

Chemical Compatibility of Elastomers and Metals

Introduction

This section explains the uses and compatibilities of elastomers commonly used in Fisher® regulators. The following tables provide the compatibility of the most common elastomers and metals to a variety of chemicals and/or compounds.

The information contained herein is extracted from data we believe to be reliable. However, because of variable service conditions over which we have no control, we do not in any way make any warranty, either express or implied, as to the properties of any materials or as to the performance of any such materials in any particular application, and we hereby expressly disclaim any responsibility for the accuracy of any of the information set forth herein.

Refer to the applicable process gas service code or standard to determine if a specific material found in the Process Gases Application Guide is allowed to be used in that service.

Elastomers: Chemical Names and Uses

NBR - Nitrile Rubber, also called Buna-N, is a copolymer of butadiene and acrylonitrile. Nitrile is recommended for: general purpose sealing, petroleum oils and fluids, water, silicone greases and oils, di-ester based lubricants (such as MIL-L-7808), and ethylene glycol based fluids (Hydrolubes). It is not recommended for: halogenated hydrocarbons, nitro hydrocarbons (such as nitrobenzene and aniline), phosphate ester hydraulic fluids (Skydrol, Cellulube, Pydraul), ketones (MEK, acetone), strong acids, ozone, and automotive brake fluid. Its temperature range is -60° to 225°F (-51° to 107°C), although this would involve more than one compound and would depend upon the stress state of the component in service.

EPDM, EPM - Ethylenepropylene rubber is an elastomer prepared from ethylene and propylene monomers. EPM is a copolymer of ethylene and propylene, while EPDM contains a small amount of a third monomer (a diene) to aid in the curing process. EP is recommended for: phosphate ester based hydraulic fluids, steam to 400°F (204°C), water, silicone oils and greases, dilute acids, dilute alkalis, ketones, alcohols, and automotive brake fluids. It is not recommended for: petroleum oils, and di-ester based lubricants. Its temperature range is -60° to 500°F (-51° to 260°C) (The high limit would make use of a special high temperature formulation developed for geothermal applications).

FKM - This is a fluoroelastomer of the polymethylene type having substituent fluoro and perfluoroalkyl or perfluoroalkoxy groups on the polymer chain. Viton® and Fluorel® are the most common trade names. FKM is recommended for: petroleum oils, di-ester based lubricants, silicate ester based lubricants (such as MLO 8200, MLO 8515, OS-45), silicone fluids and greases, halogenated hydrocarbons, selected phosphate ester fluids, and some acids. It is not recommended for: ketones, Skydrol 500, amines (UDMH), anhydrous ammonia, low molecular weight esters and ethers, and hot hydrofluoric and chlorosulfonic acids. Its temperature range is -20° to 450°F (-29° to 232°C) (This extended range would require special grades and would limit use on each end of the range.).

CR - This is chloroprene, commonly known as neoprene, which is a homopolymer of chloroprene (chlorobutadiene). CR is recommended for: refrigerants (Freons, ammonia), high aniline point petroleum oils, mild acids, and silicate ester fluids. It is not recommended for: phosphate ester fluids and ketones. Its temperature range is -60° to 200°F (-51° to 93°C), although this would involve more than one compound.

NR - This is natural rubber which is a natural polyisoprene, primarily from the tree, *Hevea Brasiliensis*. The synthetics have all but completely replaced natural rubber for seal use. NR is recommended for automotive brake fluid, and it is not recommended for petroleum products. Its temperature range is -80° to 180°F (-62° to 82°C).

FXM - This is a copolymer of tetrafluoroethylene and propylene; hence, it is sometimes called PTFE/P rubber. Common trade names are Aflas® (Asahi Glass Co., Ltd) and Fluoraz® (Greene, Tweed & Co.). It is generally used where resistance to both hydrocarbons and hot water are required. Its temperature range is 20° to 400°F (-7° to 204°C).

ECO - This is commonly called Hydrin® rubber, although that is a trade name for a series of rubber materials by B.F. Goodrich. CO is the designation for the homopolymer of epichlorohydrin, ECO is the designation for a copolymer of ethylene oxide and chloromethyl oxirane (epichlorohydrin copolymer), and ETER is the designation for the terpolymer of epichlorohydrin, ethylene oxide, and an unsaturated monomer. All the epichlorohydrin rubbers exhibit better heat resistance than nitrile rubbers, but corrosion with aluminum may limit applications. Normal temperature range is (-40° to 250°F (-40° to 121°C)), while maximum temperature ranges are -40° to 275°F (-40° to 135°C) (for homopolymer CO) and -65° to 275°F (-54° to 135°C) (for copolymer ECO and terpolymer ETER).

FFKM - This is a perfluoroelastomer generally better known as Kalrez® (DuPont) and Chemraz® (Greene, Tweed). Perfluoro rubbers of the polymethylene type have all substituent groups on the polymer chain of fluoro, perfluoroalkyl, or perfluoroalkoxy groups. The resulting polymer has superior chemical resistance and heat temperature resistance. This elastomer is extremely expensive and should be used only when all else fails. Its temperature range is 0° to 480°F (-18° to 249°C). Some materials, such as Kalrez® 1050LF is usable to 550°F (288°C) and Kalrez® 4079 can be used to 600°F (316°C).

FVMQ - This is fluorosilicone rubber which is an elastomer that should be used for static seals because it has poor mechanical properties. It has good low and high temperature resistance and is reasonably resistant to oils and fuels because of its fluorination. Because of the cost, it only finds specialty use. Its temperature range is -80° to 400°F (-62° to 204°C).

VMQ - This is the most general term for silicone rubber. Silicone rubber can be designated MQ, PMQ, and PVMQ, where the Q designates any rubber with silicon and oxygen in the polymer chain, and M, P, and V represent methyl, phenyl, and vinyl substituent groups on the polymer chain. This elastomer is used only for static seals due to its poor mechanical properties. Its temperature range is -175° to 600°F (-115° to 316°C) (Extended temperature ranges require special compounds for high or low temperatures).

Chemical Compatibility of Elastomers and Metals

General Properties of Elastomers													
PROPERTY		NATURAL RUBBER	BUNA-S	NITRILE (NBR)	NEO-PRENE (CR)	BUTYL	THIOLKOL®	SILICONE	HYPALON®	FLUORO-ELASTOMER ^(1,2) (FKM)	POLY-URETHANE ⁽²⁾	POLY-ACRYLIC ⁽¹⁾	ETHYLENE-PROPYLENE ⁽³⁾ (EPDM)
Tensile Strength, Psi (bar)	Pure Gum	3000 (207)	400 (28)	600 (41)	3500 (241)	3000 (207)	300 (21)	200 to 450 (14 to 31)	4000 (276)	----	----	100 (7)	----
	Reinforced	4500 (310)	3000 (207)	4000 (276)	3500 (241)	3000 (207)	1500 (103)	1100 (76)	4400 (303)	2300 (159)	6500 (448)	1800 (124)	2500 (172)
Tear Resistance		Excellent	Poor-Fair	Fair	Good	Good	Fair	Poor-Fair	Excellent	Good	Excellent	Fair	Poor
Abrasion Resistance		Excellent	Good	Good	Excellent	Fair	Poor	Poor	Excellent	Very Good	Excellent	Good	Good
Aging: Sunlight Oxidation		Poor Good	Poor Fair	Poor Fair	Excellent Good	Excellent Good	Good Good	Good Very Good	Excellent Very Good	Excellent Excellent	Excellent Excellent	Excellent Excellent	Good
Heat (Maximum Temperature)		200°F (93°C)	200°F (93°C)	250°F (121°C)	200°F (93°C)	200°F (93°C)	140°F (60°C)	450°F (232°C)	300°F (149°C)	400°F (204°C)	200°F (93°C)	350°F (177°C)	350°F (177°C)
Static (Shelf)		Good	Good	Good	Very Good	Good	Fair	Good	Good	----	----	Good	Good
Flex Cracking Resistance		Excellent	Good	Good	Excellent	Excellent	Fair	Fair	Excellent	----	Excellent	Good	----
Compression Set Resistance		Good	Good	Very Good	Excellent	Fair	Poor	Good	Poor	Poor	Good	Good	Fair
Solvent Resistance: Aliphatic Hydrocarbon Aromatic Hydrocarbon Oxygenated Solvent Halogenated Solvent		Very Poor Very Poor Good Very Poor	Very Poor Very Poor Good Very Poor	Good Fair Poor Very Poor	Fair Poor Fair Very Poor	Poor Very Poor Good Poor	Excellent Good Fair Poor	Poor Very Poor Poor Very Poor	Fair Poor Poor Very Poor	Excellent Very Good Good ----	Very Good Fair Poor ----	Good Poor Poor Poor	Poor Fair ---- Poor
Oil Resistance: Low Aniline Mineral Oil High Aniline Mineral Oil Synthetic Lubricants Organic Phosphates		Very Poor Very Poor Very Poor Very Poor	Very Poor Very Poor Very Poor Very Poor	Excellent Excellent Fair Very Poor	Fair Good Very Poor Very Poor	Very Poor Poor Good	Excellent Excellent Poor Poor	Poor Good Fair Poor	Fair Good Poor Poor	Excellent Excellent ---- Poor	---- ---- ---- Poor	Excellent Excellent Fair Poor	Poor Poor Poor Very Good
Gasoline Resistance: Aromatic Non-Aromatic		Very Poor Very Poor	Very Poor Very Poor	Good Excellent	Poor Good	Very Poor Very Poor	Excellent Excellent	Poor Good	Poor Fair	Good Very Good	Fair Good	Fair Poor	Fair Poor
Acid Resistance: Diluted (Under 10%) Concentrated		Good Fair	Good Poor	Good Poor	Fair Fair	Good Fair	Poor Very Poor	Fair Poor	Good Good	Excellent Very Good	Fair Poor	Poor Poor	Very Good Good
Low Temperature Flexibility (Maximum)		-65°F (-54°C)	-50°F (-46°C)	-40°F (-40°C)	-40°F (-40°C)	-40°F (-40°C)	-40°F (-40°C)	-100°F (-73°C)	-20°F (-29°C)	-30°F (-34°C)	-40°F (-40°C)	-10°F (-23°C)	-50°F (-45°C)
Permeability to Gases		Fair	Fair	Fair	Very Good	Very Good	Good	Fair	Very Good	Good	Good	Good	Good
Water Resistance		Good	Very Good	Very Good	Fair	Very Good	Fair	Fair	Fair	Excellent	Fair	Fair	Very Good
Alkali Resistance: Diluted (Under 10%) Concentrated		Good Fair	Good Fair	Good Fair	Good Good	Very Good Very Good	Poor Poor	Fair Poor	Good Good	Excellent Very Good	Fair Poor	Poor Poor	Excellent Good
Resilience		Very Good	Fair	Fair	Very Good	Very Good	Poor	Good	Good	Good	Fair	Very Poor	Very Good
Elongation (Maximum)		700%	500%	500%	500%	700%	400%	300%	300%	425%	625%	200%	500%

1. Do not use with steam.
2. Do not use with ammonia.
3. Do not use with petroleum based fluids. Use with ester based non-flammable hydraulic oils and low pressure steam applications to 300°F (149°C).
4. Except for nitric and sulfuric acid.

Chemical Compatibility of Elastomers and Metals

Fluid Compatibility of Elastomers					
FLUID	MATERIAL				
	Neoprene (CR)	Nitrile (NBR)	Fluoroelastomer (FKM)	Ethylenepropylene (EPDM)	Perfluoroelastomer (FFKM)
Acetic Acid (30%)	B	C	C	A	A
Acetone	C	C	C	A	A
Air, Ambient	A	A	A	A	A
Air, Hot (200°F (93°C))	C	B	A	A	A
Alcohol (Ethyl)	A	C	C	A	A
Alcohol (Methyl)	A	A	C	A	A
Ammonia (Anhydrous) (Cold)	A	A	C	A	A
Ammonia (Gas, Hot)	B	C	C	B	A
Beer	A	A	A	A	A
Benzene	C	C	B	C	A
Brine (Calcium Chloride)	A	A	B	A	A
Butadiene Gas	C	C	B	C	A
Butane (Gas)	A	A	A	C	A
Butane (Liquid)	C	A	A	C	A
Carbon Tetrachloride	C	C	A	C	A
Chlorine (Dry)	C	C	A	C	A
Chlorine (Wet)	C	C	B	C	A
Coke Oven Gas	C	C	A	C	A
Ethyl Acetate	C	C	C	B	A
Ethylene Glycol	A	A	A	A	A
Freon 11	C	B	A	C	A
Freon 12	A	A	B	B	A
Freon 22	A	C	C	A	A
Freon 114	A	A	B	A	A
Gasoline (Automotive)	C	B	A	C	A
Hydrogen Gas	A	A	A	A	A
Hydrogen Sulfide (Dry)	A	A ⁽¹⁾	C	A	A
Hydrogen Sulfide (Wet)	B	C	C	A	A
Jet Fuel (JP-4)	B	A	A	C	A
Methyl Ethyl Ketone (MEK)	C	C	C	A	A
MTBE	C	C	C	C	A
Natural Gas	A	A	A	C	A
Nitric Acid (50 to 100%)	C	C	B	C	A
Nitrogen	A	A	A	A	A
Oil (Fuel)	C	A	A	C	A
Propane	B	A	A	C	A
Sulfur Dioxide	A	C	A	A	A
Sulfuric Acid (up to 50%)	B	C	A	B	A
Sulfuric Acid (50 to 100%)	C	C	A	B	A
Water (Ambient)	A	A	A	A	A
Water (at 200°F (93°C))	C	B	B	A	A

1. Performance worsens with hot temperatures.
A - Recommended
B - Minor to moderate effect. Proceed with caution.
C - Unsatisfactory
N/A - Information not available

Chemical Compatibility of Elastomers and Metals

Compatibility of Metals														
CORROSION INFORMATION														
Fluid	Material													
	Carbon Steel	Cast Iron	S302 or S304 Stainless Steel	S316 Stainless Steel	Bronze	Monel®	Hastelloy® B	Hastelloy® C	Durimet® 20	Titanium	Cobalt-Base Alloy 6	S416 Stainless Steel	440C Stainless Steel	17-4PH Stainless Steel
Acetaldehyde	A	A	A	A	A	A	IL	A	A	IL	IL	A	A	A
Acetic Acid, Air Free	C	C	B	B	B	B	A	A	A	A	A	C	C	B
Acetic Acid, Aerated	C	C	A	A	A	A	A	A	A	A	A	C	C	B
Acetic Acid Vapors	C	C	A	A	B	B	IL	A	A	A	A	C	C	B
Acetone	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Acetylene	A	A	A	A	IL	A	A	A	A	IL	A	A	A	A
Alcohols	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Aluminum Sulfate	C	C	A	A	B	B	A	A	A	IL	C	C	C	IL
Ammonia	A	A	A	A	C	A	A	A	A	A	A	A	A	IL
Ammonium Chloride	C	C	B	B	B	B	A	A	A	A	B	C	C	IL
Ammonium Nitrate	A	C	A	A	C	C	A	A	A	A	A	C	B	IL
Ammonium Phosphate (Mono Basic)	C	C	A	A	B	B	A	A	B	A	A	B	B	IL
Ammonium Sulfate	C	C	B	A	B	A	A	A	A	A	C	C	C	IL
Ammonium Sulfite	C	C	A	A	C	C	IL	A	A	A	B	B	B	IL
Aniline	C	C	A	A	C	B	A	A	A	A	C	C	C	IL
Asphalt	A	A	A	A	A	A	A	A	A	IL	A	A	A	A
Beer	B	B	A	A	B	A	A	A	A	A	A	B	B	A
Benzene (Benzol)	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Benzoic Acid	C	C	A	A	A	A	IL	A	A	A	IL	A	A	A
Boric Acid	C	C	A	A	A	A	A	A	A	A	A	B	B	IL
Butane	A	A	A	A	A	A	A	A	A	IL	A	A	A	A
Calcium Chloride (Alkaline)	B	B	C	B	C	A	A	A	A	A	IL	C	C	IL
Calcium Hypochlorite	C	C	B	B	B	B	C	A	A	A	IL	C	C	IL
Carbolic Acid	B	B	A	A	A	A	A	A	A	A	IL	IL	IL	IL
Carbon Dioxide, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Carbon Dioxide, Wet	C	C	A	A	C	A	A	A	A	A	A	A	A	A
Carbon Disulfide	A	A	A	A	B	B	A	A	A	A	A	B	B	IL
Carbon Tetrachloride	B	B	B	B	A	A	B	A	A	A	IL	C	A	IL
Carbonic Acid	C	C	B	B	B	A	A	A	A	IL	A	A	A	A
Chlorine Gas, Dry	A	A	B	B	B	A	A	A	A	C	B	C	C	C
Chlorine Gas, Wet	C	C	C	C	C	C	C	B	C	A	B	C	C	C
Chlorine, Liquid	C	C	C	C	B	C	C	A	B	C	B	C	C	C
Chromic Acid	C	C	C	B	C	A	C	A	C	A	B	C	C	C
Citric Acid	IL	C	B	A	A	B	A	A	A	A	IL	B	B	B
Coke Oven Gas	A	A	A	A	B	B	A	A	A	A	A	A	A	A
Copper Sulfate	C	C	B	B	B	C	IL	A	A	A	IL	A	A	A
Cottonseed Oil	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Creosote	A	A	A	A	C	A	A	A	A	IL	A	A	A	A
Ethane	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ether	B	B	A	A	A	A	A	A	A	A	A	A	A	A
Ethyl Chloride	C	C	A	A	A	A	A	A	A	A	A	B	B	IL
Ethylene	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ethylene Glycol	A	A	A	A	A	A	IL	IL	A	IL	A	A	A	A
Ferric Chloride	C	C	C	C	C	C	C	B	C	A	B	C	C	IL
Formaldehyde	B	B	A	A	A	A	A	A	A	A	A	A	A	A
Formic Acid	IL	C	B	B	A	A	A	A	A	C	B	C	C	B
Freon, Wet	B	B	B	A	A	A	A	A	A	A	A	IL	IL	IL
Freon, Dry	B	B	A	A	A	A	A	A	A	A	A	IL	IL	IL
Furfural	A	A	A	A	A	A	A	A	A	A	A	B	B	IL
Gasoline, Refine	A	A	A	A	A	A	A	A	A	A	A	A	A	A

A - Recommended
 B - Minor to moderate effect. Proceed with caution.
 C - Unsatisfactory
 IL - Information lacking

- continued -

Chemical Compatibility of Elastomers and Metals

Compatibility of Metals (continued)														
CORROSION INFORMATION														
Fluid	Material													
	Carbon Steel	Cast Iron	S302 or S304 Stainless Steel	S316 Stainless Steel	Bronze	Monel®	Hastelloy® B	Hastelloy® C	Durimet® 20	Titanium	Cobalt-Base Alloy 6	S416 Stainless Steel	440C Stainless Steel	17-4PH Stainless Steel
Glucose	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Hydrochloric Acid, Aerated	C	C	C	C	C	C	A	B	C	C	B	C	C	C
Hydrochloric Acid, Air free	C	C	C	C	C	C	A	B	C	C	B	C	C	C
Hydrofluoric Acid, Aerated	B	C	C	B	C	C	A	A	B	C	B	C	C	C
Hydrofluoric Acid, Air free	A	C	C	B	C	A	A	A	B	C	IL	C	C	IL
Hydrogen	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Hydrogen Peroxide	IL	A	A	A	C	A	B	B	A	A	IL	B	B	IL
Hydrogen Sulfide, Liquid	C	C	A	A	C	C	A	A	B	A	A	C	C	IL
Magnesium Hydroxide	A	A	A	A	B	A	A	A	A	A	A	A	A	IL
Mercury	A	A	A	A	C	B	A	A	A	A	A	A	A	B
Methanol	A	A	A	A	A	A	A	A	A	A	A	A	B	A
Methyl Ethyl Ketone	A	A	A	A	A	A	A	A	IL	A	A	A	A	A
Milk	C	C	A	A	A	A	A	A	A	A	A	C	C	A
Natural Gas	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Nitric Acid	C	C	A	B	C	C	C	B	A	A	C	C	C	B
Oleic Acid	C	C	A	A	B	A	A	A	A	A	A	A	A	IL
Oxalic Acid	C	C	B	B	B	B	A	A	A	B	B	B	B	IL
Oxygen	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Petroleum Oils, Refined	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Phosphoric Acid, Aerated	C	C	A	A	C	C	A	A	A	B	A	C	C	IL
Phosphoric Acid, Air Free	C	C	A	A	C	B	A	A	A	B	A	C	C	IL
Phosphoric Acid Vapors	C	C	B	B	C	C	A	IL	A	B	C	C	C	IL
Picric Acid	C	C	A	A	C	C	A	A	A	IL	IL	B	B	IL
Potassium Chloride	B	B	A	A	B	B	A	A	A	A	IL	C	C	IL
Potassium Hydroxide	B	B	A	A	B	A	A	A	A	A	IL	B	B	IL
Propane	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Rosin	B	B	A	A	A	A	A	A	A	IL	A	A	A	A
Silver Nitrate	C	C	A	A	C	C	A	A	A	A	B	B	B	IL
Sodium Acetate	A	A	B	A	A	A	A	A	A	A	A	A	A	A
Sodium Carbonate	A	A	A	A	A	A	A	A	A	A	A	B	B	A
Sodium Chloride	C	C	B	B	A	A	A	A	A	A	A	B	B	B
Sodium Chromate	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Hydroxide	A	A	A	A	C	C	A	A	A	A	A	B	B	A
Sodium Hypochloride	C	C	C	C	B-C	B-C	C	A	B	A	IL	C	C	IL
Sodium Thiosulfate	C	C	A	A	C	C	A	A	A	A	IL	B	B	IL
Stannous Chloride	B	B	C	A	C	B	A	A	A	A	IL	C	C	IL
Stearic Acid	A	C	A	A	B	B	A	A	A	A	B	B	B	IL
Sulfate Liquor (Black)	A	A	A	A	C	A	A	A	A	A	A	IL	IL	IL
Sulfur	A	A	A	A	C	A	A	A	A	A	A	A	A	A
Sulfur Dioxide, Dry	A	A	A	A	A	A	B	A	A	A	A	B	B	IL
Sulfur Trioxide, Dry	A	A	A	A	A	A	B	A	A	A	A	B	B	IL
Sulfuric Acid (Aerated)	C	C	C	C	C	C	A	A	A	B	B	C	C	C
Sulfuric Acid (Air Free)	C	C	C	C	B	B	A	A	A	B	B	C	C	C
Sulfurous Acid	C	C	B	B	B	C	A	A	A	A	B	C	C	IL
Tar	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Trichloroethylene	B	B	B	A	A	A	A	A	A	A	A	B	B	IL
Turpentine	B	B	A	A	A	B	A	A	A	A	A	A	A	A
Vinegar	C	C	A	A	B	A	A	A	A	IL	A	C	C	A
Water, Boiler Feed	B	C	A	A	C	A	A	A	A	A	A	B	A	A
Water, Distilled	A	A	A	A	A	A	A	A	A	A	A	B	B	IL
Water, Sea	B	B	B	B	A	A	A	A	A	A	A	C	C	A
Whiskey and Wines	C	C	A	A	A	B	A	A	A	A	A	C	C	IL
Zinc Chloride	C	C	C	C	C	C	A	A	A	A	B	C	C	IL
Zinc Sulfate	C	C	A	A	B	A	A	A	A	A	A	B	B	IL

