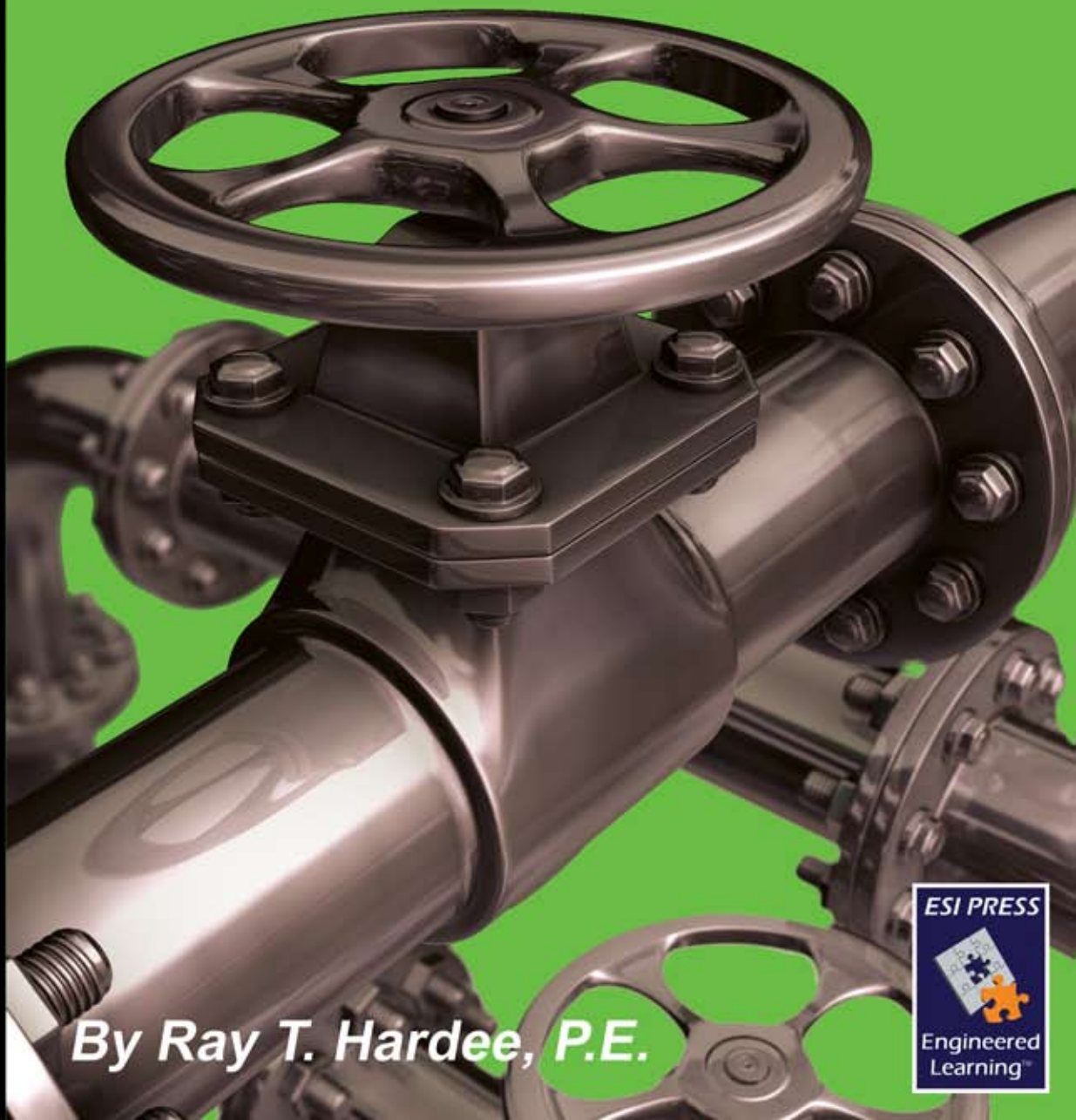


Piping System Fundamentals:

The Complete Guide to Gaining a Clear Picture of Your Piping System



By Ray T. Hardee, P.E.



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ISBN: 978-0-918601-10-0

PSF-V050808

Printed and bound in the United States of America.

