



American National Standard for

Controlled-Volume Metering Pumps

for Nomenclature, Definitions, Application, and Operation



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Application, and Operation

Sponsor

Hydraulic Institute, Inc.

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American National Standard

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Contents

	Page
Foreword	vii
7 Controlled-volume metering pumps	1
7.0 Introduction	1
7.0.1 Purpose.....	1
7.0.2 Scope	1
7.0.3 Units, symbols and subscripts	1
7.1 Types and nomenclature.....	1
7.1.1 Construction characteristics of controlled-volume metering pumps	1
7.1.2 Description of liquid ends	4
7.1.3 Drive and control mechanisms	7
7.1.4 Nomenclature	10
7.2 Definitions	12
7.2.1 Accuracy and performance.....	13
7.2.2 Accuracy, steady state	13
7.2.3 Capacity, rate of flow	13
7.2.4 Displacement per stroke (<i>D</i>)	13
7.2.5 Efficiency, mechanical	13
7.2.6 Efficiency, volumetric	14
7.2.7 Linearity	14
7.2.8 Net positive inlet pressure (NPIP)/Net positive suction head (NPSH)	14
7.2.9 Head, acceleration/pressure, acceleration	14
7.2.10 Power, pump input	16
7.2.11 Power, pump output power (hydraulic horsepower)	16
7.2.12 Pressures	16
7.2.13 Repeatability	19
7.2.14 Slip (<i>S</i>)	19
7.2.15 Stroke length (<i>L_m</i>).....	19
7.2.16 Stroke speed (<i>n</i>)	19
7.2.17 Stroke speed, maximum allowable	19
7.2.18 Stroke speed, minimum allowable	19
7.2.19 Suction lift, static.....	19
7.2.20 Suction lift, total.....	19

7.2.21	Temperature, maximum rated (t_{max})	19
7.2.22	Temperature, minimum rated (t_{min})	19
7.2.23	Turndown ratio	19
7.2.24	Specific gravity (s).	20
7.3	Design and application	20
7.3.1	Typical uses and industries.	20
7.3.2	General principles.	21
7.3.3	Sizing and selection	22
7.3.4	System components	24
7.4	Installation, operation, and maintenance.	25
7.4.1	Safety	25
7.4.2	Storage	25
7.4.3	Location of pump	26
7.4.4	Foundation	26
7.4.5	Installation.	26
7.4.6	Inspection	27
7.5	Troubleshooting.	28
Figures		
7.1	— Basic elements of a controlled-volume metering pump.	3
7.1.2.1	— Plunger pump	4
7.1.2.2	— Piston pump	5
7.1.2.3	— Mechanically coupled disc diaphragm.	5
7.1.2.4a	— Hydraulic disc with contour plates	6
7.1.2.4b	— Hydraulic disc with diaphragm positioning valve	6
7.1.2.5	— Hydraulic tubular diaphragm	7
7.1.2.6	— Hydraulic conical diaphragm	7
7.1.3.1	— Electromagnetic drive	8
7.1.3.2	— Reciprocating air drive.	9
7.1.3.3	— Fixed stroke-length drive	9
7.1.3.4	— Mechanical lost-motion drive	10
7.1.3.5	— Hydraulic lost-motion drive	11
7.1.3.6	— Variable stroke-length drive (non-lost-motion).	11
7.3.1a	— Rate of flow versus pressure	21
7.3.1b	— Flow profile for reciprocating pump	21
7.3.1c	— Actual flow curve, rate of flow versus stroke length	22
7.3.1d	— Theoretical and actual flow curve, rate of flow versus stroke length	22

Tables

7.0.3a — Symbols	2
7.0.3b — Subscripts.	3
7.5 — Locating trouble: controlled-volume metering pumps	28



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Foreword [Not part of American National Standard (ANSI)]

Purpose and aims of the Hydraulic Institute

The purpose and aims of the Hydraulic Institute are to drive all Pump System stakeholders towards a sustainable future by:

- a) Advancing Solutions for Pump System Performance and Efficiency
- b) Developing Standards and Technical Resources
- c) Educating the Global Marketplace
- d) Advocating for the Industry

Purpose of Document:

Hydraulic Institute Standards and Guidelines may be published as American National Standards, and are adopted in the public interest to help eliminate misunderstandings between the manufacturer, the purchaser, and/or the user and to assist the purchaser in selecting and obtaining the proper product for a particular need. Use is completely voluntary and does not in any respect preclude a member from manufacturing or selling products which are not conforming.