A - Recommended
 B - Minor to moderate effect. Proceed with caution.
 C - Unsatisfactory
 IL - Information lacking

Regulator Tips

1. All regulators should be installed and used in accordance with federal, state, and local codes and regulations.
 2. Adequate overpressure protection should be installed to protect the regulator from overpressure. Adequate overpressure protection should also be installed to protect all downstream equipment in the event of regulator failure.
 3. Downstream pressures significantly higher than the regulator's pressure setting may damage soft seats and other internal parts.
 4. If two or more available springs have published pressure ranges that include the desired pressure setting, use the spring with the lower range for better accuracy.
 5. The recommended selection for orifice diameters is the smallest orifice that will handle the flow.
 6. Most regulators shown in this application guide are generally suitable for temperatures to 180°F (82°C). With high temperature fluoroelastomers (if available), the regulators can be used for temperatures to 300°F (149°C). Check the temperature capabilities to determine materials and temperature ranges available. Use stainless steel diaphragms and seats for higher temperatures, such as steam service.
 7. The full advertised range of a spring can be utilized without sacrificing performance or spring life.
 8. Regulator body size should not be larger than the pipe size. In many cases, the regulator body is one size smaller than the pipe size.
 9. Do not oversize regulators. Pick the smallest orifice size or regulator that will work. Keep in mind when sizing a station that most restricted trims that do not reduce the main port size do not help with improved low flow control.
 10. Speed of regulator response, in order:
 - Direct-operated
 - Two-path pilot-operated
 - Unloading pilot-operated
 - Control valve
- Note: Although direct-operated regulators give the fastest response, all types provide quick response.
11. When a regulator appears unable to pass the published flow rate, be sure to check the inlet pressure measured at the regulator body inlet connection. Piping up to and away from regulators can cause significant flowing pressure losses.
 12. When adjusting setpoint, the regulator should be flowing at least five percent of the normal operating flow.
 13. Direct-operated regulators generally have faster response to quick flow changes than pilot-operated regulators.
 14. Droop is the reduction of outlet pressure experienced by pressure-reducing regulators as the flow rate increases. It is stated as a percent, in inches of water column (mbar) or in pounds per square inch (bar) and indicates the difference between the outlet pressure setting made at low flow rates and the actual outlet pressure at the published maximum flow rate. Droop is also called offset or proportional band.
 15. Downstream pressure always changes to some extent when inlet pressure changes.
 16. Most soft-seated regulators will maintain the pressure within reasonable limits down to zero flow. Therefore, a regulator sized for a high flow rate will usually have a turndown ratio sufficient to handle pilot-light loads during off cycles.
 17. Do not undersize the monitor set. It is important to realize that the monitor regulator, even though it is wide-open, will require pressure drop for flow. Using two identical regulators in a monitor set will yield approximately 70 percent of the capacity of a single regulator.
 18. Diaphragms leak a small amount due to migration of gas through the diaphragm material. To allow escape of this gas, be sure casing vents (where provided) remain open.
 19. Use control lines of equal or greater size than the control tap on the regulator. If a long control line is required, make it bigger. A rule of thumb is to use the next nominal pipe size for every 20 feet (6,1 m) of control line. Small control lines cause a delayed response of the regulator, leading to increased chance of instability. 3/8-inch (9,5 mm) OD tubing is the minimum recommended control line size.
 20. For every 15 psid (1,0 bar d) pressure differential across the regulator, expect approximately a one degree drop in gas temperature due to the natural refrigeration effect. Freezing is often a problem when the ambient temperature is between 30° and 45°F (-1° and 7°C).
 21. A disk with a cookie cut appearance probably means you had an overpressure situation. Thus, investigate further.
 22. When using relief valves, be sure to remember that the reseal point is lower than the start-to-bubble point. To avoid seepage, keep the relief valve setpoint far enough above the regulator setpoint.

Regulator Tips

23. Vents should be pointed down to help avoid the accumulation of water condensation or other materials in the spring case.
24. Make control line connections in a straight run of pipe about 10 pipe diameters downstream of any area of turbulence, such as elbows, pipe swages, or block valves.
25. When installing a working monitor station, get as much volume between the two regulators as possible. This will give the upstream regulator more room to control intermediate pressure.
26. Cutting the supply pressure to a pilot-operated regulator reduces the regulator gain or sensitivity and, thus, may improve regulator stability. (This can only be used with two path control.)
27. Regulators with high flows and large pressure drops generate noise. Noise can wear parts which can cause failure and/or inaccurate control. Keep regulator noise below 110 dBA.
28. Do not place control lines immediately downstream of rotary or turbine meters.
29. Keep vents open. Do not use small diameter, long vent lines. Use the rule of thumb of the next nominal pipe size every 10 feet (3,1 m) of vent line and 3 feet (0,9 m) of vent line for every elbow in the line.
30. Fixed factor measurement (or PFM) requires the regulator to maintain outlet pressure within $\pm 1\%$ of absolute pressure. For example: Setpoint of 2 psig + 14.7 psia = 16.7 psia x 0.01 = ± 0.167 psi. (Setpoint of 0,14 bar + 1,01 bar = 1,15 bar x 0,01 = $\pm 0,0115$ bar.)
31. Regulating C_g (coefficient of flow) can only be used for calculating flow capacities on pilot-operated regulators. Use capacity tables or flow charts for determining a direct-operated regulator's capacity.
32. Do not make the setpoints of the regulator/monitor too close together. The monitor can try to take over if the setpoints are too close, causing instability and reduction of capacity. Set them at least one proportional band apart.
33. Consider a butt-weld end regulator where available to lower costs and minimize flange leakages.
34. Do not use needle valves in control lines; use full-open valves. Needle valves can cause instability.
35. Burying regulators is not recommended. However, if you must, the vent should be protected from ground moisture and plugging.

Conversions, Equivalents, and Physical Data

Pressure Equivalents								
TO OBTAIN BY MULTIPLY NUMBER OF	KG PER SQUARE CENTIMETER	POUNDS PER SQUARE INCH	ATMOSPHERE	BAR	INCHES OF MERCURY	KILOPASCALS	INCHES OF WATER COLUMN	FEET OF WATER COLUMN
Kg per square cm	1	14.22	0.9678	0,98067	28.96	98,067	394.05	32.84
Pounds per square inch	0,07031	1	0.06804	0,06895	2.036	6,895	27.7	2.309
Atmosphere	1,0332	14.696	1	1,01325	29.92	101,325	407.14	33.93
Bar	1,01972	14.5038	0.98692	1	29.53	100	402.156	33.513
Inches of Mercury	0,03453	0.4912	0.03342	0,033864	1	3,3864	13.61	1.134
Kilopascals	0,0101972	0.145038	0.0098696	0,01	0.2953	1	4.02156	0.33513
Inches of Water	0,002538	0.0361	0.002456	0,00249	0.07349	0,249	1	0.0833
Feet of Water	0,3045	0.4332	0.02947	0,029839	0.8819	2,9839	12	1

1 ounce per square inch = 0.0625 pounds per square inch

Pressure Conversion - Pounds per Square Inch to Bar ⁽¹⁾										
POUNDS PER SQUARE INCH	0	1	2	3	4	5	6	7	8	9
	Bar									
0	0,000	0,069	0,138	0,207	0,276	0,345	0,414	0,482	0,552	0,621
10	0,689	0,758	0,827	0,896	0,965	1,034	1,103	1,172	1,241	1,310
20	1,379	1,448	1,517	1,586	1,655	1,724*	1,793	1,862	1,931	1,999
30	2,068	2,137	2,206	2,275	2,344	2,413	2,482	2,551	2,620	2,689
40	2,758	2,827	2,896	2,965	3,034	3,103	3,172	3,241	3,309	3,378
50	3,447	3,516	3,585	3,654	3,723	3,792	3,861	3,930	3,999	4,068
60	4,137	4,206	4,275	4,344	4,413	4,482	4,551	4,619	4,688	4,758
70	4,826	4,895	4,964	5,033	5,102	5,171	5,240	5,309	5,378	5,447
80	5,516	5,585	5,654	5,723	5,792	5,861	5,929	5,998	6,067	6,136
90	6,205	6,274	6,343	6,412	6,481	6,550	6,619	6,688	6,757	6,826
100	6,895	6,964	7,033	7,102	7,171	7,239	7,308	7,377	7,446	7,515

1. To convert to kilopascals, move decimal point two positions to the right; to convert to megapascals, move decimal point one position to the left.
 *Note: Round off decimal points to provide no more than the desired degree of accuracy.
 To use this table, see the shaded example.
 25 psig (20 from the left column plus five from the top row) = 1,724 bar

Volume Equivalents							
TO OBTAIN BY MULTIPLY NUMBER OF	CUBIC DECIMETERS (LITERS)	CUBIC INCHES	CUBIC FEET	U.S. QUART	U.S. GALLON	IMPERIAL GALLON	U.S. BARREL (PETROLEUM)
Cubic Decimeters (Liters)	1	61.0234	0.03531	1.05668	0.264178	0.220083	0.00629
Cubic Inches	0,01639	1	5.787 x 10 ⁻⁴	1.01732	0.004329	0,003606	0.000103
Cubic Feet	28,317	1728	1	29.9221	7.48055	6,22888	0.1781
U.S. Quart	0,94636	57.75	0.03342	1	0.25	0,2082	0.00595
U.S. Gallon	3,78543	231	0.13368	4	1	0,833	0.02381
Imperial Gallon	4,54374	277.274	0.16054	4.80128	1.20032	1	0.02877
U.S. Barrel (Petroleum)	158,98	9702	5.6146	168	42	34,973	1

1 cubic meter = 1,000,000 cubic centimeters
 1 liter = 1000 milliliters = 1000 cubic centimeters

Conversions, Equivalents, and Physical Data

Volume Rate Equivalents							
MULTIPLY NUMBER OF	TO OBTAIN	LITERS PER MINUTE	CUBIC METERS PER HOUR	CUBIC FEET PER HOUR	LITERS PER HOUR	U.S. GALLONS PER MINUTE	U.S. BARRELS PER DAY
		Liters per Minute	1	0,06	2.1189	60	0.264178
Cubic Meters per Hour	16,667	1	35.314	1000	4.403	151	
Cubic Feet per Hour	0,4719	0,028317	1	28.317	0.1247	4.2746	
Liters per Hour	0,016667	0,001	0.035314	1	0.004403	0.151	
U.S. Gallons per Minute	3,785	0,2273	8.0208	227.3	1	34.28	
U.S. Barrels per Day	0,1104	0,006624	0.23394	6.624	0.02917	1	

Mass Conversion - Pounds to Kilograms										
POUNDS	0	1	2	3	4	5	6	7	8	9
	Kilograms									
0	0,00	0,45	0,91	1,36	1,81	2,27	2,72	3,18	3,63	4,08
10	4,54	4,99	5,44	5,90	6,35	6,80	7,26	7,71	8,16	8,62
20	9,07	9,53	9,98	10,43	10,89	11,34*	11,79	12,25	12,70	13,15
30	13,61	14,06	14,52	14,97	15,42	15,88	16,33	16,78	17,24	17,69
40	18,14	18,60	19,05	19,50	19,96	20,41	20,87	21,32	21,77	22,23
50	22,68	23,13	23,59	24,04	24,49	24,95	25,40	25,86	26,31	26,76
60	27,22	27,67	28,12	28,58	29,03	29,48	29,94	30,39	30,84	31,30
70	31,75	32,21	32,66	33,11	33,57	34,02	34,47	34,93	35,38	35,83
80	36,29	36,74	37,20	37,65	38,10	38,56	39,01	39,46	39,92	40,37
90	40,82	41,28	41,73	42,18	42,64	43,09	43,55	44,00	44,45	44,91

1 pound = 0,4536 kilograms
 *NOTE: To use this table, see the shaded example.
 25 pounds (20 from the left column plus five from the top row) = 11,34 kilograms

Area Equivalents						
MULTIPLY NUMBER OF	TO OBTAIN	SQUARE METERS	SQUARE INCHES	SQUARE FEET	SQUARE MILES	SQUARE KILOMETERS
		Square Meters	1	1549.99	10.7639	3.861 x 10 ⁷
Square Inches	0,0006452	1	6.944 x 10 ⁻³	2.491 x 10 ⁻¹⁰	6,452 x 10 ⁻¹⁰	
Square Feet	0,0929	144	1	3.587 x 10 ⁻⁸	9,29 x 10 ⁻⁸	
Square Miles	2 589 999	----	27,878,400	1	2,59	
Square Kilometers	1 000 000	----	10,763,867	0.3861	1	

1 square meter = 10 000 square centimeters
 1 square millimeter = 0,01 square centimeter = 0.00155 square inches

Temperature Conversion Formulas		
TO CONVERT FROM	TO	SUBSTITUTE IN FORMULA
Degrees Celsius	Degrees Fahrenheit	(°C x 9/5) + 32
Degrees Celsius	Kelvin	(°C + 273.16)
Degrees Fahrenheit	Degrees Celsius	(°F - 32) x 5/9
Degrees Fahrenheit	Degrees Rankine	(°F + 459.69)

Kinematic-Viscosity Conversion Formulas		
VISCOSITY SCALE	RANGE OF t, SEC	KINEMATIC VISCOSITY, STROKES
Saybolt Universal	32 < t < 100 t > 100	0.00226t - 1.95/t 0.00220t - 1.35/t
Saybolt Furol	25 < t < 40 t > 40	0.0224t - 1.84/t 0.0216t - 0.60/t
Redwood No. 1	34 < t < 100 t > 100	0.00226t - 1.79/t 0.00247t - 0.50/t
Redwood Admiralty	----	0.027t - 20/t
Engler	----	0.00147t - 3.74/t

Conversions, Equivalents, and Physical Data

Conversion Units		
MULTIPLY	BY	TO OBTAIN
Volume		
Cubic centimeter	0.06103	Cubic inches
Cubic feet	7.4805	Gallons (US)
Cubic feet	28.316	Liters
Cubic feet	1728	Cubic inches
Gallons (US)	0.1337	Cubic feet
Gallons (US)	3.785	Liters
Gallons (US)	231	Cubic inches
Liters	1.057	Quarts (US)
Liters	2.113	Pints (US)
Miscellaneous		
BTU	0.252	Calories
Decitherm	10,000	BTU
Kilogram	2.205	Pounds
Kilowatt Hour	3412	BTU
Ounces	28.35	Grams
Pounds	0.4536	Kilograms
Pounds	453.5924	Grams
Pounds	21,591	LPG BTU
Therm	100,000	BTU
API Bbls	42	Gallons (US)
Gallons of Propane	26.9	KWH
HP	746	KWH
HP (Steam)	42,418	BTU
Pressure		
Grams per square centimeter	0.0142	Pounds per square inch
Inches of mercury	0.4912	Pounds per square inch
Inches of mercury	1.133	Feet of water
Inches of water	0.0361	Pounds per square inch
Inches of water	0.0735	Inches of mercury
Inches of water	0.5781	Ounces per square inch
Inches of water	5.204	Pounds per foot
kPa	100	Bar
Kilograms per square centimeter	14.22	Pounds per square inch
Kilograms per square meter	0.2048	Pounds per square foot
Pounds per square inch	0.06804	Atmospheres
Pounds per square inch	0.07031	Kilograms per square centimeter
Pounds per square inch	0.145	KPa
Pounds per square inch	2.036	Inches of mercury
Pounds per square inch	2.307	Feet of water
Pounds per square inch	14.5	Bar
Pounds per square inch	27.67	Inches of water
Length		
Centimeters	0.3937	Inches
Feet	0.3048	Meters
Feet	30.48	Centimeters
Feet	304.8	Millimeters
Inches	2.540	Centimeters
Inches	25.40	Millimeters
Kilometer	0.6214	Miles
Meters	1.094	Yards
Meters	3.281	Feet
Meters	39.37	Inches
Miles (nautical)	1853	Meters
Miles (statute)	1609	Meters
Yards	0.9144	Meters
Yards	91.44	Centimeters

Other Useful Conversions		
TO CONVERT FROM	TO	MULTIPLY BY
Cubic feet of methane	BTU	1000 (approximate)
Cubic feet of water	Pounds of water	62.4
Degrees	Radians	0,01745
Gallons	Pounds of water	8,336
Grams	Ounces	0.0352
Horsepower (mechanical)	Foot pounds per minute	33,000
Horsepower (electrical)	Watts	746
Kg	Pounds	2.205
Kg per cubic meter	Pounds per cubic feet	0.06243
Kilowatts	Horsepower	1.341
Pounds	Kg	0.4536
Pounds of Air (14.7 psia and 60°F)	Cubic feet of air	13.1
Pounds per cubic feet	Kg per cubic meter	16,0184
Pounds per hour (gas)	SCFH	13.1 ÷ Specific Gravity
Pounds per hour (water)	Gallons per minute	0.002
Pounds per second (gas)	SCFH	46,160 ÷ Specific Gravity
Radians	Degrees	57.3
SCFH Air	SCFH Propane	0.81
SCFH Air	SCFH Butane	0.71
SCFH Air	SCFH 0.6 Natural Gas	1.29
SCFH	Cubic meters per hour	0.028317

Converting Volumes of Gas		
CFH TO CFH OR CFM TO CFM		
Multiply Flow of	By	To Obtain Flow of
Air	0.707	Butane
	1.290	Natural Gas
	0.808	Propane
Butane	1.414	Air
	1.826	Natural Gas
	1.140	Propane
Natural Gas	0.775	Air
	0.547	Butane
	0.625	Propane
Propane	1.237	Air
	0.874	Butane
	1.598	Natural Gas

Conversions, Equivalents, and Physical Data

Fractional Inches to Millimeters																
INCH	0	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16
	mm															
0	0,0	1,6	3,2	4,8	6,4	7,9	9,5	11,1	12,7	14,3	15,9	17,5	19,1	20,6	22,2	23,8
1	25,4	27,0	28,6	30,2	31,8	33,3	34,9	36,5	38,1	39,7	41,3	42,9	44,5	46,0	47,6	49,2
2	50,8	52,4	54,0	55,6	57,2	58,7	60,3	61,9	63,5	65,1	66,7	68,3	69,9	71,4	73,0	74,6
3	76,2	77,8	79,4	81,0	82,6	84,1	85,7	87,3	88,9	90,5	92,1	93,7	95,3	96,8	98,4	100,0
4	101,6	103,2	104,8	106,4	108,0	109,5	111,1	112,7	114,3	115,9	117,5	119,1	120,7	122,2	123,8	125,4
5	127,0	128,6	130,2	131,8	133,4	134,9	136,5	138,1	139,7	141,3	142,9	144,5	146,1	147,6	149,2	150,8
6	152,4	154,0	155,6	157,2	158,8	160,3	161,9	163,5	165,1	166,7	168,3	169,9	171,5	173,0	174,6	176,2
7	177,8	179,4	181,0	182,6	184,2	185,7	187,3	188,9	190,5	192,1	193,7	195,3	196,9	198,4	200,0	201,6
8	203,2	204,8	206,4	208,0	209,6	211,1	212,7	214,3	215,9	217,5	219,1	220,7	222,3	223,8	225,4	227,0
9	228,6	230,2	231,8	233,4	235,0	236,5	238,1	239,7	241,3	242,9	244,5	246,1	247,7	249,2	250,8	252,4
10	254,0	255,6	257,2	258,8	260,4	261,9	263,5	265,1	266,7	268,3	269,9	271,5	273,1	274,6	276,2	277,8

1-inch = 25,4 millimeters
 NOTE: To use this table, see the shaded example.
 2-1/2-inches (2 from the left column plus 1/2 from the top row) = 63,5 millimeters

Length Equivalents							
MULTIPLY NUMBER OF	TO OBTAIN	METERS	INCHES	FEET	MILLIMETERS	MILES	KILOMETERS
		Meters	1	39.37	3.2808	1000	0.0006214
Inches	0,0254	1	0.0833	25,4	0.00001578	0,0000254	
Feet	0,3048	12	1	304,8	0.0001894	0,0003048	
Millimeters	0,001	0.03937	0.0032808	1	0.000006214	0,000001	
Miles	1609,35	63,360	5,280	1 609 350	1	1,60935	
Kilometers	1000	39,370	3280.83	1 000 000	0.62137	1	

1 meter = 100 cm = 1000 mm = 0,001 km = 1,000,000 micrometers

Whole Inch-Millimeter Equivalents										
INCH	0	1	2	3	4	5	6	7	8	9
	mm									
0	0,00	25,4	50,8	76,2	101,6	127,0	152,4	177,8	203,2	228,6
10	254,0	279,4	304,8	330,2	355,6	381,0	406,4	431,8	457,2	482,6
20	508,0	533,4	558,8	584,2	609,6	635,0	660,4	685,8	711,2	736,6
30	762,0	787,4	812,8	838,2	863,6	889,0	914,4	939,8	965,2	990,6
40	1016,0	1041,4	1066,8	1092,2	1117,6	1143,0	1168,4	1193,8	1219,2	1244,6
50	1270,0	1295,4	1320,8	1346,2	1371,6	1397,0	1422,4	1447,8	1473,2	1498,6
60	1524,0	1549,4	1574,8	1600,2	1625,6	1651,0	1676,4	1701,8	1727,2	1752,6
70	1778,0	1803,4	1828,8	1854,2	1879,6	1905,0	1930,4	1955,8	1981,2	2006,6
80	2032,0	2057,4	2082,8	2108,2	2133,6	2159,0	2184,4	2209,8	2235,2	2260,6
90	2286,0	2311,4	2336,8	2362,2	2387,6	2413,0	2438,4	2463,8	2489,2	2514,6
100	2540,0	2565,4	2590,8	2616,2	2641,6	2667,0	2692,4	2717,8	2743,2	2768,6

