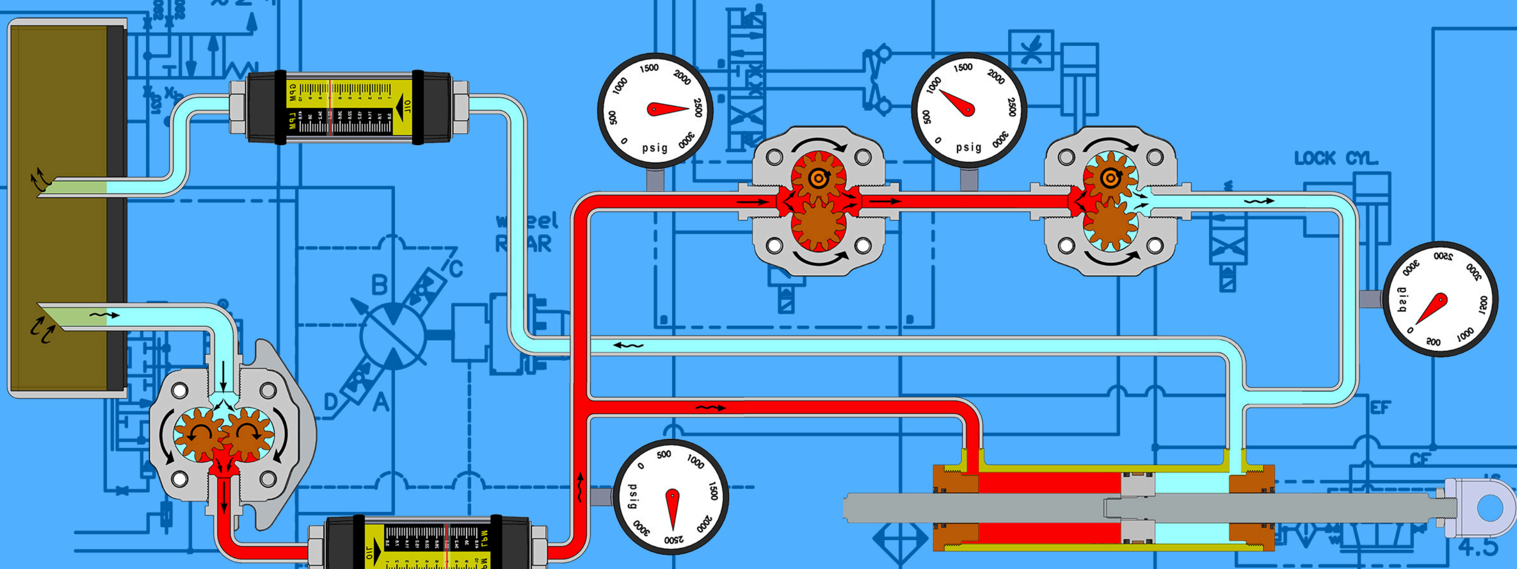
Hydraulic System Design

Reference Handbook



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Daniel L. Larson

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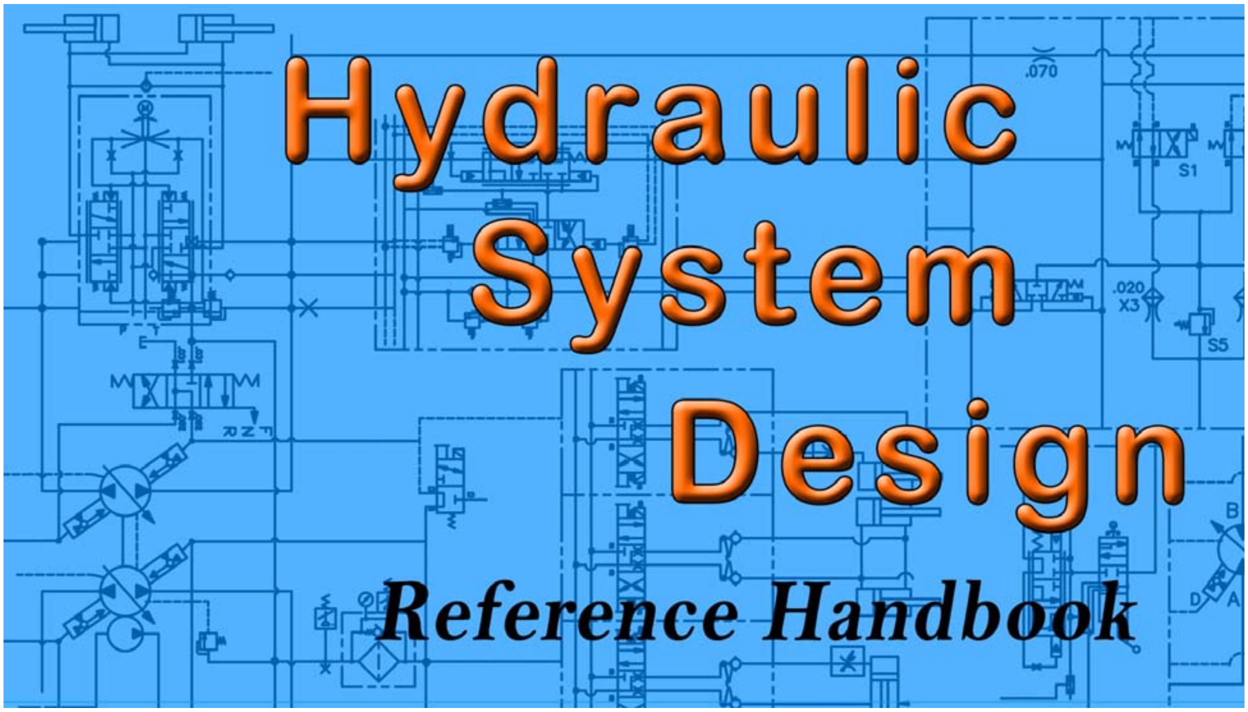

A Technicians & Engineers Resource

If found please return to author for a complimentary version of the final edited and released book.

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PREFACE

The author and publisher have taken great care in the preparation of this work and have made every effort to ensure that the information in this book was correct at press time but it still may contain errors. The information in this work is technical in nature and understanding it will require skills in math and science. Due to the nature of the subject it is expressed that any particular segment of information that may be applicable in one situation may not be applicable in another seemingly similar but actually different situation due to differences in the personnel, operating conditions, environment, materials, components, or other variables that are unforeseen and cannot be predicted by the author. There is always the possibility of printing errors, circuit errors, or errors in tables or text. For this reason the work is being offered only for educational purposes, to provide examples of principles and techniques. This book should not be considered the final authority on system design and readers should obtain clarification from other sources or a competent professional. The author and publisher do not assume and hereby disclaim any liability to any party for any loss, damage, or disruption caused by errors or omissions, whether such errors or omissions result from negligence, accident, or any other cause.

PREFACE

This book was written to support the needs of a wide range of people that work with hydraulic systems. It is intended to fit the needs of the technologist, engineer, or sales professional that is involved with designing new systems or modifying existing systems. This includes mechanics and technician level personnel that are committed to working through this book in order to carry much more knowledge to their job. This book does not use calculus but instead focusses on the actual "algebra based math" that 90% of today's application engineers utilize to properly design and understand hydraulic systems. If you are an engineer with a calculus based math background you can cover the text, review the math examples, and quickly integrate the illustrated processes and understand the applications. If your math background is technology based with algebra as its foundation you can utilize the fully worked problems to learn both the math process and the actual application of the theory being presented.

This text is a compilation of 23 years working as a fluid power system design professional teaching and designing fluid power systems for both industrial and mobile applications. The author has developed this material and taught it first to industry technicians then continued to develop the material and taught at the college vocational level, technical college, community college, and state university level. The approach used by this book first gives the history and basic information on a topic then dives right into examples of problems that are shown worked out step by step. There is a "workbook" section of additional problems that you can complete yourself with an answer key provided. The workbook problems will become a permanent part of the book to use as additional reference. This method of delivery has proven very effective in teaching both industry and college level students.