Definition of Hydraulic Institute Standard

Quoting from Article XV, Standards, of the By-Laws of the Institute, Section B:

“An Institute Standard defines the product, material, process or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, quality, rating, testing and service for which designed.”

Definition of Hydraulic Institute Guideline

A Hydraulic Institute Guideline is not normative. The guideline is tutorial in nature, to help the reader better understand the subject matter.

Comments from Users

Comments from users of this standard will be appreciated, to help the Hydraulic Institute prepare even more useful future editions. Questions arising from the content of this standard may be directed to the Technical Director of the Hydraulic Institute. If appropriate, the inquiry will then be directed to the appropriate technical committee for provision of a suitable answer.

Revisions

American National Standards of the Hydraulic Institute are reviewed on a periodic basis and may be reaffirmed, revised, or withdrawn as appropriate. Errata or addenda may be issued between revisions to address limited changes. Should an errata or addenda occur, details of the changes can be found on the publication's product page at www.pumps.org.

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This document does not contain a complete statement of all requirements, analyses, and procedures necessary to ensure safe or appropriate selection, installation, testing, inspection, and operation of any pump or associated products. Each application, service, and selection is unique with process requirements that shall be determined by the owner, operator, or its designated representative.

Units of measurement

Metric units of measurement are used, and corresponding US customary units appear in parentheses. Charts, graphs, and sample calculations are also shown in both metric and US customary units. Because values given in metric units are not exact equivalents to values given in US customary units, it is important that the selected units of measure to be applied be stated in reference to this standard. If no such statement is provided, metric units shall govern.

Consensus

Consensus for this American National Standard was achieved by use of the canvass method. The following organizations, recognized as having an interest in the standardization of pumps, were contacted prior to the approval of this revision of the standard. Inclusion in this list does not necessarily imply that the organization concurred with the submittal of the proposed standard to ANSI.

Michael Cropper	Leistritz Advanced Technologies Corp.
Jim Elsey	Las Vegas Valley Water District
Randal Ferman, PE	Rotating Equipment SME

Committee list

Although this standard was processed and approved for submittal to ANSI by the canvass method, a working committee met many times to facilitate its development. At the time it was developed, the committee had the following members:

Chair – Peter Timpanelli, LEWA America, Inc.

Committee members	Company
Chris Distaso (Alternate)	PSG, a Dover Company
Rex Beach	PSG, a Dover Company
Douglas Purdy	Wanner Engineering, Inc.



7 Controlled-volume Metering Pumps

7.0 Introduction

7.0.1 Purpose

The purpose of this standard is to define common terminology, provide education, and prevent misunderstandings between manufacturers, purchasers, and users of controlled volume metering pumps. The standard can assist purchasers in the selection and acquisition of an appropriate pump for their needs. The standard can also assist pump users to operate their pumps in an efficient and trouble-free manner and avoid common mistakes.

7.0.2 Scope

This standard applies to controlled volume metering pumps. A controlled volume metering pump is a positive displacement reciprocating pump used for accurate liquid dispensing or dosing. This standard covers pumps driven by hydraulic, pneumatic or mechanical means. Liquid ends covered include plunger, piston, and diaphragm.

7.0.3 Units, symbols and subscripts

See tables 7.0.3a and 7.0.3b for units, symbols and subscripts.

7.1 Types and nomenclature

Controlled-volume metering pumps (also known as *metering pumps*, *proportioning pumps*, *chemical injection/feed pumps*, or *dosing pumps*) are reciprocating positive displacement pumps typically used for the injection of chemical additives, proportional blending of multiple components, or metered transfer of a single liquid. These types of pumps are used in applications requiring highly accurate, repeatable, and adjustable rate of flow.

The rate of flow of a controlled-volume pump is a function of the cross-sectional area of the plunger or piston, or displacement of the diaphragm; the stroke length; and the stroking speed. The pumping action is created by a reciprocating piston and controlled by suction and discharge check valves. The rate of flow is adjusted by changing the stroke length and/or the stroking speed.

Controlled-volume metering pumps are characterized by their ability to meet specific performance requirements concerning steady state accuracy, repeatability, and linearity.