Note: All values in this table are exact, based on the relation 1-inch = 25,4 mm.
 To use this table, see the shaded example.
 25-inches (20 from the left column plus five from the top row) = 635 millimeters

Metric Prefixes and Symbols		
MULTIPLICATION FACTOR	PREFIX	SYMBOL
1 000 000 000 000 000 000 = 10 ¹⁸	exa	E
1 000 000 000 000 000 = 10 ¹⁵	peta	P
1 000 000 000 000 = 10 ¹²	tera	T
1 000 000 000 = 10 ⁹	giga	G
1 000 000 = 10 ⁶	mega	M
1 000 = 10 ³	kilo	k
100 = 10 ²	hecto	h
10 = 10 ¹	deka	da
0,1 = 10 ⁻¹	deci	d
0,01 = 10 ⁻²	centi	c
0,001 = 10 ⁻³	milli	m
0,000 01 = 10 ⁻⁶	micro	μ
0,000 000 001 = 10 ⁻⁹	nano	n
0,000 000 000 001 = 10 ⁻¹²	pico	p
0,000 000 000 000 001 = 10 ⁻¹⁵	femto	f
0,000 000 000 000 000 001 = 10 ⁻¹⁸	atto	a

Greek Alphabet								
CAPS	LOWER CASE	GREEK NAME	CAPS	LOWER CASE	GREEK NAME	CAPS	LOWER CASE	GREEK NAME
A	α	Alpha	I	ι	Iota	ρ	ρ	Rho
B	β	Beta	K	κ	Kappa	σ	σ	Sigma
Γ	γ	Gamma	Λ	λ	Lambda	τ	τ	Tau
Δ	δ	Delta	Μ	μ	Mu	υ	υ	Upsilon
E	ε	Epsilon	N	ν	Nu	φ	φ	Phi
Z	ζ	Zeta	Ξ	ξ	Xi	χ	χ	Chi
H	η	Eta	Ο	ο	Omicron	ψ	ψ	Psi
Θ	θ	Theta	Π	π	Pi	Ω	ω	Omega

Conversions, Equivalents, and Physical Data

Length Equivalents - Fractional and Decimal Inches to Millimeters											
INCHES			INCHES			INCHES			INCHES		
Fractions	Decimals	mm	Fractions	Decimals	mm	Fractions	Decimals	mm	Fractions	Decimals	mm
	0.00394	0.1		0.23	5.842	1/2	0.50	12.7		0.77	19.558
	0.00787	0.2	15/64	0.234375	5.9531		0.51	12.954		0.78	19.812
	0.01	0.254		0.23622	6.0		0.51181	13.0	25/32	0.78125	19.8438
	0.01181	0.3		0.24	6.096	33/64	0.515625	13.0969		0.78740	20.0
1/64	0.015625	0.3969	1/4	0.25	6.35		0.52	13.208		0.79	20.066
	0.01575	0.4		0.26	6.604		0.53	13.462	51/64	0.796875	20.2406
	0.01969	0.5	17/64	0.265625	6.7469	17/32	0.53125	13.4938		0.80	20.320
	0.02	0.508		0.27	6.858		0.54	13.716		0.81	20.574
	0.02362	0.6		0.27559	7.0	35/64	0.546875	13.8906	13/64	0.8125	20.6375
	0.02756	0.7		0.28	7.112		0.55	13.970		0.82	20.828
	0.03	0.762	9/32	0.28125	7.1438		0.55118	14.0		0.82677	21.0
1/32	0.03125	0.7938		0.29	7.366		0.56	14.224	53/64	0.828125	21.0344
	0.0315	0.8	19/64	0.296875	7.5406	9/16	0.5625	14.2875		0.83	21.082
	0.13543	0.9		0.30	7.62		0.57	14.478		0.84	21.336
	0.03937	1.0		0.31	7.874	37/64	0.578125	14.6844	27/32	0.84375	21.4312
	0.04	1.016	5/16	0.3125	7.9375		0.58	14.732		0.85	21.590
3/64	0.046875	1.1906		0.31496	8.0		0.59	14.986	55/64	0.859375	21.8281
	0.05	1.27		0.32	8.128		0.5905	15.0		0.86	21.844
	0.06	1.524	21/64	0.328125	8.3344	19/32	0.59375	15.0812		0.86614	22.0
1/16	0.0625	1.5875		0.33	8.382		0.60	15.24		0.87	22.098
	0.07	1.778		0.34	8.636	39/64	0.609375	15.4781	7/8	0.875	22.225
5/64	0.078125	1.9844	11/32	0.34375	8.7312		0.61	15.494		0.88	22.352
	0.07874	2.0		0.35	8.89		0.62	15.748		0.89	22.606
	0.08	2.032		0.35433	9.0	5/8	0.625	15.875	57/64	0.890625	22.6219
	0.09	2.286	23/64	0.359375	9.1281		0.62992	16.0		0.90	22.860
3/32	0.09375	2.3812		0.36	9.144		0.63	16.002		0.90551	23.0
	0.1	2.54		0.37	9.398		0.64	16.256	29/32	0.90625	23.0188
7/64	0.109375	2.7781	3/8	0.375	9.525	41/64	0.640625	16.2719		0.91	23.114
	0.11	2.794		0.38	9.652		0.65	16.510		0.92	23.368
	0.11811	3.0		0.39	9.906	21/32	0.65625	16.6688	59/64	0.921875	23.1456
	0.12	3.048	25/64	0.390625	9.9219		0.66	16.764		0.93	23.622
1/8	0.125	3.175		0.39370	10.0		0.66929	17.0	15/16	0.9375	23.8125
	0.13	3.302		0.40	10.16		0.67	17.018		0.94	23.876
	0.14	3.556	13/32	0.40625	10.3188	43/64	0.671875	17.0656		0.94488	24.0
9/64	0.140625	3.5719		0.41	10.414		0.68	17.272		0.95	24.130
	0.15	3.810		0.42	10.668	11/16	0.6875	17.4625	61/64	0.953125	24.2094
5/32	0.15625	3.9688	27/64	0.421875	10.7156		0.69	17.526		0.96	24.384
	0.15748	4.0		0.43	10.922		0.70	17.78	31/32	0.96875	24.6062
	0.16	4.064		0.43307	11.0	45/64	0.703125	17.8594		0.97	24.638
	0.17	4.318	7/16	0.4375	11.1125		0.70866	18.0		0.98	24.892
11/64	0.171875	4.3656		0.44	11.176		0.71	18.034		0.98425	25.0
	0.18	4.572		0.45	11.430	23/32	0.71875	18.2562	63/64	0.984375	25.0031
3/16	0.1875	4.7625	29/64	0.453125	11.5094		0.72	18.288		0.99	25.146
	0.19	4.826		0.46	11.684		0.73	18.542	1	1.00000	25.4000
	0.19685	5.0	15/32	0.46875	11.9062	47/64	0.734375	18.6531			
	0.2	5.08		0.47	11.938		0.74	18.796			
13/64	0.203125	5.1594		0.47244	12.0		0.74803	19.0			
	0.21	5.334		0.48	12.192	3/4	0.75	19.050			
7/32	0.21875	5.5562	31/64	0.484375	12.3031		0.76	19.304			
	0.22	5.588		0.49	12.446	49/64	0.765625	19.4469			

Note: Round off decimal points to provide no more than the desired degree of accuracy.

Conversions, Equivalents, and Physical Data

Temperature Conversions											
°C	TEMP. IN °C OR °F TO BE CONVERTED	°F	°C	TEMP. IN °C OR °F TO BE CONVERTED	°F	°C	TEMP. IN °C OR °F TO BE CONVERTED	°F	°C	TEMP. IN °C OR °F TO BE CONVERTED	°F
-273,16	-460	-796	-90,00	-130	-202,0	-17,8	0	32,0	21,1	70	158,0
-267,78	-450	-778	-84,44	-120	-184,0	-16,7	2	35,6	22,2	72	161,6
-262,22	-440	-760	-78,89	-110	-166,0	-15,6	4	39,2	23,3	74	165,2
-256,67	-430	-742	-73,33	-100	-148,0	-14,4	6	42,8	24,4	76	168,8
-251,11	-420	-724	-70,56	-95	-139,0	-13,3	8	46,4	25,6	78	172,4
-245,56	-410	-706	-67,78	-90	-130,0	-12,2	10	50,0	26,7	80	176,0
-240,00	-400	-688	-65,00	-85	-121,0	-11,1	12	53,6	27,8	82	179,6
-234,44	-390	-670	-62,22	-80	-112,0	-10,0	14	57,2	28,9	84	183,2
-228,89	-380	-652	-59,45	-75	-103,0	-8,89	16	60,8	30,0	86	186,8
-223,33	-370	-634	-56,67	-70	-94,0	-7,78	18	64,4	31,1	88	190,4
-217,78	-360	-616	-53,89	-65	-85	-6,67	20	68,0	32,2	90	194,0
-212,22	-350	-598	-51,11	-60	-76,0	-5,56	22	71,6	33,3	92	197,6
-206,67	-340	-580	-48,34	-55	-67,0	-4,44	24	75,2	34,4	94	201,2
-201,11	-330	-562	-45,56	-50	-58,0	-3,33	26	78,8	35,6	96	204,8
-195,56	-320	-544	-42,78	-45	-49,0	-2,22	28	82,4	36,7	98	208,4
-190,00	-310	-526	-40,00	-40	-40,0	-1,11	30	86,0	37,8	100	212,0
-184,44	-300	-508	-38,89	-38	-36,4	0	32	89,6	43,3	110	230,0
-178,89	-290	-490	-37,78	-36	-32,8	1,11	34	93,2	48,9	120	248,0
-173,33	-280	-472	-36,67	-34	-29,2	2,22	36	96,8	54,4	130	266,0
-169,53	-273	-459,4	-35,56	-32	-25,6	3,33	38	100,4	60,0	140	284,0
-168,89	-272	-457,6	-34,44	-30	-22,0	4,44	40	104,0	65,6	150	302,0
-167,78	-270	-454,0	-33,33	-28	-18,4	5,56	42	107,6	71,1	160	320,0
-162,22	-260	-436,0	-32,22	-26	-14,8	6,67	44	111,2	76,7	170	338,0
-156,67	-250	-418,0	-31,11	-24	-11,2	7,78	46	114,8	82,2	180	356,0
-151,11	-240	-400,0	-30,00	-22	-7,6	8,89	48	118,4	87,8	190	374,0
-145,56	-230	-382,0	-28,89	-20	-4,0	10,0	50	122,0	93,3	200	392,0
-140,00	-220	-364,0	-27,78	-18	-0,4	11,1	52	125,6	98,9	210	410,0
-134,44	-210	-356,0	-26,67	-16	3,2	12,2	54	129,2	104,4	220	428,0
-128,89	-200	-328,0	-25,56	-14	6,8	13,3	56	132,8	110,0	230	446,0
-123,33	-190	-310,0	-24,44	-12	10,4	14,4	58	136,4	115,6	240	464,0
-117,78	-180	-292,0	-23,33	-10	14,0	15,6	60	140,0	121,1	250	482,0
-112,22	-170	-274,0	-22,22	-8	17,6	16,7	62	143,6	126,7	260	500,0
-106,67	-160	-256,0	-21,11	-6	21,2	17,8	64	147,2	132,2	270	518,0
-101,11	-150	-238,0	-20,00	-4	24,8	18,9	66	150,8	137,8	280	536,0
-95,56	-140	-220,0	-18,89	-2	28,4	20,0	68	154,4	143,3	290	665,0

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Conversions, Equivalents, and Physical Data

Temperature Conversions (continued)								
°C	TEMP. IN °C OR °F TO BE CONVERTED	°F	°C	TEMP. IN °C OR °F TO BE CONVERTED	°F	°C	TEMP. IN °C OR °F TO BE CONVERTED	°F
21,1	70	158.0	204,4	400	752.0	454,0	850	1562.0
22,2	72	161.6	210,0	410	770.0	460,0	860	1580.0
23,3	74	165.2	215,6	420	788.0	465,6	870	1598.0
24,4	76	168.8	221,1	430	806.0	471,1	880	1616.0
25,6	78	172.4	226,7	440	824.0	476,7	890	1634.0
26,7	80	176.0	232,2	450	842.0	482,2	900	1652.0
27,8	82	179.6	237,8	460	860.0	487,8	910	1670.0
28,9	84	183.2	243,3	470	878.0	493,3	920	1688.0
30,0	86	186.8	248,9	480	896.0	498,9	930	1706.0
31,1	88	190.4	254,4	490	914.0	504,4	940	1724.0
32,2	90	194.0	260,0	500	932.0	510,0	950	1742.0
33,3	92	197.6	265,6	510	950.0	515,6	960	1760.0
34,4	94	201.2	271,1	520	968.0	521,1	970	1778.0
35,6	96	204.8	276,7	530	986.0	526,7	980	1796.0
36,7	98	208.4	282,2	540	1004.0	532,2	990	1814.0
37,8	100	212.0	287,8	550	1022.0	537,8	1000	1832.0
43,3	110	230.0	293,3	560	1040.0	543,3	1010	1850.0
48,9	120	248.0	298,9	570	1058.0	548,9	1020	1868.0
54,4	130	266.0	304,4	580	1076.0	554,4	1030	1886.0
60,0	140	284.0	310,0	590	1094.0	560,0	1040	1904.0
65,6	150	302.0	315,6	600	1112.0	565,6	1050	1922.0
71,1	160	320.0	321,1	610	1130.0	571,1	1060	1940.0
76,7	170	338.0	326,7	620	1148.0	576,7	1070	1958.0
82,2	180	356.0	332,2	630	1166.0	582,2	1080	1976.0
87,8	190	374.0	337,8	640	1184.0	587,8	1090	1994.0
93,3	200	392.0	343,3	650	1202.0	593,3	1100	2012.0
98,9	210	410.0	348,9	660	1220.0	598,9	1110	2030.0
104,4	220	428.0	354,4	670	1238.0	604,4	1120	2048.0
110,0	230	446.0	360,0	680	1256.0	610,0	1130	2066.0
115,6	240	464.0	365,6	690	1274.0	615,6	1140	2084.0
121,1	250	482.0	371,1	700	1292.0	621,1	1150	2102.0
126,7	260	500.0	376,7	710	1310.0	626,7	1160	2120.0
132,2	270	518.0	382,2	720	1328.0	632,2	1170	2138.0
137,8	280	536.0	287,8	730	1346.0	637,8	1180	2156.0
143,3	290	665.0	393,3	740	1364.0	643,3	1190	2174.0

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Conversions, Equivalents, and Physical Data

Temperature Conversions (continued)											
°C	TEMP. IN °C OR °F TO BE CONVERTED	°F	°C	TEMP. IN °C OR °F TO BE CONVERTED	°F	°C	TEMP. IN °C OR °F TO BE CONVERTED	°F	°C	TEMP. IN °C OR °F TO BE CONVERTED	°F
148,9	300	572.0	315,6	600	1112.0	482,2	900	1652.0	648,9	1200	2192.0
154,4	310	590.0	321,1	610	1130.0	487,8	910	1670.0	654,4	1210	2210.0
160,0	320	608.0	326,7	620	1148.0	493,3	920	1688.0	660,0	1220	2228.0
165,6	330	626.0	332,2	630	1166.0	498,9	930	1706.0	665,6	1230	2246.0
171,1	340	644.0	337,8	640	1184.0	504,4	940	1724.0	671,1	1240	2264.0
176,7	350	662.0	343,3	650	1202.0	510,0	950	1742.0	676,7	1250	2282.0
182,2	360	680.0	348,9	660	1220.0	515,6	960	1760.0	682,2	1260	2300.0
187,8	370	698.0	354,4	670	1238.0	521,1	970	1778.0	687,8	1270	2318.0
189,9	380	716.0	360,0	680	1256.0	526,7	980	1796.0	693,3	1280	2336.0
193,3	390	734.0	365,6	690	1274.0	532,2	990	1814.0	698,9	1290	2354.0
204,4	400	752.0	371,1	700	1292.0	537,8	1000	1832.0	704,4	1300	2372.0
210,0	410	770.0	376,7	710	1310.0	543,3	1010	1850.0	710,0	1310	2390.0
215,6	420	788.0	382,2	720	1328.0	548,9	1020	1868.0	715,6	1320	2408.0
221,1	430	806.0	387,8	730	1346.0	554,4	1030	1886.0	721,1	1330	2426.0
226,7	440	824.0	393,3	740	1364.0	560,0	1040	1904.0	726,7	1340	2444.0
232,2	450	842.0	398,9	750	1382.0	565,6	1050	1922.0	732,2	1350	2462.0
237,8	460	860.0	404,4	760	1400.0	571,1	1060	1940.0	737,8	1360	2480.0
243,3	470	878.0	410,0	770	1418.0	576,7	1070	1958.0	743,3	1370	2498.0
248,9	480	896.0	415,6	780	1436.0	582,2	1080	1976.0	748,9	1380	2516.0
254,4	490	914.0	421,1	790	1454.0	587,8	1090	1994.0	754,4	1390	2534.0
260,0	500	932.0	426,7	800	1472.0	593,3	1100	2012.0	760,0	1400	2552.0
265,6	510	950.0	432,2	810	1490.0	598,9	1110	2030.0	765,6	1410	2570.0
271,1	520	968.0	437,8	820	1508.0	604,4	1120	2048.0	771,1	1420	2588.0
276,7	530	986.0	443,3	830	1526.0	610,0	1130	2066.0	776,7	1430	2606.0
282,2	540	1004.0	448,9	840	1544.0	615,6	1140	2084.0	782,2	1440	2624.0
287,8	550	1022.0	454,4	850	1562.0	621,1	1150	2102.0	787,8	1450	2642.0
293,3	560	1040.0	460,0	860	1580.0	626,7	1160	2120.0	793,3	1460	2660.0
298,9	570	1058.0	465,6	870	1598.0	632,2	1170	2138.0	798,9	1470	2678.0
304,4	580	1076.0	471,1	880	1616.0	637,8	1180	2156.0	804,4	1480	2696.0
310,0	590	1094.0	476,7	890	1634.0	643,3	1190	2174.0	810,0	1490	2714.0

Conversions, Equivalents, and Physical Data

A.P.I. and Baumé Gravity Tables and Weight Factors																			
A.P.I. Gravity	Baumé Gravity	Specific Gravity	Lbs/U.S. Gallons	U.S. Gallons-/Lb	A.P.I. Gravity	Baumé Gravity	Specific Gravity	Lbs/U.S. Gallons	U.S. Gallons-/Lb	A.P.I. Gravity	Baumé Gravity	Specific Gravity	Lbs/U.S. Gallons	U.S. Gallons-/Lb	A.P.I. Gravity	Baumé Gravity	Specific Gravity	Lbs/U.S. Gallons	U.S. Gallons-/Lb
0	10.247	1.0760	8.962	0.1116	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
1	9.223	1.0679	8.895	0.1124	31	30.78	0.9808	7.251	0.1379	61	60.46	0.7351	6.119	0.1634	81	80.25	0.6659	5.542	0.1804
2	8.198	1.0599	8.828	0.1133	32	31.77	0.8654	7.206	0.1388	62	61.45	0.7313	6.087	0.1643	82	81.24	0.6628	5.516	0.1813
3	7.173	1.0520	8.762	0.1141	33	32.76	0.8602	7.163	0.1396	63	62.44	0.7275	6.056	0.1651	83	82.23	0.6597	5.491	0.1821
4	6.148	1.0443	8.698	0.1150	34	33.75	0.8550	7.119	0.1405	64	63.43	0.7238	6.025	0.1660	84	83.22	0.6566	5.465	0.1830
5	5.124	1.0366	8.634	0.1158	35	34.73	0.8498	7.075	0.1413	65	64.42	0.7201	6.994	0.1668	85	84.20	0.6536	5.440	0.1838
6	4.099	1.0291	8.571	0.1167	36	35.72	0.8448	7.034	0.1422	66	65.41	0.7165	5.964	0.1677	86	85.19	0.6506	5.415	0.1847
7	3.074	1.0217	8.509	0.1175	37	36.71	0.8398	6.993	0.1430	67	66.40	0.7128	5.934	0.1685	87	86.18	0.6476	5.390	0.1855
8	2.049	1.0143	8.448	0.1184	38	37.70	0.8348	6.951	0.1439	68	67.39	0.7093	5.904	0.1694	88	87.17	0.6446	5.365	0.1864
9	1.025	1.0071	8.388	0.1192	39	38.69	0.8299	6.910	0.1447	69	68.37	0.7057	5.874	0.1702	89	88.16	0.6417	5.341	0.1872
10	10.00	1.0000	8.328	0.1201	40	39.68	0.8251	6.870	0.1456	70	69.36	0.7022	5.845	0.1711	90	89.15	0.6388	5.316	0.1881
11	10.99	0.9930	8.270	0.1209	41	40.67	0.8203	6.830	0.1464	71	70.35	0.6988	5.817	0.1719	91	90.14	0.6360	5.293	0.1889
12	11.98	0.9861	8.212	0.1218	42	41.66	0.8155	6.790	0.1473	72	71.34	0.6953	5.788	0.1728	92	91.13	0.6331	5.269	0.1898
13	12.97	0.9792	8.155	0.1226	43	42.65	0.8109	6.752	0.1481	73	72.33	0.6919	5.759	0.1736	93	92.12	0.6303	5.246	0.1906
14	13.96	0.9725	8.099	0.1235	44	43.64	0.8063	6.713	0.1490	74	73.32	0.6886	5.731	0.1745	94	93.11	0.6275	5.222	0.1915
15	14.95	0.9659	8.044	0.1243	45	44.63	0.8017	6.675	0.1498	75	74.31	0.6852	5.703	0.1753	95	94.10	0.6247	5.199	0.1924
16	15.94	0.9593	7.989	0.1252	46	45.62	0.7972	6.637	0.1507	76	75.30	0.6819	5.676	0.1762	96	95.09	0.6220	5.176	0.1932
17	16.93	0.9529	7.935	0.1260	47	50.61	0.7927	6.600	0.1515	77	76.29	0.6787	5.649	0.1770	97	96.08	0.6193	5.154	0.1940
18	17.92	0.9465	7.882	0.1269	48	50.60	0.7883	6.563	0.1524	78	77.28	0.6754	5.622	0.1779	98	97.07	0.6166	5.131	0.1949
19	18.90	0.9402	7.930	0.1277	49	50.59	0.7839	6.526	0.1532	79	78.27	0.6722	5.595	0.1787	99	98.06	0.6139	5.109	0.1957
20	19.89	0.9340	7.778	0.1286	50	50.58	0.7796	6.490	0.1541	80	79.26	0.6690	5.568	0.1796	100	99.05	0.6112	5.086	0.1966
21	20.88	0.9279	7.727	0.1294	51	50.57	0.7753	6.455	0.1549	The relation of degrees Baume or A.P.I. to Specific Gravity is expressed by these formulas:									
22	21.87	0.9218	7.676	0.1303	52	51.55	0.7711	6.420	0.1558	For liquids lighter than water:					For liquids heavier than water:				
23	22.86	0.9159	7.627	0.1311	53	52.54	0.7669	6.385	0.1566	Degrees Baume = $\frac{140}{G} - 130$ G = $\frac{140}{130 + \text{Degrees Baume}}$					Degrees Baume = $145 - \frac{145}{G}$ G = $\frac{145}{145 - \text{Degrees Baume}}$				
24	23.85	0.9100	7.578	0.1320	54	53.53	0.7628	6.350	0.1575	Degrees A.P.I. = $\frac{141}{G} - 131.5$ G = $\frac{141.5}{131.5 + \text{Degrees A.P.I.}}$									
25	24.84	0.9042	7.529	0.1328	55	54.52	0.7587	6.136	0.1583	G = Specific Gravity = ratio of weight of a given volume of oil at 60°F to the weight of the same volume of water at 60°F.									
26	25.83	0.8984	7.481	0.1337	56	55.51	0.7547	6.283	0.1592	The above tables are based on the weight of 1 gallon (U.S.) of oil with a volume of 231 cubic inches at 60°F in air at 760 mm pressure and 50% relative humidity. Assumed weight of 1 gallon of water at 60°F in air is 8.32828 pounds.									
27	26.82	0.8927	7.434	0.1345	57	56.50	0.7507	6.249	0.1600	To determine the resulting gravity by mixing oils of different gravities:									
28	27.81	0.8871	7.387	0.1354	58	57.49	0.7467	6.216	0.1609	$D = \frac{md_1 + nd_2}{m + n}$									
29	28.80	0.8816	7.341	0.1362	59	58.48	0.7428	6.184	0.1617	D = Density or Specific Gravity of mixture									
30	29.79	0.8762	7.296	0.1371	60	59.47	0.7389	6.151	0.1626	m = Proportion of oil of d ₁ density									
										n = Proportion of oil of d ₂ density									
										d ₁ = Specific gravity of m oil									
										d ₂ = Specific gravity of n oil									