Contents

<i>Introduction.....</i>	<i>1</i>
<i>The Value of a Clear Picture.....</i>	<i>2</i>
Minimize Capital Cost.....	3
Minimize Energy Consumption.....	4
Minimize Maintenance Cost.....	5
<i>Elements of a Piping System.....</i>	<i>5</i>
Pipelines.....	6
Pumps.....	6
Controls.....	6
Flow Meters.....	6
Components.....	6
<i>The Total System.....</i>	<i>6</i>
<i>Math and the Basics.....</i>	<i>7</i>
<i>Definitions.....</i>	<i>8</i>
Viscosity.....	8
Density.....	8
Vapor Pressure.....	8
Pressure.....	8
Head.....	9
Flow Rate.....	9
Pipe.....	9
Pipe Standard Specification.....	9
Pipe Diameter.....	10
Nominal Pipe Diameter.....	10
Outside Pipe Diameter.....	10
Inside Pipe Diameter.....	10
Wall Thickness.....	10
Nominal Pipe Sizes (NPS).....	11
Absolute Roughness.....	11
Relative Roughness.....	11
<i>Basic Calculations.....</i>	<i>11</i>
Pressure & Head Calculations.....	11
<i>Bernoulli Equation.....</i>	<i>12</i>
<i>Pipeline Head Loss Calculations.....</i>	<i>15</i>
<i>Pipelines.....</i>	<i>23</i>
<i>Pipe Material Variables.....</i>	<i>24</i>
Pipe.....	24
Pipe Material.....	24
Pipe Sizing & Fluid Velocity.....	27
Pipe Aging.....	28
<i>Valves & Fittings.....</i>	<i>28</i>
Fittings.....	29
Isolation Valves.....	31
<i>Losses Through Valves.....</i>	<i>35</i>
<i>Cost of Losses Through Valves & Fittings.....</i>	<i>35</i>
Fluid Properties.....	36

Density.....	37
Viscosity.....	37
Pipe Specifications.....	37
<i>Pumps.....</i>	<i>39</i>
<i>How a Centrifugal Pump Works.....</i>	<i>40</i>
Impeller Types.....	41
Pump Casings.....	44
Sealing a Pump.....	47
Pump Drives (Fixed vs. Variable).....	50
<i>Pump Types.....</i>	<i>50</i>
Basic Pump Configurations & Arrangements.....	50
Centrifugal Pumps.....	52
Regenerative Turbine Pumps.....	54
Vertical Turbine.....	54
<i>Pump Selection Considerations.....</i>	<i>54</i>
<i>Understanding the Pump Performance Curve.....</i>	<i>55</i>
Types of Curves.....	55
Head and Flow Rate.....	57
Pump Efficiency.....	58
Net Positive Suction Head.....	58
Shutoff Head.....	59
Minimum Flow.....	59
Allowable Operating Region.....	60
Best Efficiency Point.....	60
Preferred Operating Region.....	60
Maximum Flow Rate.....	60
<i>Net Positive Suction Head.....</i>	<i>60</i>
Calculating the NPSHa.....	61
Location of Pump in the System.....	62
Pump Suction Piping.....	62
Fluid Properties.....	62
Supply Tank Pressure.....	63
<i>Pump Affinity Rules.....</i>	<i>63</i>
Changes in Impeller Speed.....	64
Changes in Impeller Diameter.....	65
<i>Pump Power & Cost of Operation.....</i>	<i>65</i>
Calculating Pump Operating Cost.....	65
Fixed Speed Flow Control.....	66
Variable Speed Flow Control.....	66
<i>Operating Pumps Properly.....</i>	<i>66</i>
Startup and Shutdown.....	67
Minimum Flow Issues.....	67
Pump Run Out.....	67
NPSH.....	67
Fluid Considerations.....	68
<i>Control Valves.....</i>	<i>69</i>
<i>Controlled Loops.....</i>	<i>70</i>
Actuated Control Valve.....	70
Self Contained Regulator.....	70
Throttle Valves.....	71

<i>How a Control Valve Operates.....</i>	71
<i>Sizing Control Valves.....</i>	73
<i>Control Valve Description.....</i>	74
Characteristic Trim.....	75
Valve Body Styles.....	75
<i>Control Valve Types.....</i>	77
<i>Linear Motion Control Valve.....</i>	77
<i>Globe Valves.....</i>	78
Pinch Valves.....	80
Diaphragm Valves.....	81
Rotary Motion Control Valve.....	81
Ball Valves.....	82
Butterfly Valves.....	83
Eccentric Rotating Plug Valves.....	84
Plug Valves.....	84
<i>Pressure Rating.....</i>	84
<i>Selecting Control Valves.....</i>	84
Normal Conditions.....	85
<i>Control Valve Cavitation.....</i>	85
<u>Flow Meters.....</u>	87
<i>Flow Meters.....</i>	88
<i>Categories of Flow Meters.....</i>	88
Differential Pressure Flow Meters.....	88
Linear Meters.....	90
<i>Head Loss Caused by Flow Meters.....</i>	92
<i>The Pressure Profile of a Differential Pressure Flow Meter.....</i>	93
<u>Piping System Components.....</u>	95
<i>Heat Exchangers.....</i>	96
<i>Filters & Strainers.....</i>	97
<i>Tanks & Vessels.....</i>	98
<i>Operational Consideration.....</i>	99
Heat Exchangers.....	99
Change in Fluid Temperature.....	99
Changes to the Process.....	100
Fouling of the Heat Exchanger.....	100
Obstructions in the Flow Stream.....	100
Using a Heat Exchanger to Indicate Flow.....	100
<i>Changes in Tanks.....</i>	101
<u>The Total System.....</u>	102
<i>Connecting.....</i>	103
<i>Pipelines.....</i>	103
Head Loss in a Single Pipeline.....	103

