and to become especially effective when they are heat treated and finish machined for high geometric accuracy. This makes gear design and manufacturing more complex. In order to perform these tasks efficiently, a gear engineer needs to excel in various other disciplines besides design, such as manufacturing, lubrication, life and failure analysis, and machine dynamics.

Designing gears is a process of synthesis where gear size and geometry, materials, machining processes, and heat treatment are selected to meet the expected level of quality in the finished gears. These considerations are critical if the gears are to perform satisfactorily under anticipated service conditions. This led to the development of various design guidelines for an optimum gear set. However, in my opinion, the quality of gear heat treatment and its effect on gear performance and related cost are still not addressed.
In this book, I discuss gear heat treat distortion for the major heat processes in detail because my experience is that distortion of gears after heat treatment always presents difficulty in minimizing manufacturing cost. Hence, distortion control offers a challenging opportunity to a gear engineer not only in ensuring a high-quality product but also in controlling cost. A case history of each successful gear heat treat process is included. These case histories will provide important information on the quality of gear that can be expected with proper control of material and processes. This information will be beneficial not only in understanding distortion, but also in the selection of the proper gear material and appropriate heat treat process for a wide range of applications.

Writing a book takes a great deal of support and cooperation from many people. I wish to acknowledge all those who helped me with this project, with special thanks to Solar Turbines, Inc; to Mr. Bruce Kravitz of Kravitz Communications for proofreading and making many valuable editorial suggestions; and to Mrs. Sharon Jackson of Solar Turbines Inc., for typing the manuscript. I am also very grateful to Mr. Darle W. Dudley of Dudley Technical Group, Inc. for his guidance and encouragement with this project.

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A.K. Rakhit
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