Conversions, Equivalents, and Physical Data

Characteristics of the Elements											
ELEMENT	SYMBOL	ATOMIC NUMBER	MASS NUMBER ⁽¹⁾	MELTING POINT (°C)	BOILING POINT (°C)	ELEMENT	SYMBOL	ATOMIC NUMBER	MASS NUMBER ⁽¹⁾	MELTING POINT (°C)	BOILING POINT (°C)
Actinium	Ac	89	(227)	1600†		Neon	Ne	10	20	-248.67	-245.9
Aluminum	Al	13	27	659.7	2057	Neptunium	Np	93	(237)		
Americum	Am	95	(243)			Nickel	Ni	28	58	1455	2900
Antimony (Stibium)	Sb	51	121	630.5	1380	Niobium	Nb	41	93	2500±50	3700
Argon	Ar	18	40	-189.2	-185.7	Nitrogen	N	7	14	-209.86	-195.8
Arsenic	As	33	75	sublimes at 615	sublimes at 615	Nobelium	No	102	(253)		
Astatine	At	85	(210)			Osmium	Os	76	192	2700	>5300
Barium	Ba	56	138	850	1140	Oxygen	O	8	16	-218.4	-182.86
Berkelium	Bk	97	(247)			Palladium	Pd	46	106	1549.4	2000
Beryllium	Be	4	9	1278±5	2970	Phosphorus	P	15	31		
Bismuth	Bi	83	209	271.3	1560±5	Platinum	Pt	78	195	1773.5	4300
Boron	B	5	11	2300	2550	Plutonium	Pu	94	(242)		
Bromine	Br	35	79	-7.2	58.78	Polonium	Po	84	(209)		
Cadmium	Cd	48	114	320.9	767±2	Potassium	K	19	39	53.3	760
Calcium	Ca	20	40	842±8	1240	Praseodymium	Pr	59	141	940	
Californium	Cf	98	(249)			Promethium	Pm	61	(145)		
Carbon	C	6	12	>3550	4200	Protactinium	Pa	91	(231)		
Cerium	Ce	58	140	804	1400	Radium	Ra	88	(226)	700	
Cesium	Cs	55	133	28.5	670	Radon	Rn	86	(222)	-71	1140
Chlorine	Cl	17	35	-103±5	-34.6	Rhenium	Re	75	187	3167±60	-61.8
Chromium	Cr	24	52	1890	2480	Rhodium	Rh	45	103	1966±3	>2500
Cobalt	Co	27	59	1495	2900	Rubidium	Rb	37	85	38.5	700
Copper	Cu	29	63	1083	2336	Ruthenium	Ru	44	102	2450	2700
Curium	Cm	96	(248)			Samarium	Sm	62	152	>1300	
Dysprosium	Dy	66	164			Scandium	Sc	21	45	1200	2400
Einsteinium	Es	99	(254)			Selenium	Se	34	80	217	688
Erbium	Er	68	166			Silicon	Si	14	28	1420	2355
Europium	Eu	63	153	1150±50		Silver	Ag	47	107	960.8	1950
Fermium	Fm	100	(252)			Sodium	Na	11	23	97.5	880
Fluorine	F	9	19	-223	-188	Strontium	Sr	38	88	800	1150
Francium	Fr	87	(223)			Sulfur	S	16	32		
Gadolinium	Gd	64	158			Tantalum	Ta	73	180	2996±50	c.4100
Gallium	Ga	31	69	29.78	1983	Technetium	Tc	43	(99)		
Germanium	Ge	32	74	958.5	2700	Tellurium	Te	52	130	452	1390
Gold	Au	79	197	1063	2600	Terbium	Tb	65	159	327±5	
Hafnium	Hf	72	180	1700 ⁽²⁾	>3200	Thallium	Tl	81	205	302	1457±10
Helium	He	2	4	-272	-268.9	Thorium	Th	90	232	1845	4500
Holmium	Ho	67	165			Thulium	Tm	69	169		
Hydrogen	H	1	1	-259.14	-252.8	Tin	Sn	50	120	231.89	2270
Indium	In	49	115	156.4	2000±10	Titanium	Ti	22	48	1800	>3000
Iodine	I	53	127	113.7	184.35	Tungsten (Wolfram)	W	74	184	3370	5900
Iridium	Ir	77	193	2454	>4800	Uranium	U	92	238	c.1133	
Iron	Fe	26	56	1535	3000	Vanadium	V	23	51	1710	3000
Krypton	Kr	36	84	-156.6	-152.9	Xenon	Xe	54	132	-112	-107.1
Lanthanum	La	57	139	826		Ytterbium	Yb	70	174	1800	
Lawrencium	Lw	103	(257)			Yttrium	Y	39	89	1490	2500
Lead	Pb	82	208	327.43	1620	Zinc	Zn	30	64	419.47	907
Lithium	Li	3	7	186	1336±5	Zirconium	Zr	40	90	1857	>2900
Lutetium	Lu	71	175								
Magnesium	Mg	12	24	651	1107						
Manganese	Mn	25	55	1260	1900						
Mendelevium	Mv	101	(256)								
Mercury	Hg	80	202	-38.87	356.58						
Molybdenum	Mo	42	98	2620±10	4800						
Neodymium	Nd	60	142	840							

1. Mass number shown is that of stable isotope most common in nature. Mass numbers shown in parentheses designate the isotope with the longest half-life (slowest rate of radioactive decay) for those elements having an unstable isotope.
 2. Calculated
 > Greater than

Conversions, Equivalents, and Physical Data

Recommended Standard Specifications for Valve Materials Pressure-Containing Castings			
<p>1 Carbon Steel ASTM A216 Grade WCC</p> <p>Temperature Range = -20° to 800°F Composition (Percent)</p> <p>C 0.25 maximum Mn 1.20 maximum P 0.04 maximum S 0.04 maximum Si 0.60 maximum</p>	<p>2 Carbon Steel ASTM A216 Grade WCB</p> <p>Temperature Range = -20° to 1000°F Composition (Percent)</p> <p>C 0.30 maximum Mn 1.00 maximum P 0.05 maximum S 0.06 maximum Si 0.60 maximum</p>	<p>11 Type 304 Stainless Steel ASTM A351 Grade CF-8</p> <p>Temperature Range = -425° to 1500°F Composition (Percent)</p> <p>C 0.08 maximum Mn 1.50 maximum Si 2.00 maximum S 0.04 maximum P 0.04 maximum Cr 18.00 to 21.00 Ni 8.00 to 11.00</p>	<p>12 Type 316 Stainless Steel ASTM A351 Grade CF-8M</p> <p>Temperature Range = -425° to 1500°F Composition (Percent)</p> <p>C 0.08 maximum Mn 1.50 maximum Si 2.00 maximum P 0.04 maximum S 0.04 maximum Cr 18.00 to 21.00 Ni 9.00 to 12.00 Mo 2.00 to 3.00</p>
<p>3 Carbon Steel ASTM A352 Grade LCC</p> <p>Temperature Range = -50° to 650°F Composition: same as ASTM A216 Grade WCC</p>	<p>4 Carbon Steel ASTM A352 Grade LCB</p> <p>Temperature Range = -50° to 650°F Composition: same as ASTM A216 Grade WCB</p>	<p>13 Cast Iron ASTM A126 Class B</p> <p>Temperature Range = -150° to 450°F Composition (Percent)</p> <p>P 0.75 maximum S 0.12 maximum</p>	<p>14 Cast Iron ASTM A126 Class C</p> <p>Temperature Range = -150° to 450°F Composition (Percent)</p> <p>P 0.75 maximum S 0.12 maximum</p>
<p>5 Chrome Moly Steel ASTM A217 Grade C5</p> <p>Temperature Range = -20° to 1100°F Composition (Percent)</p> <p>C 0.20 maximum Mn 0.40 to 0.70 P 0.05 maximum S 0.06 maximum Si 0.75 maximum Cr 4.00 to 6.50 Mo 0.45 to 0.65</p>	<p>6 Carbon Moly Steel ASTM A217 Grade WC1</p> <p>Temperature Range = -20° to 850°F Composition (Percent)</p> <p>C 0.25 Mn 0.50 to 0.80 P 0.05 maximum S 0.06 maximum Si 0.60 maximum Mo 0.45 to 0.65</p>	<p>15 Ductile Iron ASTM A395 Type 60-45-15</p> <p>Temperature Range = -20° to 650°F Composition (Percent)</p> <p>C 3.00 minimum Si 2.75 maximum P 0.80 maximum</p>	<p>16 Ductile Ni-Resist* Iron ASTM A439 Type D-2B</p> <p>Temperature Range = -20° to 750°F Composition (Percent)</p> <p>C 3.00 maximum Si 1.50 to 3.00 Mn 0.70 to 1.25 P 0.08 maximum Ni 18.00 to 22.00 Cr 2.75 to 4.00</p>
<p>7 Chrome Moly Steel ASTM A217 Grade WC6</p> <p>Temperature Range = -20° to 1000°F Composition (Percent)</p> <p>C 0.20 maximum Mn 0.50 to 0.80 P 0.05 maximum S 0.06 maximum Si 0.60 maximum Cr 1.00 to 1.50 Mo 0.45 to 0.65</p>	<p>8 Chrome Moly Steel ASTM A217 Grade WC9</p> <p>Temperature Range = -20° to 1050°F Composition (Percent)</p> <p>C 0.18 maximum Mn 0.40 to 0.70 P 0.05 maximum Si 0.60 maximum Cr 2.00 to 2.75 Mo 0.90 to 1.20</p>	<p>17 Standard Valve Bronze ASTM B62</p> <p>Temperature Range = -325° to 450°F Composition (Percent)</p> <p>Cu 84.00 to 86.00 Sn 4.00 to 6.00 Pb 4.00 to 6.00 Zn 4.00 to 6.00 Ni 1.00 maximum Fe 0.30 maximum P 0.05 maximum</p>	<p>18 Tin Bronze ASTM B143 Alloy 1A</p> <p>Temperature Range = -325° to 400°F Composition (Percent)</p> <p>Cu 86.00 to 89.00 Sn 9.00 to 11.00 Pb 0.30 maximum Zn 1.00 to 3.00 Ni 1.00 maximum Fe 0.15 maximum P 0.05 maximum</p>
<p>9 3.5% Nickel Steel ASTM A352 Grade LC3</p> <p>Temperature Range = -150° to 650°F Composition (Percent)</p> <p>C 0.15 maximum Mn 0.50 to 0.80 P 0.05 maximum S 0.05 maximum Si 0.60 maximum Ni 3.00 to 4.00</p>	<p>10 Chrome Moly Steel ASTM A217 Grade C12</p> <p>Temperature Range = -20° to 1100°F Composition (Percent)</p> <p>C 0.20 maximum Si 1.00 maximum Mn 0.35 to 0.65 Cr 8.00 to 10.00 Mo 0.90 to 1.20 P 0.05 maximum S 0.06 maximum</p>	<p>19 Manganese Bronze ASTM B147 Alloy 8A</p> <p>Temperature Range = -325° to 350°F Composition (Percent)</p> <p>Cu 55.00 to 60.00 Sn 1.00 maximum Pb 0.40 maximum Ni 0.50 maximum Fe 0.40 to 2.00 Al 0.50 to 1.50 Mn 1.50 maximum Zn Remainder</p>	<p>20 Aluminum Bronze ASTM B148 Alloy 9C</p> <p>Temperature Range = -325° to 500°F Composition (Percent)</p> <p>Cu 83.00 minimum Al 10.00 to 11.50 Fe 3.00 to 5.00 Mn 0.50 Ni 2.50 maximum Minimum total named elements = 99.5</p>

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Conversions, Equivalents, and Physical Data

Recommended Standard Specifications for Valve Materials Pressure-Containing Castings (continued)			
<p>21 Mondel® Alloy 411 (Weldable Grade)</p> <p>Temperature Range = -325° to 900°F</p> <p>Composition (Percent)</p> <p>Ni 60.00 minimum Cu 26.00 to 33.00 C 0.30 maximum Mn 1.50 maximum Fe 3.50 maximum S 0.015 maximum Si 1.00 to 2.00 Nb 1.00 to 3.00</p>	<p>22 Nickel-Moly Alloy "B" ASTM A494 (Hastelloy® "B" †)</p> <p>Temperature Range = -325° to 700°F</p> <p>Composition (Percent)</p> <p>Cr 1.00 maximum Fe 4.00 to 6.00 C 0.12 maximum Si 1.00 maximum Co 2.50 maximum Mn 1.00 maximum V 0.20 to 0.60 Mo 26.00 to 30.00 P 0.04 maximum S 0.03 maximum Ni Remainder</p>	<p>31 Type 302 Stainless Steel ASTM A276 Type 302</p> <p>Composition (Percent)</p> <p>C 0.15 maximum Mn 2.00 maximum P 0.045 maximum S 0.030 maximum Si 1.00 maximum Cr 17.00 to 19.00 Ni 8.00 to 10.00</p>	<p>32 Type 304 Stainless Steel ASTM A276 Type 304</p> <p>Composition (Percent)</p> <p>C 0.08 maximum Mn 2.00 maximum P 0.045 maximum S 0.030 maximum Si 1.00 maximum Cr 18.00 to 20.00 Ni 8.00 to 12.00</p>
<p>23 Nickel-Moly-Chrome Alloy "C" ASTM A494 (Hastelloy® "C" †)</p> <p>Temperature Range = -325° to 1000°F</p> <p>Composition (Percent)</p> <p>Cr 15.50 to 17.50 Fe 4.50 to 7.50 W 3.75 to 5.25 C 0.12 maximum Si 1.00 maximum Co 2.50 maximum Mn 1.00 maximum V 0.20 to 0.40 Mo 16.00 to 18.00 P 0.04 S 0.03 Ni Remainder</p>	<p>24 Cobalt-based Alloy No.6 Stellite † No. 6</p> <p>Composition (Percent)</p> <p>C 0.90 to 1.40 Mn 1.00 W 3.00 to 6.00 Ni 3.00 Cr 26.00 to 32.00 Mo 1.00 Fe 3.00 Se 0.40 to 2.00 Co Remainder</p>	<p>33 Type 316 Stainless Steel ASTM A276 Type 316</p> <p>Composition (Percent)</p> <p>C 0.08 maximum Mn 2.00 maximum P 0.045 maximum S 0.030 maximum Si 1.00 maximum Cr 16.00 to 18.00 Ni 10.00 to 14.00 Mo 2.00 to 3.00</p>	<p>34 Type 316L Stainless Steel ASTM A276 Type 316L</p> <p>Composition (Percent)</p> <p>C 0.03 maximum Mn 2.00 maximum P 0.045 maximum S 0.030 maximum Si 1.00 maximum Cr 16.00 to 18.00 Ni 10.00 to 14.00 Mo 2.00 to 3.00</p>
<p>25 Aluminum Bar ASTM B211 Alloy 20911-T3</p> <p>Composition (Percent)</p> <p>Si 0.40 maximum Fe 0.70 maximum Cu 5.00 to 6.00 Zn 0.30 maximum Bi 0.20 to 0.60 Pb 0.20 to 0.60 Other Elements 0.15 maximum Al Remainder</p>	<p>26 Yellow Brass Bar ASTM B16 1/2 Hard</p> <p>Composition (Percent)</p> <p>Cu 60.00 to 63.00 Pb 2.50 to 3.70 Fe 0.35 maximum Zn Remainder</p>	<p>35 Type 410 Stainless Steel ASTM A276 Type 410</p> <p>Composition (Percent)</p> <p>C 0.15 maximum Mn 1.00 maximum P 0.040 maximum S 0.030 maximum Si 1.00 maximum Cr 11.50 to 13.50 Al 0.10 to 0.30</p>	<p>36 Type 17-4PH Stainless Steel ASTM A461 Grade 630</p> <p>Composition (Percent)</p> <p>C 0.07 maximum Mn 1.00 maximum Si 1.00 maximum P 0.04 maximum S 0.03 maximum Cr 15.50 to 17.50 Nb 0.05 to 0.45 Cu 3.00 to 5.00 Ni 3.00 to 5.00 Fe Remainder</p>
<p>27 Naval Brass Bar ASTM B21 Allow 464</p> <p>Composition (Percent)</p> <p>Cu 59.00 to 62.00 Sn 0.50 to 1.00 Pb 0.20 maximum Zn Remainder</p>	<p>28 Leaded Steel Bar AISI 12L14</p> <p>Composition (Percent)</p> <p>C 0.15 maximum Mn 0.80 to 1.20 P 0.04 to 0.09 S 0.25 to 0.35 Pb 0.15 to 0.35</p>	<p>37 Nickel-Copper Alloy Bar Alloy K500 (K Monel®*)</p> <p>Composition (Percent)</p> <p>Ni 63.00 to 70.00 Fe 2.00 maximum Mn 1.50 maximum Si 1.00 maximum C 0.25 maximum S 0.01 maximum Al 2.00 to 4.00 Ti 0.25 to 1.00 Cu Remainder</p>	<p>38 Nickel-Moly Alloy "B" Bar ASTM B335 (Hastelloy® "B" †)</p> <p>Composition (Percent)</p> <p>Cr 1.00 maximum Fe 4.00 to 6.00 C 0.04 maximum Si 1.00 maximum Co 2.50 maximum Mn 1.00 maximum V 0.20 to 0.40 Mo 26.00 to 30.00 P 0.025 maximum S 0.030 maximum Ni Remainder</p>
<p>29 Carbon Steel Bar ASTM A108 Grade 1018</p> <p>Composition (Percent)</p> <p>C 0.15 to 0.20 Mn 0.60 to 0.90 P 0.04 maximum S 0.05 maximum</p>	<p>30 AISI 4140 Chrome-Moly Steel (Suitable for ASTM A193 Grade B7 bolt material)</p> <p>Composition (Percent)</p> <p>C 0.38 to 0.43 Mn 0.75 to 1.00 P 0.035 maximum S 0.04 maximum Si 0.20 to 0.35 Cr 0.80 to 1.10 Mo 0.15 to 0.25 Fe Remainder</p>	<p>39 Nickel-Moly-Chrome Alloy "C" Bar ASTM B336 (Hastelloy® "C" †)</p> <p>Composition (Percent)</p> <p>Cr 14.50 to 16.50 Fe 4.00 to 7.00 W 3.00 to 4.50 C 0.08 maximum Si 1.00 maximum Co 2.50 maximum Mn 1.00 maximum Va 0.35 maximum Mo 15.00 to 17.00 P 0.04 S 0.03 Ni Remainder</p>	