Contents

Combining Pipelines in Series.....	103
Unconstrained Flow.....	104
Flow Through a Siphon.....	107
Combining Pipelines in Branches.....	108
Combining Pipelines in Networks.....	109
Pipelines in Parallel.....	109
Complex Networks.....	111
The System.....	112
Pumps & Pipelines.....	112
Adjusting Flow through the System.....	116
Using a Control Valve.....	117
Changing Pump Impeller Diameter.....	118
Changing Pump Speed.....	120
Running Multiple Pumps.....	121
Summary of Controlling Flow.....	123
Solving Hydraulic Network System.....	123
Compressed Air System.....	124
Cooling System.....	125
Changes to Systems.....	128
Changing Tank Levels & Pressures.....	128
Design Case.....	130
Changing Fluid Properties.....	132
Changing the Pipelines.....	135
<u>Total System Examples.....</u>	<u>136</u>
Increasing the System Capacity.....	137
Modeling the System.....	138
Cleaning the Heat Exchangers.....	140
Conclusion.....	141
Reducing Pumping Costs.....	142
Evaluating the System.....	143
Conclusion.....	146
Minimizing Maintenance Cost.....	146
Final Words.....	147
<u>References.....</u>	<u>149</u>
<u>Nomenclature.....</u>	<u>151</u>
<u>Glossary.....</u>	<u>154</u>
<u>Index.....</u>	<u>157</u>

About the Author

Ray T. Hardee, P.E.

**CEO & Vice President of Engineering
Engineered Software, Inc.**

One of the principal founders of Engineered Software, Ray Hardee is also Co-Owner and Chief Engineer. Starting in 1982, Hardee was chiefly responsible for engineering and sales for Engineered Software. Prior to establishing Engineered Software, Hardee had over 13 years in the power generation industry. Hardee graduated with Honors from the United States Merchant Marine Academy in Kings Point, NY. Upon graduation, Hardee became an officer in the U.S. Naval Nuclear Power program and qualified submarines.

After the Navy, Hardee worked for Ebasco Services and was involved in the start-up and test group where he would perform the pre-operational tests for both nuclear and fossil power plants. Hardee has contributed dozens of articles and papers to various magazines and standards publications and has given over a thousand presentations on fluid piping around the world.

Chapter One

Introduction

A fluid piping system consists of pipelines, pumps, components, tanks, and control valves connected together to deliver fluid to a variety of locations at a specific flow rate and/or pressure.

Piping systems meet the needs of a variety of applications including:

- Industrial and commercial cooling applications
- Process piping systems in chemical plants and refineries
- HVAC chilled water systems and hydronic heating systems
- Food and beverage applications
- Pharmaceutical process systems
- Ultra pure water systems used in pharmaceutical and integrated chip manufacturing
- Marine and shipboard applications
- Waste collection and treatment systems

In short, a fluid piping system is one in which there are pipelines transporting a fluid.

Most textbooks on fluid dynamics limit the study of piping systems by isolating the various items in the system and evaluating them individually. For example, one learns how to calculate the energy of a fluid anywhere in the system using the Bernoulli equation and how to determine the head loss in a fully charged pipe with a Newtonian fluid, but little effort goes into learning what happens when multiple pipelines are connected. The study of pumps is often limited to how the impeller imparts kinetic energy to the fluid and how the casing converts the energy of the fluid to potential energy, but does not cover Net Positive Suction Head.

After entering the work force, we continue to look at the piping system as a collection of the various parts. We talk to a valve vendor when we have a problem with a control valve, a pump vendor for pump problems, and an instrument vendor when there are control issues. However there is no vendor to call to see how each item in the total piping system affects its operation.

As a result, we are typically left to our own devices to gain a clear understanding of how the total piping system operates. This is why it can be difficult to get a fluid piping system to operate properly. In reality, if we have a problem with any element in a system, it is usually caused by the various elements not working well together.

The objective of this piping system fundamentals book is to provide piping system practitioners (engineers, designers, maintenance supervisors, and plant operators) with the fundamentals of how total piping systems operate. Our approach provides a basic understanding of the various elements found in a piping system, and then shows how the elements operate together as a whole.

It is not our objective to derive the equations involved in describing system operation. In fact, we will minimize the amount of math that must be used. Most of the engineering equations we will be using are found in Chapter 2 and are presented in such a way that one can gain an understanding of what is happening system wide.

The Value of a Clear Picture

Learning a topic is easier if there is a tangible reward for the efforts, such as saving money and time. Therefore, we will be presenting three real-life piping system case studies. After we gain a clear understanding of system operation, we will use the information to optimize these examples.

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ISBN 978-0-918601-10-0