

# CAMERON HYDRAULIC DATA

#### **Preface to the Twentieth Edition**

The Cameron Hydraulic Data Book is a Flowserve Corporation publication and, as in the previous nineteen editions, is published as an aid to engineers involved with the selection and application of pumping equipment.

The twentieth edition includes some new content additions. First is a helpful reference on mechanical seal piping plans which starts on Page 8-29. This guide includes illustrated pump cross-sections and piping plan schematics as well as a description of the purpose, typical applications and preventative maintenance tips for each plan. The new edition also includes an updated Pump Selection Guide (Section 11) which matches the complete pump portfolio of Flowserve Corporation with primary served markets. The selection matrix helps users determine which pump types are generally applied in 70 different fluid pumping applications. This section also includes an expanded Quick Reference guide for seven different pump categories, with product models, pump types and typical performance ranges. Finally, we've added friction loss tables for PVC and polyethylene piping in Section 3 starting on page 3-48.

In addition, a number of minor modifications, corrections and clarifications initiated by users and the editor have been made throughout the book.

To facilitate locating the desired data, a detailed index is provided in the rear of this book (Section 10). It should be noted that for the convenient reference this index is arranged in two (2) parts: first a General Index with items listed alphabetically, page 10-2 through 10-10, and secondly, an Index of Liquids arranged alphabetically, page 10-11 through page 10-14.

Frequent reference to this index is suggested for quickly locating the information desired



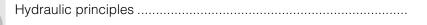
## **Cameron Hydraulic Data**





#### Contents

Section





Selected formulas and equivalents	2

Friction data		
Water	Paper stock	
Viscous liquids	Fittings	

Liquids-miscellaneous data	
Density—specific gravity—vapor pressure	4
Viscosity etc.	

Steam data	5

Electrical data
-----------------

Miscellaneous data	
Arithmetical and geometrical formulas	8

Metric (SI) conversions-General data	9	

Index-Two Sections	
	40
Section No. 1-General Index (A to Z)	ΙU
,	
Section No. 2-Index of Liquids (A to Z)	

11	Pump selection guide	11
----	----------------------	----

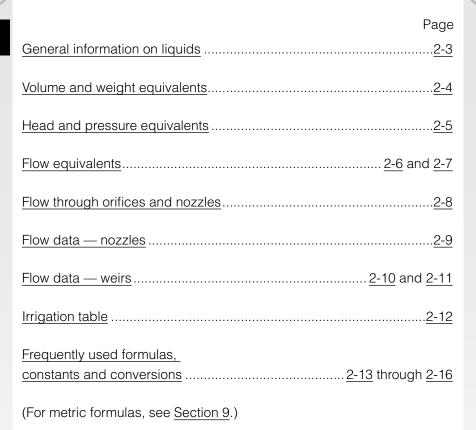




<u>Introduction</u>	<u>1-3</u>
<u>Liquids</u>	<u>1-3</u>
<u>Liquid Flow</u>	<u>1-4</u>
Viscosity	<u>1-5</u>
Pumping	<u>1-6</u>
Volume-System Head Calculations-Suction Head	<u>1-6,</u> <u>1-7</u>
Suction Lift-Total Discharge Head-Velocity Head	<u>1-7,</u> <u>1-8</u>
Total Sys. Head-Pump Head-Pressure-Spec. Gravity	<u>1-9</u> , <u>1-10</u>
Net Positive Suction Head	<u>1-11</u>
NPSH-Suction Head-Life; Examples:	<u>1-11</u> to <u>1-16</u>
NPSH-Hydrocarbon Corrections	<u>1-16</u>
NPSH-Reciprocating Pumps	<u>1-17</u>
Acceleration Head-Reciprocating Pumps	<u>1-18</u>
Entrance Losses-Specific Speed	<u>1-19</u>
Specific Speed-Impeller	<u>1-19</u>
Specific Speed-Suction	<u>1-20,</u> <u>1-21</u>
<u>Submergence</u>	<u>1-21,</u> <u>1-22</u>
Intake Design-Vertical Wet Pit Pumps	<u>1-22,</u> <u>1-27</u>
Work Performed in Pumping	<u>1-27</u>
Temperature Rise	<u>1-28</u>
Characteristic Curves	<u>1-29</u>
Affinity Laws-Stepping Curves	<u>1-30</u>
System Curves	<u>1-31</u>
Parallel and Series Operation	<u>1-32,</u> <u>1-33</u>
Water Hammer	<u>1-34</u>
Reciprocating Pumps-Performance	<u>1-35</u>
Recip. Pumps-Pulsation Analysis & System Piping	<u>1-36</u> to <u>1-45</u>
Pump Drivers-Speed Torque Curves	<u>1-45,</u> <u>1-46</u>
Engine Drivers-Impeller Profiles	<u>1-47</u>
Hydraulic Institute Charts	<u>1-48</u> to <u>1-52</u>
Bibliography	<u>1-53</u>