Controlled-volume metering pumps are employed in a number of different environments and applications, several types have been developed with different liquid ends and drive and control mechanisms. The basic elements of the pumps are the driver, stroke-length adjustment, pumphead, and the gearbox. These are shown in Figure 7.1, which illustrates the general arrangement of these elements and how they are combined to form a controlled-volume metering pump. Detailed descriptions of these elements follow below.

7.1.1 Construction characteristics of controlled-volume metering pumps

NOTE: The following definitions and illustrations represent typical construction characteristics of controlled-volume metering pumps but do not necessarily represent recommended designs. Variations in design may exist without violating the intent of this standard.

Table 7.0.3a — Symbols

Symbol	Term	Metric unit	Abbreviation	US customary unit	Abbreviation	Conversion factor ^a
A	Area of piston/plunger	square centimeter	cm ²	square inch	in ²	6.45
β (beta)	Meter or orifice ratio	dimensionless	—	dimensionless	—	1
C	Coefficient for acceleration head	dimensionless	—	dimensionless	—	1
d	Diameter	millimeter	mm	inch	in	25.4
D	Displacement	cubic centimeter	cm ³	cubic inches	in ³	16.39
Δ (delta)	Difference	dimensionless	—	dimensionless	—	1
η (eta)	Efficiency	percent	%	percent	%	1
g	Gravitational acceleration	meter/second squared	m/s ²	foot/second squared	ft/s ²	0.3048
γ (gamma)	Specific weight	newton/cubic meter	N/m ³	pound/cubic foot	lb/ft ³	0.0064
H	Head	meter	m	foot	ft	0.3048
L	Pipe line length	meter	m	foot	ft	0.3048
L _m	Stroke length	millimeter	mm	inch	in	25.4
M	Number of pistons	dimensionless	—	dimensionless	—	1
n	Pump speed	stroke/minute	spm	stroke/minute	spm	1
N	Pump crankshaft speed	revolution/minute	rpm	revolution/minute	rpm	1
NPIPA	Net positive inlet pressure available	bar absolute	bara	pound/square inch absolute	psia	0.0689
NPIPR	Net positive inlet pressure required	bar absolute	bara	pound/square inch absolute	psia	0.0689
NPSHA	Net positive suction head available	meter absolute	m	foot	ft	0.3048
NPSHR	Net positive suction head required	meter	m	foot	ft	0.3048
ν (nu)	Kinematic viscosity	millimeter squared/second	mm ² /s	Seconds Saybolt Universal	SSU	0.216 @ 100° F and > 325 SSU ^b
π	pi = 3.1416	dimensionless	—	dimensionless	—	1
p	Pressure	bar	bar	pound/square inch	psi	0.0689
P	Power	kilowatt	kW	horsepower	hp	0.7457
Q	Rate of flow (capacity)	liter/hour	L/h	US gallon/hour	gph	3.7854
ρ (rho)	Density	kilogram/cubic meter	kg/m ³	pound mass/cubic foot	lbm/ft ³	16.02
sG	Specific gravity	dimensionless	—	dimensionless	—	1
S	Slip	percent	%	percent	%	1
t	Temperature	degree Celsius	°C	degree Fahrenheit	°F	(°F–32) × ⁵ / ₉
τ (tau)	Torque	newton-meter	N•m	pound-foot	lb-ft	1.356
μ (mu)	Viscosity, absolute	centipoise	cP	centipoise	cP	1
v	Velocity	meter/second	m/s	foot/second	ft/s	3.281
x	Exponent	none	none	none	none	1
Z	Elevation gauge distance above or below datum	meter	m	foot	ft	0.3048

^a Conversion factor × US customary units = metric units (except temperature).

^b Refer to ASTM D2161 for viscosity lower than 70 cSt.

Table 7.0.3b — Subscripts

Subscript	Term	Subscript	Term
a	Absolute	mot	Motor
A	Actual	ni	Net Inlet
acc	Acceleration	o	Outlet
atm	Atmospheric pressure	oa	Overall
b	Barometric	p	Pump
c	Piston or plunger	s	Suction
d	Discharge	t	Theoretical
D	Design	Δ (delta)	Differential
drv	Driver	v	Velocity
f	Friction loss	V	Volume
g	Gauge	vp	Vapor pressure
H	Total head	w	Hydraulic or water
i	Inlet	z	Fluid level delta
max	Maximum	1	Test condition
min	Minimum	2	Specific condition