The author believes that to truly understand the fundamental basics of hydraulic systems one needs to understand the math that describes the physics of those systems. As you first hear this you may be inclined to disagree but after completing this book you will understand why the "basics" are so important. Please understand that the math required to understand hydraulic system design rarely needs to go beyond basic algebra which is a requirement in nearly all technical and technology disciplines. I have found that even amongst calculus based engineering programs this approach is valuable in quickly understanding the relationships.

This book is intended to be the "repository" and a starting point for approaches, methods, and solutions to design and size hydraulic systems. There is ample room at the end of each chapter to add additional notes as you learn and combine additional knowledge. It is the hopes of the author that this is one of the books that you keep with you for reference as you work in the field as a hydraulic system professional.

About the Author

Daniel L. Larson received his Associate of Applied Science Degree in Fluid Power Technology from Alexandria Technical College; his Bachelor of Science Degree in Industrial Technology from Minnesota State University; and his Masters of Science Degree from Bemidji State University with his research emphasis on Hydraulic Regenerative Braking. In 1993 Larson passed the "Certified Fluid Power Specialist" exam administered through the International Fluid Power Society and has remained certified to date. Larson has worked in industry designing and teaching fluid power systems for both industrial and mobile applications from 1993 to the present with 7 patents in the field & 6 patents pending. His background includes working for distributors, OEM manufacturers, and consulting. In addition to his industry experience Larson has taught Fluid Power, Mechatronics, Manufacturing Engineering, and CAD courses to industry technicians, vocational level, technical college, community college, and state university level students.

With a love for the industry and a greater love of learning Larson's belief is that teaching requires one to be willing to learn always and often from the very student's he is responsible too. It is often called the "facilitating of learning" which best describes his style coupled with the ability to create a special collaborative atmosphere he calls a "learning community", one that works together.

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Just a little note about the goals of the book

You can see the chapter outline at **www.flpo.net**

This book is intended to fill a needed gap in the available teaching references in the field of fluid power system design. There are many books covering components and how they are used such as the Vickers text book or the Rexroth text which are both well respected text books that have taken decades to develop and do a marvelous job to meet their goal. Our book is not intended to replace those time tested text books. There are many other text book and publications on the subject of Fluid Power but none seem to fill the area of both teaching and providing reference for the system design process, especially the math behind the process and taking you step by step to solving those problems.

The fluid power application engineering profession is made up of a mix of professionals most of which have 2 or 4 year technology degrees that focused on algebra based math. These professionals are providing the majority of design activities using algebra based math and well proven approaches using formulas that have been developed and perfected for nearly 50 years. Those individuals are often called "application engineers" and they are the backbone of the field.

The International Fluid Power Society is arguably the leading authority on fluid power certification and education related activities for the profession. The certified hydraulic specialist (HS) designation has a very well prepared study guide for the individual intending to take the written test. This study guide is generally intended to be used in conjunction with a college program / course or with a specific study review class and is best suited to be led by a professional fluid power educator. By design the study guide is intended to be brief and focused on teaching to the test and is serving its purpose extremely well. Our text book was conceived on the idea that if you were to write a textbook that was to be comprehensive in nature and covered not only the basic material related to the certification test but go well beyond that to include as much depth as an application engineer would need for a reference. The idea is to expand on all areas of system design well beyond the study guide in a manner consistent with a college level text book that a student could use to learn from and then use that same book as a resource throughout their career.

As an example:

> Chapter 16 of our book covers Accumulators and includes 37 pages that covers: History of the accumulator, Examine and compare power density to energy density, Describe uses for hydraulic accumulators, Identify symbols for various types of accumulators, Examine the bladder, diaphragm, and piston type accumulator, Explore gas laws related to accumulator operation, examine the isothermal and adiabatic condition and the N exponent, Perform accumulator sizing and calculations, Cover types of accumulators, advantages / disadvantages, and goes through 12 separate examples of calculating and sizing accumulators using both the Basic Gas laws and more advanced methods. The chapter ends with problems that the student can perform in order to practice and develop the skills necessary to learn the process.

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