Conversions, Equivalents, and Physical Data

Recommended Standard Specifications for Valve Materials Pressure-Containing Castings								
MATERIAL CODE AND DESCRIPTION			MINIMUM PHYSICAL PROPERTIES				MODULUS OF ELASTICITY AT 70°F (PSI x 10 ⁶)	APPROXIMATE BRINELL HARDNESS
			Tensile (Psi)	Yield Point (Psi)	Elong. in 2-inches (%)	Reduction of Area (%)		
1	Carbon Steel	ASTM A 216 Grade WCC	70,000	40,000	22	35	30.4	137 to 187
2	Carbon Steel	ASTM A 216 Grade WCB	70,000	36,000	22	35	27.9	137 to 187
3	Carbon Steel	ASTM A 352 Grade LCC	70,000	40,000	22	35	29.9	137 to 187
4	Carbon Steel	ASTM A 352 Grade LCB	65,000	35,000	24	35	27.9	137 to 187
5	Chrome Moly Steel	ASTM A217 Grade C5	90,000	60,000	18	35	27.4	241 Maximum
6	Carbon Moly Steel	ASTM A217 Grade WC1	65,000	35,000	24	35	29.9	215 Maximum
7	Chrome Moly Steel	ASTM A217 Grade WC6	70,000	40,000	20	35	29.9	215 Maximum
8	Chrome Moly Steel	ASTM A217 Grade WC9	70,000	40,000	20	35	29.9	241 Maximum
9	3.5% Nickel Steel	ASTM A352 Grade LC3	65,000	40,000	24	35	27.9	137
10	Chrome Moly Steel	ASTM A217 Grade C12	90,000	60,000	18	35	27.4	180 to 240
11	Type 304 Stainless Steel	ASTM A351 Grade CF8	65,000	28,000	35	----	28.0	140
12	Type 316 Stainless Steel	ASTM A351 Grade CF8M	70,000	30,000	30	----	28.3	156 to 170
13	Cast Iron	ASTM A126 Class B	31,000	----	----	----	----	160 to 220
14	Cast Iron	ASTM A126 Class C	41,000	----	----	----	----	160 to 220
15	Ductile Iron	ASTM A395 Type 60-45-15	60,000	45,000	15	----	23-26	143 to 207
16	Ductile Ni-Resist Iron ⁽¹⁾	ASTM A439 Type D-2B	58,000	30,000	7	----	----	148 to 211
17	Standard Valve Bronze	ASTM B62	30,000	14,000	20	17	13.5	55 to 65*
18	Tin Bronze	ASTM B143 Alloy 1A	40,000	18,000	20	20	15	75 to 85*
19	Manganese Bronze	ASTM B147 Alloy 8A	65,000	25,000	20	20	15.4	98*
20	Aluminum Bronze	ASTM B148 Alloy 9C	75,000	30,000	12 minimum	12	17	150
21	Mondel Alloy 411	(Weldable Grade)	65,000	32,500	25	----	23	120 to 170
22	Nickel-Moly Alloy "B"	ASTM A494 (Hastelloy® "B")	72,000	46,000	6	----	----	----
23	Nickel-Moly-Chrome Alloy "C"	ASTM A494 (Hastelloy® "C")	72,000	46,000	4	----	----	----
24	Cobalt-base Alloy No.6	Stellite No. 6	121,000	64,000	1 to 2	----	30.4	----
25	Aluminum Bar	ASTM B211 Alloy 20911-T3	44,000	36,000	15	----	10.2	95
26	Yellow Brass Bar	ASTM B16-1/2 Hard	45,000	15,000	7	50	14	----
27	Naval Brass Bar	ASTM B21 Alloy 464	60,000	27,000	22	55	----	----
28	Leaded Steel Bar	AISI 12L14	79,000	71,000	16	52	----	163
29	Carbon Steel Bar	ASTM A108 Grade 1018	69,000	48,000	38	62	----	143
30	AISI 4140 Chrome-Moly Steel	(Suitable for ASTM A193 Grade B7 bolt material)	135,000	115,000	22	63	29.9	255
31	Type 302 Stainless Steel	ASTM A276 Type 302	85,000	35,000	60	70	28	150
32	Type 304 Stainless Steel	ASTM A276 Type 304	85,000	35,000	60	70	----	149
33	Type 316 Stainless Steel	ASTM A276 Type 316	80,000	30,000	60	70	28	149
34	Type 316L Stainless Steel	ASTM A276 Type 316L	81,000	34,000	55	----	----	146
35	Type 410 Stainless Steel	ASTM A276 Type 410	75,000	40,000	35	70	29	155
36	Type 17-4PH Stainless Steel	ASTM A461 Grade 630	135,000	105,000	16	50	29	275 to 345
37	Nickel-Copper Alloy Bar	Alloy K500 (K Monel®)	100,000	70,000	35	----	26	175 to 260
38	Nickel-Moly Alloy "B" Bar	ASTM B335 (Hastelloy® "B")	100,000	46,000	30	----	----	----
39	Nickel-Moly Alloy "C" Bar	ASTM B336 (Hastelloy® "C")	100,000	46,000	20	----	----	----

1. 500 kg load.

Conversions, Equivalents, and Physical Data

Physical Constants of Hydrocarbons										
NO.	COMPOUND	FORMULA	MOLECULAR WEIGHT	BOILING POINT AT 14.696 PSIA (°F)	VAPOR PRESSURE AT 100°F (PSIA)	FREEZING POINT AT 14.696 PSIA (°F)	CRITICAL CONSTANTS		SPECIFIC GRAVITY AT 14.696 PSIA	
							Critical Temperature (°F)	Critical Pressure (psia)	Liquid ^{(3, 4), 60°F/60°F}	Gas at 60°F (Air = 1) ⁽¹⁾
1	Methane	CH ₄	16.043	-258.69	(5000) ⁽²⁾	-296.46 ⁽⁵⁾	-116.63	667.8	0.3000 ⁽⁸⁾	0.5539
2	Ethane	C ₂ H ₆	30.070	-127.48	(800) ⁽²⁾	-297.89 ⁽⁵⁾	90.09	707.8	0.3564 ⁽⁷⁾	1.0382
3	Propane	C ₃ H ₈	44.097	-43.67	190	-305.84 ⁽⁵⁾	206.01	616.3	0.5077 ⁽⁷⁾	1.5225
4	n-Butane	C ₄ H ₁₀	58.124	31.10	51.6	-217.05	305.65	550.7	0.5844 ⁽⁷⁾	2.0068
5	Isobutane	C ₄ H ₁₀	58.124	10.90	72.2	-255.29	274.98	529.1	0.5631 ⁽⁷⁾	2.0068
6	n-Pentane	C ₅ H ₁₂	72.151	96.92	15.570	-201.51	385.7	488.6	0.6310	2.4911
7	Isopentane	C ₅ H ₁₂	72.151	82.12	20.44	-255.83	369.10	490.4	0.6247	2.4911
8	Neopentane	C ₅ H ₁₂	72.151	49.10	35.9	2.17	321.13	464.0	0.5967 ⁽⁷⁾	2.4911
9	n-Hexane	C ₆ H ₁₄	86.178	155.72	4.956	-139.58	453.7	436.9	0.6640	2.9753
10	2-Methylpentane	C ₆ H ₁₄	86.178	140.47	6.767	-244.63	435.83	436.6	0.6579	2.9753
11	3-Methylpentane	C ₆ H ₁₄	86.178	145.89	6.098	- - - -	448.3	453.1	0.6689	2.9753
12	Neohexane	C ₆ H ₁₄	86.178	121.52	9.856	-147.72	420.13	446.8	0.6540	2.9753
13	2,3-Dimethylbutane	C ₆ H ₁₄	86.178	136.36	7.404	-199.38	440.29	453.5	0.6664	2.9753
14	n-Heptane	C ₇ H ₁₆	100.205	209.17	1.620	-131.05	512.8	396.8	0.6882	3.4596
15	2-Methylhexane	C ₇ H ₁₆	100.205	194.09	2.271	-180.89	495.00	396.5	0.6830	3.4596
16	3-Methylhexane	C ₇ H ₁₆	100.205	197.32	2.130	- - - -	503.78	408.1	0.6917	3.4596
17	3-Ethylpentane	C ₇ H ₁₆	100.205	200.25	2.012	-181.48	513.48	419.3	0.7028	3.4596
18	2,2-Dimethylpentane	C ₇ H ₁₆	100.205	174.54	3.492	-190.86	477.23	402.2	0.6782	3.4596
19	2,4-Dimethylpentane	C ₇ H ₁₆	100.205	176.89	3.292	-182.63	475.95	396.9	0.6773	3.4596
20	3,3-Dimethylpentane	C ₇ H ₁₆	100.205	186.91	2.773	-210.01	505.85	427.2	0.6976	3.4596
21	Triptane	C ₇ H ₁₆	100.205	177.58	3.374	-12.82	496.44	428.4	0.6946	3.4596
22	n-Octane	C ₈ H ₁₈	114.232	258.22	0.537	-70.18	564.22	360.6	0.7068	3.9439
23	Disobutyl	C ₈ H ₁₈	114.232	228.39	1.101	-132.07	530.44	360.6	0.6979	3.9439
24	Isooctane	C ₈ H ₁₈	114.232	210.63	1.708	-161.27	519.46	372.4	0.6962	3.9439
25	n-Nonane	C ₉ H ₂₀	128.259	303.47	0.179	-64.28	610.68	332	0.7217	4.4282
26	n-Decane	C ₁₀ H ₂₂	142.286	345.48	0.0597	-21.36	652.1	304	0.7342	4.9125
27	Cyclopentane	C ₅ H ₁₀	70.135	120.65	9.914	-136.91	461.5	653.8	0.7504	2.4215
28	Methylcyclopentane	C ₆ H ₁₂	84.162	161.25	4.503	-224.44	499.35	548.9	0.7536	2.9057
29	Cyclohexane	C ₆ H ₁₂	84.162	177.29	3.264	43.77	536.7	591	0.7834	2.9057
30	Methylcyclohexane	C ₇ H ₁₄	98.189	213.68	1.609	-195.98	570.27	503.5	0.7740	3.3900
31	Ethylene	C ₂ H ₄	28.054	-154.62	- - - -	-272.45 ⁽⁵⁾	48.58	729.8	- - - -	0.9686
32	Propene	C ₃ H ₆	42.081	-53.90	226.4	-301.45 ⁽⁵⁾	196.9	669	0.5220 ⁽⁷⁾	1.4529
33	1-Butene	C ₄ H ₈	56.108	20.75	63.05	-301.63 ⁽⁵⁾	295.6	583	0.6013 ⁽⁷⁾	1.9372
34	Cis-2-Butene	C ₄ H ₈	56.108	38.69	45.54	-218.06	324.37	610	0.6271 ⁽⁷⁾	1.9372
35	Trans-2-Butene	C ₄ H ₈	56.108	33.58	49.80	-157.96	311.86	595	0.6100 ⁽⁷⁾	1.9372
36	Isobutene	C ₄ H ₈	56.108	19.59	63.40	-220.61	292.55	580	0.6004 ⁽⁷⁾	1.9372
37	1-Pentene	C ₅ H ₁₀	70.135	85.93	19.115	-265.39	376.93	590	0.645 ⁽⁷⁾	2.4215
38	1,2-Butadiene	C ₄ H ₆	54.092	51.56	(20) ⁽²⁾	-213.16	(339) ⁽²⁾	(653) ⁽²⁾	0.658 ⁽⁷⁾	1.8676
39	1,3-Butadiene	C ₄ H ₆	54.092	24.06	(60) ⁽²⁾	-164.02	306	628	0.6272 ⁽⁷⁾	1.8676
40	Isoprene	C ₅ H ₈	68.119	93.30	16.672	-230.74	(412) ⁽²⁾	(558.4) ⁽²⁾	0.6861	2.3519
41	Acetylene	C ₂ H ₂	26.038	-119 ⁽⁶⁾	- - - -	-114 ⁽⁵⁾	95.31	890.4	0.615 ⁽⁹⁾	0.8990
42	Benzene	C ₆ H ₆	78.114	176.17	3.224	41.96	552.22	710.4	0.8844	2.6969
43	Toluene	C ₇ H ₈	92.141	231.13	1.032	-138.94	605.55	595.9	0.8718	3.1812
44	Ethylbenzene	C ₈ H ₁₀	106.168	277.16	0.371	-138.91	651.24	523.5	0.8718	3.6655
45	o-Xylene	C ₈ H ₁₀	106.168	291.97	0.264	-13.30	675.0	541.4	0.8848	3.6655
46	m-Xylene	C ₈ H ₁₀	106.168	282.41	0.326	-54.12	651.02	513.6	0.8687	3.6655
47	p-Xylene	C ₈ H ₁₀	106.168	281.05	0.342	55.86	649.6	509.2	0.8657	3.6655
48	Styrene	C ₈ H ₈	104.152	293.29	(0.24) ⁽²⁾	-23.10	706.0	580	0.9110	3.5959
49	Isopropylbenzene	C ₉ H ₁₂	120.195	306.34	0.188	-140.82	676.4	465.4	0.8663	4.1498

1. Calculated values.
2. () - Estimated values.
3. Air saturated hydrocarbons.
4. Absolute values from weights in vacuum.
5. At saturation pressure (- - - -).
6. Sublimation point.
7. Saturation pressure at 60°F.
8. Apparent value for methane at 60°F.
9. Specific gravity, 119°F/60°F (sublimation point).

Conversions, Equivalents, and Physical Data

Physical Constants of Various Fluids								
FLUID	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°F AT 14.696 PSIA)	VAPOR PRESSURE AT 70°F (PSIG)	CRITICAL TEMPERATURE (°F)	CRITICAL PRESSURE (PSIA)	SPECIFIC GRAVITY	
							Liquid 60°F/60°F	Gas
Acetic Acid	HC ₂ H ₃ O ₃	60.06	245	----	----	----	1.05	----
Acetone	C ₃ H ₆ O	58.08	133	----	455	691	0.79	2.01
Air	N ₂ O ₂	28.97	-317	----	-221	547	0.86 [†]	1.0
Alcohol, Ethyl	C ₂ H ₆ O	46.07	173	2.3 ⁽²⁾	470	925	0.794	1.59
Alcohol, Methyl	CH ₄ O	32.04	148	4.63 ⁽²⁾	463	1174	0.796	1.11
Ammonia	NH ₃	17.03	-28	114	270	1636	0.62	0.59
Ammonium Chloride ⁽¹⁾	NH ₄ Cl	----	----	----	----	----	1.07	----
Ammonium Hydroxide ⁽¹⁾	NH ₄ OH	----	----	----	----	----	0.91	----
Ammonium Sulfate ⁽¹⁾	(NH ₄) ₂ SO ₄	----	----	----	----	----	1.15	----
Aniline	C ₆ H ₇ N	93.12	365	----	798	770	1.02	----
Argon	A	39.94	-302	----	-188	705	1.65	1.38
Bromine	Br ₂	159.84	138	----	575	----	2.93	5.52
Calcium Chloride ⁽¹⁾	CaCl ₂	----	----	----	----	----	1.23	----
Carbon Dioxide	CO ₂	44.01	-109	839	88	1072	0.801 ⁽³⁾	1.52
Carbon Disulfide	CS ₂	76.1	115	----	----	----	1.29	2.63
Carbon Monoxide	CO	28.01	-314	----	-220	507	0.80	0.97
Carbon Tetrachloride	CCl ₄	153.84	170	----	542	661	1.59	5.31
Chlorine	Cl ₂	70.91	-30	85	291	1119	1.42	2.45
Chromic Acid	H ₂ CrO ₄	118.03	----	----	----	----	1.21	----
Citric Acid	C ₆ H ₈ O ₇	192.12	----	----	----	----	1.54	----
Copper Sulfate ⁽¹⁾	CuSO ₄	----	----	----	----	----	1.17	----
Ether	(C ₂ H ₅) ₂ O	74.12	34	----	----	----	0.74	2.55
Ferric Chloride ⁽¹⁾	FeCl ₃	----	----	----	----	----	1.23	----
Fluorine	F ₂	38.00	-305	300	-200	809	1.11	1.31
Formaldehyde	H ₂ CO	30.03	-6	----	----	----	0.82	1.08
Formic Acid	HCO ₂ H	46.03	214	----	----	----	1.23	----
Furfural	C ₅ H ₄ O ₂	96.08	324	----	----	----	1.16	----
Glycerine	C ₃ H ₈ O ₃	92.09	554	----	----	----	1.26	----
Glycol	C ₂ H ₆ O ₂	62.07	387	----	----	----	1.11	----
Helium	He	4.003	-454	----	-450	33	0.18	0.14
Hydrochloric Acid	HCl	36.47	-115	----	----	----	1.64	----
Hydrofluoric Acid	HF	20.01	66	0.9	446	----	0.92	----
Hydrogen	H ₂	2.016	-422	----	-400	188	0.07 ⁽³⁾	0.07
Hydrogen Chloride	HCl	36.47	-115	613	125	1198	0.86	1.26
Hydrogen Sulfide	H ₂ S	34.07	-76	252	213	1307	0.79	1.17
Isopropyl Alcohol	C ₃ H ₈ O	60.09	180	----	----	----	0.78	2.08
Linseed Oil	----	----	538	----	----	----	0.93	----

1. Aqueous Solution - 25% by weight of compound.
2. Vapor pressure in psia at 100°F.
3. Density of liquid, gm/ml at normal boiling point.

Conversions, Equivalents, and Physical Data

Physical Constants of Various Fluids (continued)								
FLUID	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°F AT 14.696 PSIA)	VAPOR PRESSURE AT 70°F (PSIG)	CRITICAL TEMPERATURE (°F)	CRITICAL PRESSURE (PSIA)	SPECIFIC GRAVITY	
							Liquid 60°F/60°F	Gas
Magnesium Chloride ⁽¹⁾	MgCl ₂	----	----	----	----	----	1.22	----
Mercury	Hg	200.61	670	----	----	----	13.6	6.93
Methyl Bromide	CH ₃ Br	94.95	38	13	376	----	1.73	3.27
Methyl Chloride	CH ₃ Cl	50.49	-11	59	290	969	0.99	1.74
Naphthalene	C ₁₀ H ₈	128.16	424	----	----	----	1.14	4.43
Nitric Acid	HNO ₃	63.02	187	----	----	----	1.5	----
Nitrogen	N ₂	28.02	-320	----	-233	493	0.81 ⁽³⁾	0.97
Oil, Vegetable	----	----	----	----	----	----	0.91 to 0.94	----
Oxygen	O ₂	32	-297	----	-181	737	1.14 ⁽³⁾	1.105
Phosgene	COCl ₂	98.92	47	10.7	360	823	1.39	3.42
Phosphoric Acid	H ₃ PO ₄	98.00	415	----	----	----	1.83	----
Potassium Carbonate ⁽¹⁾	K ₂ CO ₃	----	----	----	----	----	1.24	----
Potassium Chloride ⁽¹⁾	KCl	----	----	----	----	----	1.16	----
Potassium Hydroxide ⁽¹⁾	KOH	----	----	----	----	----	1.24	----
Refrigerant 11	CCl ₃ F	137.38	75	13.4	388	635	----	5.04
Refrigerant 12	CCl ₂ F ₂	120.93	-22	70.2	234	597	----	4.2
Refrigerant 13	CClF ₃	104.47	-115	458.7	84	561	----	----
Refrigerant 21	CHCl ₂ F	102.93	48	8.4	353	750	----	3.82
Refrigerant 22	CHClF ₂	86.48	-41	122.5	205	716	----	----
Refrigerant 23	CHF ₃	70.02	-119	635	91	691	----	----
Sodium Chloride ⁽¹⁾	NaCl	----	----	----	----	----	1.19	----
Sodium Hydroxide ⁽¹⁾	NaOH	----	----	----	----	----	1.27	----
Sodium Sulfate ⁽¹⁾	Na ₂ SO ₄	----	----	----	----	----	1.24	----
Sodium Thiosulfate ⁽¹⁾	Na ₂ SO ₃	----	----	----	----	----	1.23	----
Starch	(C ₆ H ₁₀ O ₅) _x	----	----	----	----	----	1.50	----
Sugar Solutions ⁽¹⁾	C ₁₂ H ₂₂ O ₁₁	----	----	----	----	----	1.10	----
Sulfuric Acid	H ₂ SO ₄	98.08	626	----	----	----	1.83	----
Sulfur Dioxide	SO ₂	64.6	14	34.4	316	1145	1.39	2.21
Turpentine	----	----	320	----	----	----	0.87	----
Water	H ₂ O	18.016	212	0.9492 ⁽²⁾	706	3208	1.00	0.62
Zinc Chloride ⁽¹⁾	ZnCl ₂	----	----	----	----	----	1.24	----
Zinc Sulfate ⁽¹⁾	ZnSO ₄	----	----	----	----	----	1.31	----

1. Aqueous Solution - 25% by weight of compound.
 2. Vapor pressure in psia at 100°F.
 3. Density of liquid, gm/ml at normal boiling point.

Conversions, Equivalents, and Physical Data

Properties of Water				
TEMPERATURE OF WATER (°F)	SATURATION PRESSURE (POUNDS PER SQUARE INCH ABSOLUTE)	WEIGHT (POUNDS PER GALLON)	SPECIFIC GRAVITY 60°F/60°F	CONVERSION FACTOR ⁽¹⁾ , LBS/HR TO GPM
32	0.0885	8.345	1.0013	0.00199
40	0.1217	8.345	1.0013	0.00199
50	0.1781	8.340	1.0007	0.00199
60	0.2653	8.334	1.0000	0.00199
70	0.3631	8.325	0.9989	0.00200
80	0.5069	8.314	0.9976	0.00200
90	0.6982	8.303	0.9963	0.00200
100	0.9492	8.289	0.9946	0.00201
110	1.2748	8.267	0.9919	0.00201
120	1.6924	8.253	0.9901	0.00200
130	2.2225	8.227	0.9872	0.00202
140	2.8886	8.207	0.9848	0.00203
150	3.718	8.182	0.9818	0.00203
160	4.741	8.156	0.9786	0.00204
170	5.992	8.127	0.9752	0.00205
180	7.510	8.098	0.9717	0.00205
190	9.339	8.068	0.9681	0.00206
200	11.526	8.039	0.9646	0.00207
210	14.123	8.005	0.9605	0.00208
212	14.696	7.996	0.9594	0.00208
220	17.186	7.972	0.9566	0.00209
240	24.969	7.901	0.9480	0.00210
260	35.429	7.822	0.9386	0.00211
280	49.203	7.746	0.9294	0.00215
300	67.013	7.662	0.9194	0.00217
350	134.63	7.432	0.8918	0.00224
400	247.31	7.172	0.8606	0.00232
450	422.6	6.892	0.8270	0.00241
500	680.8	6.553	0.7863	0.00254
550	1045.2	6.132	0.7358	0.00271
600	1542.9	5.664	0.6796	0.00294
700	3093.7	3.623	0.4347	0.00460

1. Multiply flow in pounds per hour by the factor to get equivalent flow in gallons per minute. Weight per gallon is based on 7.48 gallons per cubic foot.