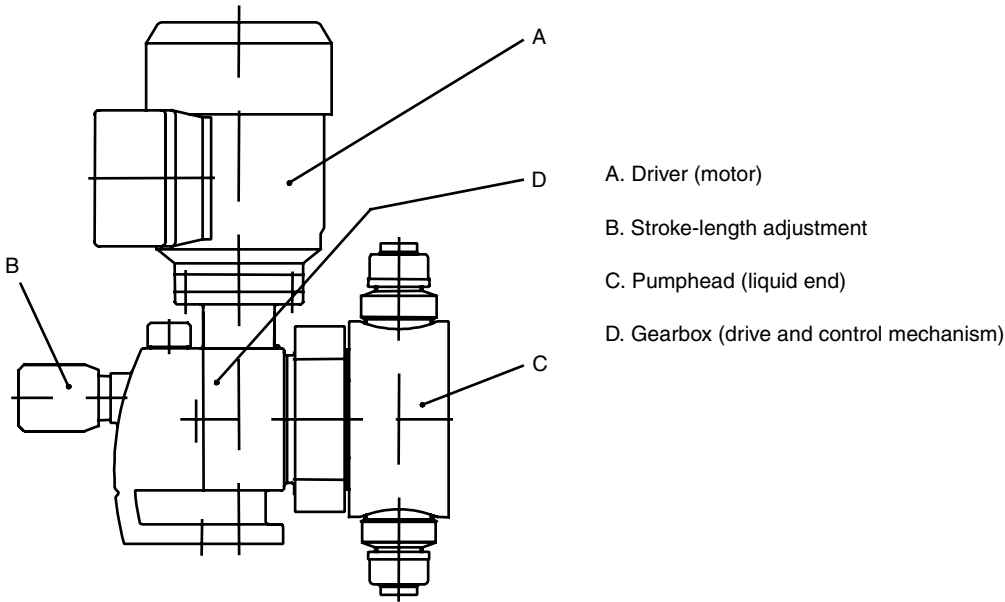


Figure 7.1 — Basic elements of a controlled-volume metering pump

Liquid end

- Plunger
- Piston
- Mechanical coupled disc diaphragm
- Hydraulic coupled disc diaphragm
- Hydraulic coupled tubular diaphragm
- Hydraulic coupled conical diaphragm

Drive and control mechanisms

- Electromagnetic drive (solenoid)
- Reciprocating air/gas drive
- Motor driven,¹ variable speed
- Motor driven,¹ mechanical lost motion
- Motor driven,¹ hydraulic lost motion
- Motor driven,¹ variable eccentric (non-lost-motion)

7.1.2 Description of liquid ends

The pump liquid end assembly (also called the *reagent head assembly*, *pumphead*, or *wet end*) includes all parts that contain or are in direct contact with the liquid being pumped.

7.1.2.1 Plunger

A plunger liquid end (see Figure 7.1.2.1) contains a reciprocating plunger in direct contact with the liquid being displaced. It uses packing within a stuffing box or seals to restrict leakage. This design is not inherently leak free. The plunger design allows for lower Net positive suction head required (NPSHR), limited by the vapor pressure of the liquid, and suction check valve losses. This design can be used in high-pressure applications. In operation the process liquid is admitted through the suction check valve as the plunger moves away from the wet end. As the plunger moves towards the wet end, the suction check valve closes and the discharge check valve opens discharging liquid.

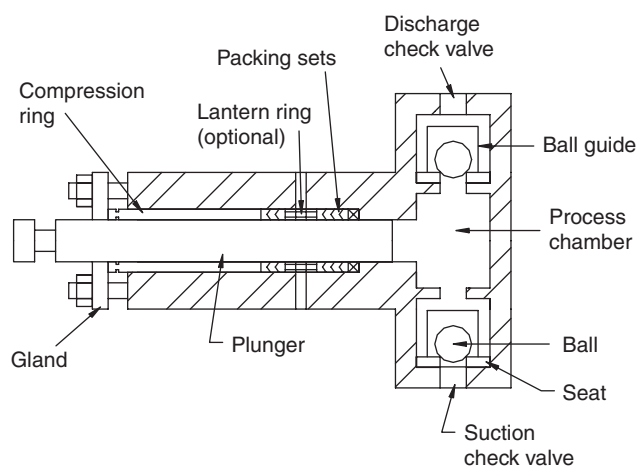


Figure 7.1.2.1 — Plunger pump

¹ Motor driven is understood to include electric, pneumatic, hydraulic turbine, gasoline, diesel, or hydraulic motors.