# Selected Formulas and Equivalents



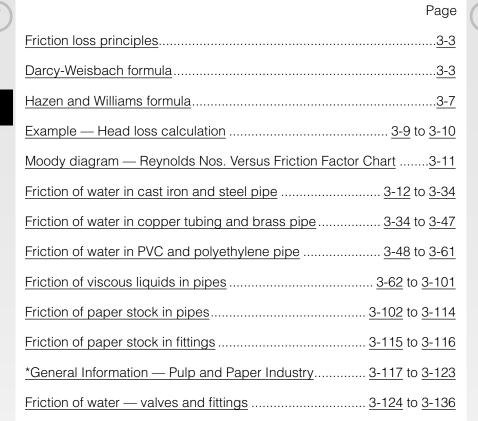












\*NOTE: Pages <u>3-117</u> through <u>3-123</u> are located in this section (following Paper Stock Friction Data) for convenience and ready reference.

equivalent length straight pipe......3-134 to 3-135

Friction — viscous liquids — valves and fittings......3-136

Friction of water — valves and fittings in terms









<u>Proj</u>	perti	es o	f Li	iqu	<u>ids</u>
) Joneity	, inform	ation		•	

Page



API scales	<u>4-6</u>
Properties of sodium and calcium chloride	<u>4-10</u>
Properties of caustic soda	<u>4-11</u>
Baume scales	<u>4-12</u>
Densities of sugar solutions	<u>4-13</u>
Specific gravity of petroleum vs. temperature	<u>4-14</u>
Specific gravity of hydrocarbons	4-15

### Vapor pressure information

Viscosity of turbine oils

Vapor pressure of gasolines	<u>4-19</u>
Vapor pressure of hydrocarbons	4-20
Vapor pressure of various liquids	<u>4-21</u>
Vapor proceure of refrigerant liquide	1-22

Viscosity information	4-23
Viscosity conversions	
Viscosity of crankcase oils	4-28

Viscosity of turbine oils	<u>4-29</u>
Viscosity of fuel oils	<u>4-30</u>
Viscosity of petroleum oils vs. temperature	<u>4-31</u>
Viscosity of miscellaneous liquids	<u>4-32</u>
Viscosity of refrigerant liquids	<u>4-33</u>
Viscosity of sucrose solutions	<u>4-34</u>

Viscosity blending chart	<u>4-35</u>
Petroleum temperature volume relations	4-36
Viscosities and specific gravities of misc. liquids	<u>4-37</u> to <u>4-45</u>
Pump performance with viscous liquids	4-45

	·
Pump performance corrections charts	<u>4-47</u> and <u>4-48</u>
Pump performance on paper stock	4-49
Slurry information	<u>4-50</u> to <u>4-56</u>