Properties of Saturated Steam							
ABSOLUTE PRESSURE		VACUUM (INCHES OF HG)	TEMP. (°F)	HEAT OF THE LIQUID (BTU/LB.)	LATENT HEAT OF EVAPORATION (BTU/LB.)	TOTAL HEAT OF STEAM HG (BTU/LB.)	SPECIFIC VOLUME (CUBIC FT./LB.)
PSIA	Inches of Hg						
0.20	0.41	29.51	53.14	21.21	1063.8	1085.0	1526.0
0.25	0.51	29.41	59.30	27.36	1060.3	1087.7	1235.3
0.30	0.61	29.31	64.47	32.52	1057.4	1090.0	1039.5
0.35	0.71	29.21	68.93	36.97	1054.9	1091.9	898.5
0.40	0.81	29.11	72.86	40.89	1052.7	1093.6	791.9
0.45	0.92	29.00	76.38	44.41	1050.7	1095.1	708.5
0.50	1.02	28.90	79.58	47.60	1048.8	1096.4	641.4
0.60	1.22	28.70	85.21	53.21	1045.7	1098.9	540.0
0.70	1.43	28.49	90.08	58.07	1042.9	1101.0	466.9
0.80	1.63	28.29	94.38	62.36	1040.4	1102.8	411.7
0.90	1.83	28.09	98.24	66.21	1038.3	1104.5	368.4
1.0	2.04	27.88	101.74	69.70	1036.3	1106.0	333.6
1.2	2.44	27.48	107.92	75.87	1032.7	1108.6	280.9
1.4	2.85	27.07	113.26	81.20	1029.6	1110.8	243.0
1.6	3.26	26.66	117.99	85.91	1026.9	1112.8	214.3
1.8	3.66	26.26	122.23	90.14	1024.5	1114.6	191.8
2.0	4.07	25.85	126.08	93.99	1022.2	1116.2	173.73
2.2	4.48	25.44	129.62	97.52	1020.2	1117.7	158.85
2.4	4.89	25.03	132.89	100.79	1018.3	1119.1	146.38
2.6	5.29	24.63	135.94	103.83	1016.5	1120.3	135.78
2.8	5.70	24.22	138.79	106.68	1014.8	1121.5	126.65
3.0	6.11	23.81	141.48	109.37	1013.2	1122.6	67.24
3.5	7.13	22.79	147.57	115.46	1009.6	1125.1	61.98
4.0	8.14	21.78	152.97	120.86	1006.4	1127.3	57.50
4.5	9.16	20.76	157.83	125.71	1003.6	1129.3	53.64
5.0	10.18	19.74	162.24	130.13	1001.0	1131.1	50.29
5.5	11.20	18.72	166.30	134.19	998.5	1132.7	67.24
6.0	12.22	17.70	170.06	137.96	996.2	1134.2	61.98
6.5	13.23	16.69	173.56	141.47	994.1	1135.6	57.50
7.0	14.25	15.67	176.85	144.76	992.1	1136.9	53.64
7.5	15.27	14.65	179.94	147.86	990.2	1138.1	50.29
8.0	16.29	13.63	182.86	150.79	988.5	1139.3	47.34
8.5	17.31	12.61	185.64	153.57	986.8	1140.4	44.73
9.0	18.32	11.60	188.28	156.22	985.2	1141.4	42.40
9.5	19.34	10.58	190.80	158.75	983.6	1142.3	40.31
10.0	20.36	9.56	193.21	161.17	982.1	1143.3	38.42
11.0	22.40	7.52	197.75	165.73	979.3	1145.0	35.14
12.0	24.43	5.49	201.96	169.96	976.6	1146.6	32.40
13.0	26.47	3.45	205.88	173.91	974.2	1148.1	30.06
14.0	28.50	1.42	209.56	177.61	971.9	1149.5	28.04

- continued -

Conversions, Equivalents, and Physical Data

Properties of Saturated Steam (continued)													
PRESSURE (PSI)		TEMP. (°F)	HEAT OF THE LIQUID (BTU/LB)	LATENT HEAT OF EVAPORATION (BTU/LB)	TOTAL HEAT OF STEAM H _g (BTU/LB)	SPECIFIC VOLUME ∇ (FT ³ /LB)	PRESSURE (PSI)		TEMP. (°F)	HEAT OF THE LIQUID (BTU/LB)	LATENT HEAT OF EVAPORATION (BTU/LB)	TOTAL HEAT OF STEAM H _g (BTU/LB)	SPECIFIC VOLUME ∇ (FT ³ /LB)
Absolute P'	Gauge P						Absolute P'	Gauge P					
14.696	0.0	212.00	180.07	970.3	1150.4	26.80	----	----	----	----	----	----	----
15.0	0.3	213.03	181.11	969.7	1150.8	26.29	75.0	60.3	307.60	277.43	904.5	1181.9	5.816
16.0	1.3	216.32	184.42	967.6	1152.0	24.72	76.0	61.3	308.50	278.37	903.7	1182.1	5.743
17.0	2.3	219.44	187.56	965.5	1153.1	23.39	77.0	62.3	309.40	279.30	903.1	1182.4	5.673
18.0	3.3	222.41	190.56	963.6	1154.2	22.17	78.0	63.3	310.29	280.21	902.4	1182.6	5.604
19.0	4.3	225.24	193.42	961.9	1155.3	21.08	79.0	64.3	311.16	281.12	901.7	1182.8	5.537
20.0	5.3	227.96	196.16	960.1	1156.3	20.089	80.0	65.3	312.03	282.02	901.1	1183.1	5.472
21.0	6.3	230.57	198.79	958.4	1157.2	19.192	81.0	66.3	312.89	282.91	900.4	1183.3	5.408
22.0	7.3	233.07	201.33	956.8	1158.1	18.375	82.0	67.3	313.74	283.79	899.7	1183.5	5.346
23.0	8.3	235.49	203.78	955.2	1159.0	17.627	83.0	68.3	314.59	284.66	899.1	1183.8	5.285
24.0	9.3	237.82	206.14	953.7	1159.8	16.938	84.0	69.3	315.42	285.53	898.5	1184.0	5.226
25.0	10.3	240.07	208.42	952.1	1160.6	16.303	85.0	70.3	316.25	286.39	897.8	1184.2	5.168
26.0	11.3	242.25	210.62	950.7	1161.3	15.715	86.0	71.3	317.07	287.24	897.2	1184.4	5.111
27.0	12.3	244.36	212.75	949.3	1162.0	15.170	87.0	72.3	317.88	288.08	896.5	1184.6	5.055
28.0	13.3	246.41	214.83	947.9	1162.7	14.663	88.0	73.3	318.68	288.91	895.9	1184.8	5.001
29.0	14.3	248.40	216.86	946.5	1163.4	14.189	89.0	74.3	319.48	289.74	895.3	1185.1	4.948
30.0	15.3	250.33	218.82	945.3	1164.1	13.746	90.0	75.3	320.27	290.56	894.7	1185.3	4.896
31.0	16.3	252.22	220.73	944.0	1164.7	13.330	91.0	76.3	321.06	291.38	894.1	1185.5	4.845
32.0	17.3	254.05	222.59	942.8	1165.4	12.940	92.0	77.3	321.83	292.18	893.5	1185.7	4.796
33.0	18.3	255.84	224.41	941.6	1166.0	12.572	93.0	78.3	322.60	292.98	892.9	1185.9	4.747
34.0	19.3	257.58	226.18	940.3	1166.5	12.226	94.0	79.3	323.36	293.78	892.3	1186.1	4.699
35.0	20.3	259.28	227.91	939.2	1167.1	11.898	95.0	80.3	324.12	294.56	891.7	1186.2	4.652
36.0	21.3	260.95	229.60	938.0	1167.6	11.588	96.0	81.3	324.87	295.34	891.1	1186.4	4.606
37.0	22.3	262.57	231.26	936.9	1168.2	11.294	97.0	82.3	325.61	296.12	890.5	1186.6	4.561
38.0	23.3	264.16	232.89	935.8	1168.7	11.015	98.0	83.3	326.35	296.89	889.9	1186.8	4.517
39.0	24.3	265.72	234.48	934.7	1169.2	10.750	99.0	84.3	327.08	297.65	889.4	1187.0	4.474
40.0	25.3	267.25	236.03	933.7	1169.7	10.498	100.0	85.3	327.81	298.40	888.8	1187.2	4.432
41.0	26.3	268.74	237.55	932.6	1170.2	10.258	101.0	86.3	328.53	299.15	888.2	1187.4	4.391
42.0	27.3	270.21	239.04	931.6	1170.7	10.029	102.0	87.3	329.25	299.90	887.6	1187.5	4.350
43.0	28.3	271.64	240.51	930.6	1171.1	9.810	103.0	88.3	329.96	300.64	887.1	1187.7	4.310
44.0	29.3	273.05	241.95	929.6	1171.6	9.601	104.0	89.3	330.66	301.37	886.5	1187.9	4.271
45.0	30.3	274.44	243.36	928.6	1172.0	9.401	105.0	90.3	331.36	302.10	886.0	1188.1	4.232
46.0	31.3	275.80	244.75	927.7	1172.4	9.209	106.0	91.3	332.05	302.82	885.4	1188.2	4.194
47.0	32.3	277.13	246.12	926.7	1172.9	9.025	107.0	92.3	332.74	303.54	884.9	1188.4	4.157
48.0	33.3	278.45	247.47	925.8	1173.3	8.848	108.0	93.3	333.42	304.26	884.3	1188.6	4.120
49.0	34.3	279.74	248.79	924.9	1173.7	8.678	109.0	94.3	334.10	304.97	883.7	1188.7	4.084
50.0	35.3	281.01	250.09	924.0	1174.1	8.515	110.0	95.3	334.77	305.66	883.2	1188.9	4.049
51.0	36.3	282.26	251.37	923.0	1174.4	8.359	111.0	96.3	335.44	306.37	882.6	1189.0	4.015
52.0	37.3	283.49	252.63	922.2	1174.8	8.208	112.0	97.3	336.11	307.06	882.1	1189.2	3.981
53.0	38.3	284.70	253.87	921.3	1175.2	8.062	113.0	98.3	336.77	307.75	881.6	1189.4	3.947
54.0	39.3	285.90	255.09	920.5	1175.6	7.922	114.0	99.3	337.42	308.43	881.1	1189.5	3.914
55.0	40.3	287.07	256.30	919.6	1175.9	7.787	115.0	100.3	338.07	309.11	880.6	1189.7	3.882
56.0	41.3	288.28	257.50	918.8	1176.3	7.656	116.0	101.3	338.72	309.79	880.0	1189.8	3.850
57.0	42.3	289.37	258.67	917.9	1176.6	7.529	117.0	102.3	339.36	310.46	879.5	1190.0	3.819
58.0	43.3	290.50	259.82	917.1	1176.9	7.407	118.0	103.3	339.99	311.12	879.0	1190.1	3.788
59.0	44.3	291.61	260.96	916.3	1177.3	7.289	119.0	104.3	340.62	311.78	878.4	1190.2	3.758
60.0	45.3	292.71	262.09	915.5	1177.6	7.175	120.0	105.3	341.25	312.44	877.9	1190.4	3.728
61.0	46.3	293.79	263.20	914.7	1177.9	7.064	121.0	106.3	341.88	313.10	877.4	1190.5	3.699
62.0	47.3	294.85	264.30	913.9	1178.2	6.957	122.0	107.3	342.50	313.75	876.9	1190.7	3.670
63.0	48.3	295.90	265.38	913.1	1178.5	6.853	123.0	108.3	343.11	314.40	876.4	1190.8	3.642
64.0	49.3	296.94	266.45	912.3	1178.8	6.752	124.0	109.3	343.72	315.04	875.9	1190.9	3.614
65.0	50.3	297.97	267.50	911.6	1179.1	6.655	125.0	110.3	344.33	315.68	875.4	1191.1	3.587
66.0	51.3	298.99	268.55	910.8	1179.4	6.560	126.0	111.3	344.94	316.31	874.9	1191.2	3.560
67.0	52.3	299.99	269.58	910.1	1179.7	6.468	127.0	112.3	345.54	316.94	874.4	1191.3	3.533
68.0	53.3	300.98	270.60	909.4	1180.0	6.378	128.0	113.3	346.13	317.57	873.9	1191.5	3.507
69.0	54.3	301.96	271.61	908.7	1180.3	6.291	129.0	114.3	346.73	318.19	873.4	1191.6	3.481
70.0	55.3	302.92	272.61	907.9	1180.6	6.206	130.0	115.3	347.32	318.81	872.9	1191.7	3.455
71.0	56.3	303.88	273.60	907.2	1180.8	6.124	131.0	116.3	347.90	319.43	872.5	1191.9	3.430
72.0	57.3	304.83	274.57	906.5	1181.1	6.044	132.0	117.3	348.48	320.04	872.0	1192.0	3.405
73.0	58.3	305.76	275.54	905.8	1181.3	5.966	133.0	118.3	349.06	320.65	871.5	1192.1	3.381
74.0	59.3	306.68	276.49	905.1	1181.6	5.890	134.0	119.3	349.64	321.25	871.0	1192.2	3.357

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Conversions, Equivalents, and Physical Data

Properties of Saturated Steam (continued)													
PRESSURE (PSI)		TEMP. (°F)	HEAT OF THE LIQUID (BTU/LB)	LATENT HEAT OF EVAPORATION (BTU/LB)	TOTAL HEAT OF STEAM H _g (BTU/LB)	SPECIFIC VOLUME ∇ (FT ³ /LB)	PRESSURE (PSI)		TEMP. (°F)	HEAT OF THE LIQUID (BTU/LB)	LATENT HEAT OF EVAPORATION (BTU/LB)	TOTAL HEAT OF STEAM H _g (BTU/LB)	SPECIFIC VOLUME ∇ (CU. FT./LB.)
Absolute P'	Gauge P						Absolute P'	Gauge P					
135.0	120.3	350.21	321.85	870.6	1192.4	3.333	400.0	385.3	444.59	424.0	780.5	1204.5	1.1613
136.0	121.3	350.78	322.45	870.1	1192.5	3.310	420.0	405.3	449.39	429.4	775.2	1204.6	1.1061
137.0	122.3	351.35	323.05	869.6	1192.6	3.287	440.0	425.3	454.02	434.6	770.0	1204.6	1.0556
138.0	123.3	351.91	323.64	869.1	1192.7	3.264	460.0	445.3	458.50	439.7	764.9	1204.6	1.0094
139.0	124.3	352.47	324.23	868.7	1192.9	3.242	480.0	465.3	462.82	444.6	759.9	1204.5	0.9670
140.0	125.3	353.02	324.82	868.2	1193.0	3.220	500.0	485.3	467.01	449.4	755.0	1204.4	0.9278
141.0	126.3	353.57	325.40	867.7	1193.1	3.198	520.0	505.3	471.07	454.1	750.1	1204.2	0.7815
142.0	127.3	354.12	325.98	867.2	1193.2	3.177	540.0	525.3	475.01	458.6	745.4	1204.0	0.8578
143.0	128.3	354.67	326.56	866.7	1193.3	3.155	560.0	545.3	478.85	463.0	740.8	1203.8	0.8265
144.0	129.3	355.21	327.13	866.3	1193.4	3.134	580.0	565.3	482.58	467.4	736.1	1203.5	0.7973
145.0	130.3	355.76	327.70	865.8	1193.5	3.114	600.0	585.3	486.21	471.6	731.6	1203.2	0.7698
146.0	131.3	356.29	328.27	865.3	1193.6	3.094	620.0	605.3	489.75	475.7	727.2	1202.9	0.7440
147.0	132.3	356.83	328.83	864.9	1193.8	3.074	640.0	625.3	493.21	479.8	722.7	1202.5	0.7198
148.0	133.3	357.36	329.39	864.5	1193.9	3.054	660.0	645.3	496.58	483.8	718.3	1202.1	0.6971
149.0	134.3	357.89	329.95	864.0	1194.0	3.034	680.0	665.3	499.88	487.7	714.0	1201.7	0.6757
150.0	135.3	358.42	330.51	863.6	1194.1	3.015	700.0	685.3	503.10	491.5	709.7	1201.2	0.6554
152.0	137.3	359.46	331.61	862.7	1194.3	2.977	720.0	705.3	506.25	495.3	705.4	1200.7	0.6362
154.0	139.3	360.49	332.70	861.8	1194.5	2.940	740.0	725.3	509.34	499.0	701.2	1200.2	0.6180
156.0	141.3	361.52	333.79	860.9	1194.7	2.904	760.0	745.3	512.36	502.6	697.1	1199.7	0.6007
158.0	143.3	362.53	334.86	860.0	1194.9	2.869	780.0	765.3	505.33	506.2	692.9	1199.1	0.5843
160.0	145.3	363.53	335.93	859.2	1195.1	2.834	800.0	785.3	518.23	509.7	688.9	1198.6	0.5687
162.0	147.3	364.53	336.98	858.3	1195.3	2.801	820.0	805.3	521.08	513.2	684.8	1198.0	0.5538
164.0	149.3	365.51	338.02	857.5	1195.5	2.768	840.0	825.3	523.88	516.6	680.8	1197.4	0.5396
166.0	151.3	366.48	339.05	856.6	1195.7	2.736	860.0	845.3	526.63	520.0	676.8	1196.8	0.5260
168.0	153.3	367.45	340.07	855.7	1195.8	2.705	880.0	865.3	529.33	523.3	672.8	1196.1	0.5130
170.0	155.3	368.41	341.09	854.9	1196.0	2.675	900.0	885.3	531.98	526.6	668.8	1195.4	0.5006
172.0	157.3	369.35	342.10	854.1	1196.2	2.645	920.0	905.3	534.59	529.8	664.9	1194.7	0.4886
174.0	159.3	370.29	343.10	853.3	1196.4	2.616	940.0	925.3	537.16	533.0	661.0	1194.0	0.4772
176.0	161.3	371.22	344.09	852.4	1196.5	2.587	960.0	945.3	539.68	536.2	657.1	1193.3	0.4663
178.0	163.3	372.14	345.06	851.6	1196.7	2.559	980.0	965.3	542.17	539.3	653.3	1192.6	0.4557
180.0	165.3	373.06	346.03	850.8	1196.9	2.532	1000.0	985.3	544.61	542.4	649.4	1191.8	0.4456
182.0	167.3	373.96	347.00	850.0	1197.0	2.505	1050.0	1035.3	550.57	550.0	639.9	1189.9	0.4218
184.0	169.3	374.86	347.96	849.2	1197.2	2.479	1100.0	1085.3	556.31	557.4	630.4	1187.8	0.4001
186.0	171.3	375.75	348.92	848.4	1197.3	2.454	1150.0	1135.3	561.86	565.6	621.0	1185.6	0.3802
188.0	173.3	376.64	349.86	847.6	1197.5	2.429	1200.0	1185.3	567.22	571.7	611.7	1183.4	0.619
190.0	175.3	377.51	350.79	846.8	1197.6	2.404	1250.0	1235.3	572.42	578.6	602.4	1181.0	0.3450
192.0	177.3	378.38	351.72	846.1	1197.8	2.380	1300.0	1285.3	577.46	585.4	593.2	1178.6	0.3293
194.0	179.3	379.24	352.64	845.3	1197.9	2.356	1350.0	1335.3	582.35	592.1	584.0	1176.1	0.3148
196.0	181.3	380.10	353.55	844.5	1198.1	2.333	1400.0	1385.3	587.10	598.7	574.7	1173.4	0.3012
198.0	183.3	380.95	354.46	843.7	1198.2	2.310	1450.0	1435.3	591.73	605.2	565.5	1170.7	0.2884
200.0	185.3	381.79	355.36	843.0	1198.4	2.288	1500.0	1485.3	596.23	611.6	556.3	1167.9	0.2765
205.0	190.3	383.86	357.58	841.0	1198.7	2.234	1600.0	1585.3	604.90	624.1	538.0	1162.1	0.2548
210.0	195.3	385.90	359.77	839.2	1199.0	2.183	1700.0	1685.3	613.15	636.3	519.6	1155.9	0.2354
215.0	200.3	387.89	361.91	837.4	1199.3	2.134	1800.0	1785.3	621.03	648.3	501.1	1149.4	0.2179
220.0	205.3	389.86	364.02	835.6	1199.6	2.087	1900.0	1885.3	628.58	660.1	482.4	1142.4	0.2021
225.0	210.3	391.79	366.09	833.8	1199.9	2.0422	2000.0	1985.3	635.82	671.7	463.4	1135.1	0.1878
230.0	215.3	393.68	368.13	832.0	1200.1	1.9992	2100.0	2085.3	642.77	683.3	444.1	1127.4	0.1746
235.0	220.3	395.54	370.14	830.3	1200.4	1.9579	2200.0	2185.3	649.46	694.8	424.4	1119.2	0.1625
240.0	225.3	397.37	372.12	828.5	1200.6	1.9183	2300.0	2285.3	655.91	706.5	403.9	1110.4	0.1513
245.0	230.3	399.18	374.08	826.8	1200.9	1.8803	2400.0	2385.3	662.12	718.4	382.7	1101.1	0.1407
250.0	235.3	400.95	376.00	825.1	1201.1	1.8438	2500.0	2485.3	668.13	730.6	360.5	1091.1	0.1307
255.0	240.3	402.70	377.89	823.4	1201.3	1.8086	2600.0	2585.3	673.94	743.0	337.2	1080.2	0.1213
260.0	245.3	404.42	379.76	821.8	1201.5	1.7748	2700.0	2685.3	679.55	756.2	312.1	1068.3	0.1123
265.0	250.3	406.11	381.60	820.1	1201.7	1.7422	2800.0	2785.3	684.99	770.1	284.7	1054.8	0.1035
270.0	255.3	407.78	383.42	818.5	1201.9	1.7107	2900.0	2885.3	690.26	785.4	253.6	1039.0	0.0947
275.0	260.3	409.43	385.21	816.9	1202.1	1.6804	3000.0	2985.3	695.36	802.5	217.8	1020.3	0.0858
280.0	265.3	411.05	386.98	815.3	1202.3	1.6511	3100.0	3085.3	700.31	825.0	168.1	993.1	0.0753
285.0	270.3	412.65	388.73	813.7	1202.4	1.6228	3200.0	3185.3	705.11	872.4	62.0	934.4	0.0580
290.0	275.3	414.23	390.46	812.1	1202.6	1.5954	3206.2	3191.5	705.40	902.7	0.0	902.7	0.0503
295.0	280.3	415.79	392.16	810.5	1202.7	1.5689	----	----	----	----	----	----	----
300.0	285.3	417.33	393.84	809.0	1202.8	1.5433	----	----	----	----	----	----	----
320.0	305.3	423.29	400.39	803.0	1203.4	1.4485	----	----	----	----	----	----	----
340.0	325.3	428.97	406.66	797.1	1203.7	1.3645	----	----	----	----	----	----	----
360.0	345.3	434.40	412.67	797.4	1204.1	1.2895	----	----	----	----	----	----	----
380.0	365.3	439.60	418.45	785.8	1204.3	1.2222	----	----	----	----	----	----	----

Conversions, Equivalents, and Physical Data

Properties of Saturated Steam (Metric)							
TEMPERATURE, °K	PRESSURE, BAR	VOLUME, m/kg		ENTHALPY, kJ/kg		ENTROPY, kJ/(kg x °K)	
		Condensed	Vapor	Condensed	Vapor	Condensed	Vapor
150	6.30 to 11	1.073 to 3	9.55 + 9	- 539.6	2273	- 2.187	16.54
160	7.72 to 10	1.074 to 3	9.62 + 8	- 525.7	2291	- 2.106	15.49
170	7.29 to 9	1.076 to 3	1.08 + 8	- 511.7	2310	- 2.026	14.57
180	5.38 to 8	1.077 to 3	1.55 + 7	- 497.8	2328	- 1.947	13.76
190	3.23 to 7	1.078 to 3	2.72 + 6	- 483.8	2347	- 1.868	16.03
200	1.62 to 6	1.079 to 3	5.69 + 5	- 467.5	2366	- 1.789	12.38
210	7.01 to 6	1.081 to 3	1.39 + 5	- 451.2	2384	- 1.711	11.79
220	2.65 to 5	1.082 to 3	3.83 + 4	- 435.0	2403	- 1.633	11.20
230	8.91 to 5	1.084 to 3	1.18 + 4	- 416.3	2421	- 1.555	10.79
240	3.72 to 4	1.085 to 3	4.07 + 3	- 400.1	2440	- 1.478	10.35
250	7.59 to 4	1.087 to 3	1.52 + 3	- 318.5	2459	- 1.400	9.954
255	1.23 to 3	1.087 to 3	956.4	- 369.8	2468	- 1.361	9.768
260	1.96 to 3	1.088 to 3	612.2	- 360.5	2477	- 1.323	9.590
265	3.06 to 3	1.089 to 3	400.4	- 351.2	2486	- 1.281	9.461
270	4.69 to 3	1.090 to 3	265.4	- 339.6	2496	- 1.296	9.255
273.15	6.11 to 3	1.091 to 3	206.3	- 333.5	2502	- 1.221	9.158
273.15	0.00611	1.000 to 3	206.3	0.00	2502	0.000	9.158
275	0.00697	1.000 to 3	181.7	7.80	2505	0.028	9.109
280	0.00990	1.000 to 3	130.4	28.8	2514	0.104	8.890
285	0.01387	1.000 to 3	99.4	49.8	2523	0.178	8.857
290	0.01917	1.001 to 3	69.7	70.7	2532	0.251	8.740
295	0.02617	1.002 to 3	51.94	91.6	2541	0.323	8.627
300	0.03531	1.003 to 3	39.13	112.5	2550	0.393	8.520
305	0.04712	1.005 to 3	27.90	133.4	2559	0.462	8.417
310	0.06221	1.007 to 3	22.93	154.3	2568	0.530	8.318
315	0.08132	1.009 to 3	17.82	175.2	2577	0.597	8.224
320	0.01053	1.011 to 3	13.98	196.1	2586	0.649	8.151
325	0.01351	1.013 to 3	11.06	217.0	2595	0.727	8.046
330	0.01719	1.016 to 3	8.82	237.9	2604	0.791	7.962
335	0.02167	1.018 to 3	7.09	258.8	2613	0.854	7.881
340	0.02713	1.021 to 3	5.74	279.8	2622	0.916	7.804
345	0.3372	1.024 to 3	4.683	300.7	2630	0.977	7.729
350	0.4163	1.027 to 3	3.846	321.7	2639	1.038	7.657
355	0.5100	1.030 to 3	3.180	342.7	2647	1.097	7.588
360	0.6209	1.034 to 3	2.645	363.7	2655	1.156	7.521
365	0.7514	1.038 to 3	2.212	384.7	2663	1.214	7.456
370	0.9040	1.041 to 3	1.861	405.8	2671	1.271	7.394
373.15	1.0133	1.044 to 3	1.679	419.1	2676	1.307	7.356
375	1.0815	1.045 to 3	1.574	426.8	2679	1.328	7.333
380	1.2869	1.049 to 3	1.337	448.0	2687	1.384	7.275
385	1.5233	1.053 to 3	1.142	469.2	2694	1.439	7.210
390	1.794	1.058 to 3	0.980	490.4	2702	1.494	7.163
400	2.455	1.067 to 3	0.731	532.9	2716	1.605	7.058
410	3.302	1.077 to 3	0.553	575.6	2729	1.708	6.959
420	4.370	1.088 to 3	0.425	618.6	2742	1.810	6.865
430	5.699	1.099 to 3	0.331	661.8	2753	1.911	6.775
440	7.333	1.110 to 3	0.261	705.3	2764	2.011	6.689
450	9.319	1.123 to 3	0.208	749.2	2773	2.109	6.607
460	11.71	1.137 to 3	0.167	793.5	2782	2.205	6.528
470	14.55	1.152 to 3	0.136	838.2	2789	2.301	6.451
480	17.90	1.167 to 3	0.111	883.4	2795	2.395	6.377
490	21.83	1.184 to 3	0.0922	929.1	2799	2.479	6.312
500	26.40	1.203 to 3	0.0776	975.6	2801	2.581	6.233
510	31.66	1.222 to 3	0.0631	1023	2802	2.673	6.163
520	37.70	1.244 to 3	0.0525	1071	2801	2.765	6.093
530	44.58	1.268 to 3	0.0445	1119	2798	2.856	6.023
540	52.38	1.294 to 3	0.0375	1170	2792	2.948	5.953
550	61.19	1.323 to 3	0.0317	1220	2784	3.039	5.882
560	71.08	1.355 to 3	0.0269	1273	2772	3.132	5.808
570	82.16	1.392 to 3	0.0228	1328	2757	3.225	5.733
580	94.51	1.433 to 3	0.0193	1384	2737	3.321	5.654
590	108.3	1.482 to 3	0.0163	1443	2717	3.419	5.569
600	123.5	1.541 to 3	0.0137	1506	2682	3.520	5.480
610	137.3	1.612 to 3	0.0115	1573	2641	3.627	5.318
620	159.1	1.705 to 3	0.0094	1647	2588	3.741	5.259
625	169.1	1.778 to 3	0.0085	1697	2555	3.805	5.191
630	179.1	1.856 to 3	0.0075	1734	2515	3.875	5.115
635	190.9	1.935 to 3	0.0066	1783	2466	3.950	5.025
640	202.7	2.075 to 3	0.0057	1841	2401	4.037	4.912
645	215.2	2.351 to 3	0.0045	1931	2292	4.223	4.732
647.31	221.2	3.170 to 3	0.0032	2107	2107	4.443	4.443

Conversions, Equivalents, and Physical Data

Properties of Superheated Steam														
PRESSURE (PSI)		SAT. TEMP. (°F)	TOTAL TEMPERATURE — °F											
Absolute P'	Gauge P		360°	400°	440°	480°	500°	600°	700°	800°	900°	1000°	1200°	
14.696	0.0	212.00	∇ h _g	33.03 1221.1	34.68 1239.9	36.32 1258.8	37.96 1277.6	38.78 1287.1	42.86 1334.8	46.94 1383.2	51.00 1432.3	55.07 1482.3	59.13 1533.1	67.25 1637.5
20.0	5.3	227.96	∇ h _g	24.21 1220.3	25.43 1239.2	26.65 1258.2	27.86 1277.1	28.46 1286.6	31.47 1334.4	34.47 1382.9	37.46 1432.1	40.45 1482.1	43.44 1533.0	49.41 1637.4
30.0	15.3	250.33	∇ h _g	16.072 1218.6	16.897 1237.9	17.714 1257.0	18.528 1276.2	18.933 1285.7	20.95 1333.8	22.96 1382.4	24.96 1431.17	26.95 1481.8	28.95 1532.7	32.93 1637.2
40.0	25.3	267.25	∇ h _g	12.001 1216.9	12.628 1236.5	13.247 1255.9	13.962 1275.2	14.168 1284.8	15.688 1333.1	17.198 1381.9	18.702 1431.3	20.20 1481.4	21.70 1532.4	24.69 1637.0
50.0	35.3	281.01	∇ h _g	9.557 1215.2	10.065 1235.1	10.567 1254.7	11.062 1274.2	11.309 1283.9	12.532 1332.5	13.744 1381.4	14.950 1430.9	16.152 1481.1	17.352 1532.1	19.747 1636.8
60.0	45.3	292.71	∇ h _g	7.927 1213.4	8.357 1233.6	8.779 1253.5	9.196 1273.2	9.403 1283.0	10.427 1331.8	11.441 1380.9	12.449 1430.5	13.452 1480.8	14.454 1531.9	16.451 1636.6
70.0	55.3	302.92	∇ h _g	6.762 1211.5	7.136 1232.1	7.502 1252.3	7.863 1272.2	8.041 1282.0	8.924 1331.1	9.796 1380.4	10.662 1430.1	11.524 1480.5	12.383 1531.6	14.097 1636.3
80.0	65.3	312.03	∇ h _g	5.888 1209.7	6.220 1230.7	6.544 1251.1	6.862 1271.1	7.020 1281.1	7.797 1330.5	8.562 1379.9	9.322 1429.7	10.077 1480.1	10.830 1531.3	12.332 1636.2
90.0	75.3	320.27	∇ h _g	5.208 1207.7	5.508 1229.1	5.799 1249.8	6.084 1270.1	6.225 1280.1	6.920 1329.8	7.603 1379.4	8.279 1429.3	8.952 1479.8	9.623 1531.0	10.959 1635.9
100.0	85.3	327.81	∇ h _g	4.663 1205.7	4.937 1227.6	5.202 1248.6	5.462 1269.0	5.589 1279.1	6.218 1329.1	6.835 1378.9	7.446 1428.9	8.052 1479.5	8.656 1530.8	9.860 1635.7
120.0	105.3	341.25	∇ h _g	3.844 1201.6	4.081 1224.4	4.307 1246.0	4.527 1266.9	4.636 1277.2	5.165 1327.7	5.683 1377.8	6.195 1428.1	6.702 1478.8	7.207 1530.2	8.212 1635.3
140.0	125.3	353.02	∇ h _g	3.258 1197.3	3.468 1221.1	3.667 1243.3	3.860 1264.7	3.954 1275.2	4.413 1326.4	4.861 1376.8	5.301 1427.2	5.738 1478.2	6.172 1529.7	7.035 1634.9
160.0	145.3	363.53	∇ h _g	---- ----	3.008 1217.6	3.187 1240.6	3.359 1262.4	3.443 1273.1	3.849 1325.0	4.244 1375.7	4.631 1426.4	5.015 1477.5	5.396 1529.1	6.152 1634.5
180.0	165.3	373.06	∇ h _g	---- ----	2.649 1214.0	2.813 1237.8	2.969 1260.2	3.044 1271.0	3.411 1323.5	3.964 1374.7	4.110 1425.6	4.452 1476.8	4.792 1528.6	5.466 1634.1
200.0	185.3	381.79	∇ h _g	---- ----	2.361 1210.3	2.513 1234.9	2.656 1257.8	2.726 1268.9	3.060 1322.1	3.380 1373.6	3.693 1424.8	4.002 1476.2	4.309 1528.0	4.917 1633.7
220.0	205.3	389.86	∇ h _g	---- ----	2.125 1206.5	2.267 1231.9	2.400 1255.4	2.465 1266.7	2.772 1320.7	3.066 1372.6	3.352 1424.0	3.634 1475.5	3.913 1527.5	4.467 1633.3
240.0	225.3	397.37	∇ h _g	---- ----	1.9276 1202.5	2.062 1228.8	2.187 1253.0	2.247 1264.5	2.533 1319.2	2.804 1371.5	3.068 1432.2	3.327 1474.8	3.584 1526.9	4.093 1632.9
260.0	245.3	404.42	∇ h _g	---- ----	---- ----	1.8882 1225.7	2.006 1250.5	2.063 1262.3	2.330 1317.7	2.582 1370.4	2.827 1422.3	3.067 1474.2	3.305 1526.3	3.776 1632.5
280.0	265.3	411.05	∇ h _g	---- ----	---- ----	1.7388 1222.4	1.8512 1247.9	1.9047 1260.0	2.156 1316.2	2.392 1369.4	2.621 1421.5	2.845 1473.5	3.066 1525.8	3.504 1632.1
300.0	285.3	417.33	∇ h _g	---- ----	---- ----	1.6090 1219.1	1.7165 1245.3	1.7675 1257.6	2.005 1314.7	2.227 1368.3	2.442 1420.6	2.652 1472.8	2.859 1525.2	3.269 1631.7
320.0	305.3	423.29	∇ h _g	---- ----	---- ----	1.4950 1215.6	1.5985 1242.6	1.6472 1255.2	1.8734 1313.2	2.083 1367.2	2.285 1419.8	2.483 1472.1	2.678 1524.7	3.063 1631.3
340.0	325.3	428.97	∇ h _g	---- ----	---- ----	1.3941 1212.1	1.4941 1239.9	1.5410 1252.8	1.7569 1311.6	1.9562 1366.1	2.147 1419.0	2.334 1471.5	2.518 1524.1	2.881 1630.9
360.0	345.3	343.40	∇ h _g	---- ----	---- ----	1.3041 1208.4	1.4012 1237.1	1.4464 1250.3	1.6533 1310.1	1.8431 1365.0	2.025 1418.1	2.202 1470.8	2.376 1523.5	2.719 1630.5

∇ = specific volume, cubic feet per pound
h_g = total heat of steam, BTU per pound

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Conversions, Equivalents, and Physical Data

Properties of Superheated Steam (continued)															
PRESSURE (PSI)		SAT. TEMP. °F		TOTAL TEMPERATURE — °F											
Absolute P'	Gauge P			500°	540°	600°	640°	660°	700°	740°	800°	900°	1000°	1200°	
380.0	365.3	439.60	∇ ηγ	1.3616 1247.7	1.4444 1273.1	1.5605 1308.5	1.6345 1331.0	1.6707 1342.0	1.7419 1363.8	1.8118 1385.3	1.9149 1417.3	2.083 1470.1	2.249 1523.0	2.575 1630.0	
400.0	385.3	444.59	∇ h _g	1.2851 1245.1	1.3652 1271.0	1.4770 1306.9	1.5480 1329.6	1.5827 1340.8	1.6508 1362.7	1.7177 1384.3	1.8161 1416.4	1.9767 1469.4	2.134 1522.4	2.445 1629.6	
420.0	405.3	449.39	∇ h _g	1.2158 1242.5	1.2935 1268.9	1.4014 1305.3	1.4697 1328.3	1.5030 1339.5	1.5684 1361.6	1.6324 1383.3	1.7267 1415.5	1.8802 1468.7	2.031 1521.9	2.327 1629.2	
440.0	425.3	454.02	∇ h _g	1.1526 1239.8	1.2282 1266.7	1.3327 1303.6	1.3984 1326.9	1.4306 1338.2	1.4934 1360.4	1.5549 1382.3	1.6454 1414.7	1.7925 1468.1	1.9368 1521.3	2.220 1628.8	
460.0	445.3	458.5	∇ h _g	1.0948 1237.0	1.1685 1264.5	1.2698 1302.0	1.3334 1325.4	1.3644 1336.9	1.4250 1359.3	1.4842 1381.3	1.5711 1413.8	1.7124 1467.4	1.8508 1520.7	2.122 1628.4	
480.0	465.3	462.82	∇ h _g	1.0417 1234.2	1.1138 1262.3	1.2122 1300.3	1.2737 1324.0	1.3038 1335.6	1.3622 1358.2	1.4193 1380.3	1.5031 1412.9	1.6390 1466.7	1.7720 1520.2	2.033 1628.0	
500.0	485.3	467.01	∇ h _g	0.9927 1231.3	1.0633 1260.0	1.1591 1298.6	1.2188 1322.6	1.2478 1334.2	1.3044 1357.0	1.3596 1379.3	1.4405 1412.1	1.5715 1466.0	1.6996 1519.6	1.9504 1627.6	
520.0	505.3	471.07	∇ h _g	0.9473 1228.3	1.0166 1257.7	1.1101 1296.9	1.1681 1321.1	1.1962 1332.9	1.2511 1355.8	1.3045 1378.2	1.3826 1411.2	1.5091 1465.3	1.636 1519.0	1.8743 1627.2	
540.0	525.3	475.01	∇ h _g	0.9052 1225.3	0.9733 1255.4	1.0646 1295.2	1.1211 1319.7	1.1485 1331.5	1.2017 1354.6	1.2535 1377.2	1.3291 1410.3	1.4514 1464.6	1.5707 1518.5	1.8039 1626.8	
560.0	545.3	478.85	∇ h _g	0.8659 1222.2	0.9330 1253.0	1.0224 1293.4	1.0775 1318.2	1.1041 1330.2	1.1558 1353.5	1.2060 1376.1	1.2794 1409.4	1.3978 1463.9	1.5132 1517.9	1.7385 1626.4	
580.0	565.3	482.58	∇ h _g	0.8291 1219.0	0.8954 1250.5	0.9830 1291.7	1.0368 1316.7	1.0627 1328.8	1.1131 1352.3	1.1619 1375.1	1.2331 1408.6	1.3479 1463.2	1.4596 1517.3	1.6776 1626.0	
600.0	585.3	486.21	∇ h _g	0.7947 1215.7	0.8602 1248.1	0.9463 1289.9	0.9988 1315.2	1.0241 1327.4	1.0732 1351.1	1.1207 1374.0	1.1899 1407.7	1.3013 1462.5	1.4096 1516.7	1.6208 1625.5	
620.0	605.0	489.75	∇ h _g	0.7624 1212.4	0.8272 1245.5	0.9118 1288.1	0.9633 1313.7	0.9880 1326.0	1.0358 1349.9	1.0821 1373.0	1.1494 1406.8	1.2577 1461.8	1.3628 1516.2	1.5676 1625.1	
640.0	625.3	493.21	∇ h _g	0.7319 1209.0	0.7963 1243.0	0.8795 1296.2	0.9299 1312.2	0.9541 1324.6	1.0008 1348.6	1.0459 1371.9	1.1115 1405.9	1.2168 1461.1	1.3190 1515.6	1.5178 1624.7	
660.0	645.3	496.58	∇ h _g	0.7032 1205.4	0.7670 1240.4	0.8491 1284.4	0.8985 1310.6	0.9222 1323.2	0.9679 1347.4	1.0119 1370.8	1.0759 1405.0	1.1784 1460.4	1.2778 1515.0	1.4709 1624.3	
680.0	665.3	499.88	∇ h _g	0.6759 1201.8	0.7395 1237.7	0.8205 1282.5	0.8690 1309.1	0.8922 1321.7	0.9369 1346.2	0.9800 1369.8	1.0424 1404.1	1.1423 1459.7	1.2390 1514.5	1.4269 1623.9	
700.0	685.3	503.10	∇ h _g	---	0.7134 1235.0	0.7934 1280.6	0.8411 1307.5	0.8639 1320.3	0.9077 1345.0	0.9498 1368.7	1.0108 1403.2	1.1082 1459.0	1.2024 1513.9	1.3853 1623.5	
750.	735.3	510.86	∇ h _g	---	0.6540 1227.9	0.7319 1275.7	0.7778 1303.5	0.7996 1316.6	0.8414 1341.8	0.8813 1366.0	0.9391 1400.9	1.0310 1457.2	1.1196 1512.4	1.2912 1622.4	
800.0	785.3	518.23	∇ h _g	---	0.6015 1220.5	0.6779 1270.7	0.7223 1299.4	0.7433 1312.9	0.7833 1338.6	0.8215 1363.2	0.8763 1398.6	0.9633 1455.4	1.0470 1511.0	1.2088 1621.4	
850.0	835.3	525.26	∇ h _g	---	0.5546 1212.7	0.6301 1265.5	0.6732 1295.2	0.6934 1309.0	0.7320 1335.4	0.7685 1360.4	0.8209 1396.3	0.9037 1453.6	0.9830 1509.5	1.1360 1620.4	
90.0	885.3	531.98	∇ h _g	---	0.5124 1204.4	0.5873 1260.1	0.6294 1290.9	0.6491 1305.1	0.6863 1332.1	0.7215 1357.5	0.7716 1393.9	0.8506 1451.8	0.9262 1508.1	1.0714 1619.3	
950.0	935.3	538.42	∇ h _g	---	0.4740 1195.5	0.5489 1254.6	0.5901 1286.4	0.6092 1301.1	0.6453 1328.7	0.6793 1354.7	0.7275 1391.6	0.8031 1450.0	0.8753 1506.6	1.0136 1618.3	
1000.0	985.3	544.61	∇ h _g	---	---	0.5140 1248.8	0.5546 1281.9	0.5733 1297.0	0.6084 1325.3	0.6413 1351.7	0.6878 1389.2	0.7604 1448.2	0.8294 1505.1	0.9615 1617.3	

∇ = specific volume, cubic feet per pound
h_g = total heat of steam, BTU per pound

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Conversions, Equivalents, and Physical Data