# **Steam Data**

	Page
Notes on steam	<u>5-3</u>
Enthalpy and entropy — entropy — definition	<u>5-4</u>
Mollier diagram	<u>5-5</u>
Pressure-enthalpy chart	<u>5-6</u>
Steam Tables:	
Temperature Data (to 705.47°F)	<u>5-7</u>
Pressure Data (in Hg Abs)	<u>5-14</u>
Pressure Data (mm Hg Abs)	<u>5-17</u>
Pressure Data (to 3208.2 psia)	<u>5-19</u>
Superheated Steam Data	<u>5-21</u>
Theoretical steam rates for steam turbines	<u>5-25</u>
Approximate turbine efficiencies	<u>5-30</u>
Vapor flow formulas	<u>5-32</u>
Pressure drop in steam piping	<u>5-34</u>
Low-pressure steam flow	5-38

Pressure drop in steam fittings.....5-39

Psychometric chart .....5-40

Boiler feed flow data.....5-42









	Page
Summary of electrical formulas	<u>6-3</u>
Motor selections	<u>6-4</u>
Motor efficiencies	<u>6-5</u>
Motor characteristics	<u>6-6</u>
Full load currents of motors	<u>6-8</u>
Motor wiring	<u>6-9</u>
Motor branch circuit protection	<u>6-11</u>
Properties of conductors	<u>6-12</u>
Carrying capacity of insulated wire	<u>6-14</u>
Effect of voltage and frequency variation	<u>6-15</u>
Allowable voltage and frequency variations	<u>6-16</u>
Full load speeds of synchronous motors	<u>6-17</u>
NEMA motor frame dimensions (T/TS)6-1	8 and 6-19
Bedplate pad and motor dimensions for_	
NEMA motor frames 6-20	<u>0</u> thru <u>6-23</u>
H.I. — NEMA Type C face-mounted motors — standard dimension	ons <u>6-24</u>
Dimensions (Type C, JM, and JP motor shafts)	<u>6-25</u>
H.I. — NEMA Type HP and HPH vertical solid shaft motor —	
standard dimension	<u>6-26</u>
Dimensions (HP–HPH)	<u>6-27</u>
Standard dimensions for NEMA vertical inline motor	
shaft extensions (P-Base construction)	<u>6-28</u>







	Page
Weights of flanged cast-iron pipe	<u>7-3</u>
Weights of flanged cast-iron fittings	<u>7-4</u>
Dimensions of cast-iron flanges	<u>7-5</u>
Dimensions of cast-iron flanged fittings	<u>7-7</u>
Dimensions and weights of steel pipe	<u>7-8</u> thru <u>7-12</u>
Dimensions of steel pipe flanges	<u>7-13</u> thru <u>7-15</u>
Flange ratings — 150 lb	<u>7-16</u>
Flange ratings — 300 lb.	<u>7-17</u>
Flange ratings — 400 lb.	<u>7-18</u>
Flange ratings — 600 lb.	<u>7-19</u>
Flange ratings — 900 lb.	<u>7-20</u>
Flange ratings — 1500 lb.	<u>7-21</u>
Flange ratings — 2500 lb.	7-22





	Page
Decimal and millimeter equivalents	<u>8-3</u>
Arithmetical and geometrical formulas	<u>8-3</u>
Approximate altitude and barometer reading	<u>8-4</u>
Barometer reading corrections	<u>8-5</u> to <u>8-9</u>
Weight and dimensions of copper tubing and pipe	<u>8-10</u>
Volume in partially filled horizontal tanks	<u>8-11</u>
Capacities and cylinders and tanks	<u>8-12</u>
Displacement per stroke of plungers	<u>8-13</u>
Areas of circles	<u>8-14</u>
Hardness conversion table	<u>8-15</u>
Use of gages and U tubes	<u>8-16</u> to <u>8-20</u>
Pump data sheet for material selection	<u>8-21</u>
Pump materials	<u>8-22</u> to <u>8-28</u>
Mechanical seal piping plans	<u>8-29</u> to <u>8-43</u>





	Page
General notes	<u>9-3</u>
Common English equivalents and formulas	<u>9-4</u>
Notes on international system (SI) of units	<u>9-5</u>
Metric (SI) conversion data	<u>9-8</u>
Fahrenheit and Celsius equivalents (Conversion Table)	<u>9-11</u>
Metric (SI) conversion factors	<u>9-14</u> to <u>9-27</u>
Metric flow formulas	9-28