Properties of Superheated Steam (continued)														
PRESSURE (PSI)		SAT. TEMP. °F	▽ h _g	TOTAL TEMPERATURE — °F (t)										
Absolute p'	Gauge			660°	700°	740°	760°	780°	800°	860°	900°	1000°	1100°	1200°
1100.0	1085.3	556.31	▽ h _g	0.5110 1288.5	0.5445 1318.3	0.5755 1345.8	0.5904 1358.9	0.6049 1371.7	0.6191 1384.3	0.6601 1420.8	0.6866 1444.5	0.7503 1502.2	0.8117 1558.8	0.8716 1615.2
1200.0	1185.3	567.22	▽ h _g	0.4586 1279.6	0.4909 1311.0	0.5206 1339.6	0.5347 1353.2	0.5484 1366.4	0.5617 1379.3	0.6003 1416.7	0.6250 1440.7	0.6843 1499.2	0.7412 1556.4	0.7967 1613.1
1300.0	1285.3	577.46	▽ h _g	0.4139 1270.2	0.4454 1303.4	0.4739 1333.3	0.4874 1347.3	0.5004 1361.0	0.5131 1374.3	0.5496 1412.5	0.5728 1437.0	0.6284 1496.2	0.6816 1553.9	0.7333 1611.0
1400.0	1385.3	587.10	▽ h _g	0.3753 1260.3	0.4062 1295.5	0.4338 1326.7	0.4468 1341.3	0.4593 1355.4	0.4714 1369.1	0.5061 1408.2	0.5281 1433.1	0.5805 1493.2	0.6305 1551.4	0.6789 1608.9
1500.0	1485.3	596.23	▽ h _g	0.3413 1249.8	0.3719 1287.2	0.3989 1320.0	0.4114 1335.2	0.4235 1349.7	0.4352 1363.8	0.4684 1403.9	0.4893 1429.3	0.5390 1490.1	0.5862 1548.9	0.6318 1606.8
1600.0	1585.3	604.90	▽ h _g	0.3112 1238.7	0.3417 1278.7	0.3682 1313.0	0.3804 1328.8	0.3921 1343.9	0.4034 1358.4	0.4353 1399.5	0.4553 1425.3	0.5027 1487.0	0.5474 1546.4	0.5906 1604.6
1700.0	1685.3	613.15	▽ h _g	0.2842 1226.8	0.3148 1269.7	0.3410 1305.8	0.3529 1322.3	0.3643 1337.9	0.3753 1352.9	0.4061 1395.0	0.4253 1421.4	0.4706 1484.0	0.5132 1543.8	0.5542 1602.5
1800.0	1785.3	621.03	▽ h _g	0.2597 1214.0	0.2907 1260.3	0.3166 1298.4	0.3284 1315.5	0.3395 1331.8	0.3502 1347.2	0.3801 1390.4	0.3986 1417.4	0.4421 1480.8	0.4828 1541.3	0.5218 1600.4
1900.0	1885.3	628.58	▽ h _g	0.2371 1200.2	0.2688 1250.4	0.2947 1290.6	0.3063 1308.6	0.3171 1325.4	0.3277 1341.5	0.3568 1385.8	0.3747 1413.3	0.4165 1477.7	0.4556 1538.8	0.4929 1598.2
2000.0	1985.3	635.82	▽ h _g	0.2161 1184.9	0.2489 1240.0	0.2748 1282.6	0.2863 1301.4	0.2972 1319.0	0.3074 1335.5	0.3358 1381.2	0.3532 1409.2	0.3935 1474.5	0.4311 1536.2	0.4668 1596.1
2100.0	2085.3	642.77	▽ h _g	0.1962 1167.7	0.2306 1229.0	0.2567 1274.3	0.2682 1294.0	0.2789 1312.3	0.2890 1329.5	0.3167 1376.4	0.3337 1405.0	0.3727 1471.4	0.4089 1533.6	0.4433 1593.9
2200.0	2185.3	649.46	▽ h _g	0.1768 1147.8	0.2135 1217.4	0.2400 1265.7	0.2514 1286.3	0.2621 1305.4	0.2721 1323.3	0.2994 1371.5	0.3159 1400.8	0.3538 1468.2	0.3887 1531.1	0.4218 1591.8
2300.0	2285.3	655.91	▽ h _g	0.1575 1123.8	0.1978 1204.9	0.2247 1256.7	0.2362 1278.4	0.2468 1298.4	0.2567 1316.9	0.2835 1366.6	0.2997 1396.5	0.3365 1464.9	0.3703 1528.5	0.4023 1589.6
2400.0	2385.3	662.12	▽ h _g	---- ----	0.1828 1191.5	0.2105 1247.3	0.2221 1270.2	0.2327 1291.1	0.2425 1310.3	0.2689 1361.6	0.2848 1392.2	0.3207 1461.7	0.3534 1525.9	0.3843 1587.4
2500.0	2485.3	668.13	▽ h _g	--- ---	0.1686 1176.8	0.1973 1207.6	0.2090 1216.8	0.2196 1283.6	0.2294 1303.6	0.2555 1356.5	0.2710 1387.8	0.3061 1458.4	0.3379 1523.2	0.3678 1585.3
2600.0	2585.3	673.94	▽ h _g	---- ----	0.1549 1160.6	0.1849 1227.3	0.1967 1252.9	0.2074 1275.8	0.2172 1296.8	0.2431 1351.4	0.2584 1383.4	0.2926 1455.1	0.3236 1520.6	0.3526 1583.1
2700.0	2685.3	679.55	▽ h _g	--- ---	0.1415 1142.5	0.1732 1216.5	0.1853 1243.8	0.1960 1267.9	0.2059 1289.7	0.2315 1346.1	0.2466 1378.9	0.2801 1451.8	0.3103 1518.0	0.3385 1580.9
2800.0	2785.3	684.99	▽ h _g	---- ----	0.1281 1121.4	0.1622 1205.1	0.1745 1234.2	0.1854 1259.6	0.1953 1282.4	0.2208 1340.8	0.2356 1374.3	0.2685 1448.5	0.2979 1515.4	0.3254 1578.7
2900.0	2885.3	690.26	▽ h _g	--- ---	0.1143 1095.9	0.1517 1193.0	0.1644 1224.3	0.1754 1251.1	0.1853 1274.9	0.2108 1335.3	0.2254 1369.7	0.2577 1445.1	0.2864 1512.7	0.3132 1576.5
3000.0	2985.3	695.36	▽ h _g	---- ----	0.0984 1060.7	0.1416 1180.1	0.1548 1213.8	0.1660 1242.2	0.1760 1267.2	0.2014 1329.7	0.2159 1365.0	0.2476 1441.8	0.2757 1510.0	0.3018 1574.3
3100.0	3085.3	700.31	▽ h _g	--- ---	---- ----	0.1320 1166.2	0.1456 1202.9	0.1571 1233.0	0.1672 1259.3	0.1926 1324.1	0.2070 1360.3	0.2382 1438.4	0.2657 1507.4	0.2911 1572.1
3200.0	3185.3	705.11	▽ h _g	---- ----	--- ---	0.1226 1151.1	0.1369 1191.4	0.1486 1223.5	0.1589 1251.1	0.1843 1318.3	0.1986 1355.5	0.2293 1434.9	0.2563 1504.7	0.2811 1569.9
3206.2	3191.5	705.40	▽ h _g	--- ---	--- ---	0.1220 1150.2	0.1363 1190.6	0.1480 1222.9	0.1583 1250.5	0.1838 1317.9	0.1981 1355.2	0.2288 1434.7	0.2557 1504.5	0.2806 1569.8

▽ = specific volume, cubic feet per pound
h_g = total heat of steam, BTU per pound

Conversions, Equivalents, and Physical Data

Determine Velocity of Steam in Pipes:

$$\text{Velocity (ft/s)} = \frac{(25) (A)}{(V)}$$

Where: A = Nominal pipe section area = $\frac{\pi (d)^2}{4}$
 d = Diameter

V = Specific volume from steam tables in ft³/lb (m³/kg)

Note: Specific volume changes with steam pressure and temperature. Make sure to calculate velocities of inlet and outlet piping of the regulator.

Recommended Steam Pipe Line Velocities	
STEAM CONDITION	VELOCITY, FEET/SECOND (METERS/SECOND)
0 to 15 psig (0 to 1,0 bar), Dry and saturated	100 (30,5)
15 psig (1,0 bar), Dry and saturated and up	175 (53,3)
200 psig (13,8 bar), Superheated and up	250 (76,2)

Typical Condensation Rates In Insulated Steam Pipes						
PRESSURE, PSIG (bar)	RATES IN POUNDS/HOUR (KG/HOUR) PER FOOT OF PIPE WITH 2-INCHES OF INSULATION					
	Pipe Diameter in Inches					
	3/4	1	1-1/2	2	3	4
1 (0,069)	0.02 (0,009)	0.03 (0,014)	0.03 (0,014)	0.04 (0,018)	0.05 (0,023)	0.06 (0,027)
5 (0,34)	0.03 (0,014)	0.03 (0,014)	0.04 (0,018)	0.04 (0,018)	0.05 (0,023)	0.06 (0,027)
10 (0,69)	0.03 (0,014)	0.03 (0,014)	0.04 (0,018)	0.04 (0,018)	0.05 (0,023)	0.07 (0,032)
25 (1,7)	0.03 (0,014)	0.04 (0,018)	0.05 (0,023)	0.05 (0,023)	0.06 (0,027)	0.08 (0,036)
50 (3,4)	0.04 (0,018)	0.04 (0,018)	0.05 (0,023)	0.06 (0,027)	0.09 (0,041)	0.11 (0,05)
75 (5,2)	0.04 (0,018)	0.05 (0,023)	0.06 (0,027)	0.07 (0,032)	0.11 (0,05)	0.14 (0,064)
100 (6,9)	0.05 (0,023)	0.05 (0,023)	0.07 (0,032)	0.08 (0,036)	0.12 (0,054)	0.15 (0,068)
125 (8,6)	0.05 (0,023)	0.06 (0,027)	0.07 (0,032)	0.08 (0,036)	0.13 (0,059)	0.16 (0,073)
150 (10,3)	0.06 (0,027)	0.06 (0,027)	0.08 (0,036)	0.09 (0,041)	0.14 (0,064)	0.17 (0,077)
200 (13,8)	0.06 (0,027)	0.07 (0,032)	0.08 (0,036)	0.09 (0,041)	0.15 (0,068)	0.19 (0,086)

Typical Condensation Rates In Steam Pipes Without Insulation						
PRESSURE, PSIG (bar)	RATES IN POUNDS/HOUR (KG/HOUR) PER FOOT OF BARE PIPE AT 72°F (22°C) AMBIENT AIR					
	Pipe Diameter in Inches					
	3/4	1	1-1/2	2	3	4
1 (0,069)	0.11 (0,05)	0.15 (0,068)	0.21 (0,095)	0.25 (0,113)	0.38 (0,172)	0.46 (0,209)
5 (0,34)	0.14 (0,064)	0.16 (0,073)	0.22 (0,1)	0.26 (0,118)	0.41 (0,186)	0.50 (0,227)
10 (0,69)	0.15 (0,068)	0.18 (0,082)	0.24 (0,109)	0.29 (0,132)	0.44 (0,2)	0.53 (0,24)
25 (1,7)	0.17 (0,077)	0.22 (0,1)	0.31 (0,141)	0.36 (0,163)	0.53 (0,24)	0.65 (0,295)
50 (3,4)	0.22 (0,1)	0.27 (0,122)	0.39 (0,177)	0.46 (0,209)	0.66 (0,299)	0.83 (0,376)
75 (5,2)	0.26 (0,118)	0.31 (0,141)	0.45 (0,204)	0.54 (0,245)	0.77 (0,349)	1.04 (0,472)
100 (6,9)	0.29 (0,132)	0.35 (0,159)	0.50 (0,227)	0.61 (0,277)	0.86 (0,39)	1.11 (0,503)
125 (8,6)	0.32 (0,145)	0.39 (0,177)	0.55 (0,249)	0.68 (0,308)	0.94 (0,426)	1.23 (0,558)
150 (10,3)	0.35 (0,159)	0.42 (0,191)	0.60 (0,272)	0.74 (0,336)	1.03 (0,467)	1.33 (0,603)
200 (13,8)	0.40 (0,181)	0.49 (0,222)	0.69 (0,313)	0.81 (0,367)	1.19 (0,54)	1.50 (0,68)

Conversions, Equivalents, and Physical Data

Flow of Water Through Schedule 40 Steel Pipes																	
DISCHARGE		PRESSURE DROP PER 100 FEET AND VELOCITY IN SCHEDULE 40 PIPE FOR WATER AT 60°F															
Gallons per Minute	Cubic Ft. per Second	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)
0.2	0.000446	1/8-Inch		1/4-Inch		3/8-Inch		1/2-Inch		3/4-Inch							
0.3	0.000668	1.13	1.86	0.616	0.359	0.924	0.903	0.504	0.159	0.317	0.061						
0.4	0.000891	1.69	4.22	1.23	1.61	0.672	0.345	0.422	0.086								
0.5	0.00111	2.26	6.98	1.54	2.39	0.840	0.539	0.528	0.167	0.301	0.033						
0.6	0.00134	2.82	10.5	1.85	3.29	1.01	0.751	0.633	0.240	0.361	0.041						
0.8	0.00178	3.39	14.7	2.46	5.44	1.34	1.25	0.844	0.408	0.481	0.102	1-inch					
1	0.00223	4.52	25.0	3.08	8.28	1.68	1.85	1.06	0.600	0.602	0.155	0.371	0.048	1-1/4-Inch			
2	0.00446	5.65	37.2	6.16	30.1	3.36	6.58	2.11	2.10	1.20	0.526	0.743	0.164	0.429	0.044	1-1/2-Inch	
3	0.00668	6.16	134.4	9.25	64.1	5.04	13.9	3.17	4.33	1.81	1.09	1.114	0.336	0.644	0.090	0.473	0.043
4	0.00891	9.25		6.72	23.9	4.22	7.42	2.41	1.83	1.49	0.565	0.858	0.150	0.630	0.071		
5	0.01114	12.33	111.2	8.40	36.7	5.28	11.2	3.01	2.75	1.86	0.835	1.073	0.223	0.788	0.104		
6	0.01337	2-Inch		2-1/2-Inch		10.08	51.9	6.33	15.8	3.61	3.84	2.23	1.17	1.29	0.309	0.943	0.145
8	0.01782	0.574	0.044	13.44	91.1	8.45	27.7	4.81	6.60	4.81	6.60	2.97	1.99	1.72	0.518	1.26	0.241
10	0.02228	0.765	0.073	10.56	42.4	6.02	9.99	3.71	2.99	6.02	9.99	3.71	2.99	2.15	0.774	1.58	0.361
15	0.03342	0.956	0.108	3-Inch		9.03	21.6	5.57	6.36	9.03	21.6	5.57	6.36	3.22	1.63	2.37	0.755
20	0.04456	1.43	0.224	1.34	0.158	0.868	0.056	3-1/2-Inch		12.03	37.8	7.43	10.9	4.29	2.78	3.16	1.28
25	0.05570	1.91	3.375	8.40	36.7	5.28	11.2	3.01	2.75	1.86	0.835	1.073	0.223	0.788	0.104		
30	0.06684	2.39	0.561	1.68	0.234	1.09	0.083	0.812	0.041	9.28	16.7	5.37	4.22	3.94	1.93		
35	0.07798	2.87	0.786	2.01	0.327	1.30	0.114	0.974	0.056	11.14	23.8	6.44	5.92	4.73	2.72		
40	0.08912	3.35	1.05	2.35	0.436	1.52	0.151	1.14	0.071	12.99	32.2	7.51	7.90	5.52	3.64		
45	0.1003	3.83	1.35	2.68	0.556	1.74	0.192	1.30	0.095	14.85	41.5	8.59	10.24	6.30	4.65		
50	0.1114	4.30	1.67	3.02	0.668	1.95	0.239	1.46	0.117	1.13	0.064	9.67	12.80	7.09	5.85		
60	0.1337	4.78	2.03	3.35	0.839	2.17	0.288	1.62	0.142	1.26	0.076	10.74	15.66	7.88	7.15		
70	0.1560	5.74	2.87	4.02	1.18	2.60	0.46	1.95	0.204	1.51	0.107	12.89	22.2	9.47	10.21		
80	0.1782	6.70	3.84	4.69	1.59	3.04	0.540	2.27	0.261	1.76	0.143	1.12	0.047	11.05	13.71		
90	0.2005	7.65	4.97	5.36	2.03	3.47	0.687	2.60	0.334	2.02	0.180	1.28	0.060	12.62	17.59		
100	0.2228	8.60	6.20	6.03	2.53	3.91	0.861	2.92	0.416	2.27	0.224	1.44	0.074	14.20	22.0		
125	0.2785	9.56	7.59	6.70	3.09	4.34	1.05	3.25	0.509	2.52	0.272	1.60	0.090	15.778	26.9		
150	0.3342	11.97	11.76	8.38	4.71	5.43	1.61	4.06	0.769	3.15	0.415	2.01	0.135	19.72	41.4		
175	0.3899	14.36	16.70	10.05	6.69	6.51	2.24	4.87	1.08	3.78	0.580	2.41	0.190	1.67	0.077		
200	0.4456	16.75	22.3	11.73	8.97	7.60	3.00	5.68	1.44	4.41	0.774	2.81	0.253	1.94	0.102		
225	0.5013	19.14	28.8	13.42	11.68	8.68	3.87	6.49	1.85	5.04	0.985	3.21	0.323	2.22	0.130	8-Inch	
250	0.557	15.09	14.63	9.77	4.83	7.30	2.32	5.67	1.23	3.61	0.401	2.50	0.162	1.44	0.043		
275	0.6127	10.85	5.93	8.12	2.84	6.30	1.46	6.30	1.46	4.01	0.495	2.78	0.195	1.60	0.051		
300	0.6684	11.94	7.14	8.93	3.40	6.93	1.79	6.93	1.79	4.41	0.583	3.05	0.234	1.76	0.061		
325	0.7241	13.00	8.36	9.74	4.02	7.56	2.11	7.56	2.11	4.81	0.683	3.33	0.275	1.92	0.072		
350	0.7798	14.12	9.89	10.53	4.09	8.19	2.47	8.19	2.47	5.21	0.797	3.61	0.320	2.08	0.083		
375	0.8355	11.36	5.51	8.82	2.84	5.62	0.919	8.82	2.84	5.62	0.919	3.89	0.367	2.24	0.095		
400	0.8912	12.17	6.18	9.45	3.25	6.02	1.05	9.45	3.25	6.02	1.05	4.16	0.416	2.40	0.108		
425	0.9469	12.98	7.03	10.08	3.68	6.42	1.19	10.08	3.68	6.42	1.19	4.44	0.471	2.56	0.121		
450	1.003	13.80	7.89	10.71	4.12	6.82	1.33	10.71	4.12	6.82	1.33	4.72	0.529	2.73	0.136		
475	1.059	14.61	8.80	11.34	4.60	7.22	1.48	11.34	4.60	7.22	1.48	5.00	0.590	2.89	0.151		
500	1.114	11.97	5.12	11.97	5.12	7.62	1.64	11.97	5.12	7.62	1.64	5.27	0.653	3.04	0.166		
550	1.225	12.60	5.65	12.60	5.65	8.02	1.81	12.60	5.65	8.02	1.81	5.55	0.720	3.21	0.182		
600	1.337	13.85	6.79	13.85	6.79	8.82	2.17	13.85	6.79	8.82	2.17	6.11	0.861	3.53	0.219		
650	1.448	15.12	8.04	15.12	8.04	9.63	2.55	15.12	8.04	9.63	2.55	6.66	1.02	3.85	0.258		
		10.43	2.98	10.43	2.98	7.22	1.18	7.22	1.18	7.22	1.18	4.17	0.301	4.17	0.301		

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Conversions, Equivalents, and Physical Data

Flow of Water Through Schedule 40 Steel Pipes (continued)																	
DISCHARGE		PRESSURE DROP PER 100 FEET AND VELOCITY IN SCHEDULE 40 PIPE FOR WATER AT 60°F															
Gallons per Minute	Cubic Ft. per Second	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)	Velocity (Ft. per Second)	Pressure Drop (PSI)
		10-Inch		12-Inch		14-Inch		16-Inch		18-Inch		20-Inch		24-Inch		30-Inch	
700	1.560	2.85	0.112	2.01	0.047	1.50	0.025	1.10	0.015	0.80	0.010	0.60	0.007	0.45	0.005	0.35	0.004
750	1.671	3.05	0.127	2.15	0.054	1.55	0.026	1.15	0.016	0.85	0.011	0.65	0.008	0.50	0.006	0.40	0.005
800	1.782	3.25	0.143	2.29	0.061	1.60	0.027	1.20	0.017	0.90	0.012	0.70	0.009	0.55	0.007	0.45	0.006
850	1.894	3.46	0.160	2.44	0.068	1.65	0.028	1.25	0.018	0.95	0.013	0.75	0.010	0.60	0.008	0.50	0.007
900	2.005	3.66	0.179	2.58	0.075	1.70	0.029	1.30	0.019	1.00	0.014	0.80	0.011	0.65	0.009	0.55	0.008
950	2.117	3.86	0.198	2.72	0.083	1.75	0.030	1.35	0.020	1.05	0.015	0.85	0.012	0.70	0.010	0.60	0.009
1000	2.228	4.07	0.218	2.87	0.091	1.80	0.031	1.40	0.021	1.10	0.016	0.90	0.013	0.75	0.011	0.65	0.010
1100	2.451	4.48	0.260	3.15	0.110	1.90	0.034	1.50	0.023	1.20	0.018	1.00	0.014	0.80	0.012	0.70	0.011
1200	2.674	4.88	0.306	3.44	0.128	2.00	0.037	1.60	0.025	1.30	0.020	1.10	0.016	0.90	0.013	0.80	0.012
1300	2.896	5.29	0.355	3.73	0.150	2.10	0.040	1.70	0.027	1.40	0.022	1.20	0.018	1.00	0.014	0.90	0.013
1400	3.119	5.70	0.409	4.01	0.171	2.20	0.043	1.80	0.029	1.50	0.024	1.30	0.020	1.10	0.015	1.00	0.014
1500	3.342	6.10	0.466	4.30	0.195	2.30	0.046	1.90	0.031	1.60	0.026	1.40	0.022	1.20	0.016	1.10	0.015
1600	3.565	6.51	0.527	4.59	0.219	2.40	0.049	2.00	0.033	1.70	0.028	1.50	0.023	1.30	0.017	1.20	0.016
1800	4.010	7.32	0.663	5.16	0.276	2.60	0.056	2.20	0.037	1.90	0.032	1.60	0.026	1.40	0.019	1.30	0.017
2000	4.456	8.14	0.808	5.73	0.339	2.80	0.063	2.40	0.041	2.10	0.035	1.70	0.028	1.50	0.021	1.40	0.018
2500	5.570	10.17	1.24	7.17	0.515	3.50	0.090	2.80	0.055	2.50	0.043	2.00	0.035	1.70	0.024	1.60	0.020
3000	6.684	12.20	1.76	8.60	0.731	4.20	0.125	3.30	0.073	3.00	0.057	2.30	0.041	1.90	0.028	1.80	0.023
3500	7.798	14.24	2.38	10.03	0.982	5.00	0.165	4.00	0.098	3.50	0.077	2.70	0.048	2.10	0.034	2.00	0.028
4000	8.912	16.27	3.08	11.47	1.27	5.80	0.215	4.80	0.130	4.00	0.090	3.00	0.055	2.30	0.040	2.20	0.032
4500	10.03	18.31	3.87	12.90	1.60	6.60	0.265	5.60	0.170	4.50	0.110	3.30	0.062	2.50	0.046	2.30	0.036
5000	11.14	20.35	4.71	14.33	1.95	7.40	0.320	6.40	0.210	5.00	0.120	3.80	0.070	2.70	0.052	2.40	0.040
6000	13.37	24.41	6.74	17.20	2.77	9.00	0.430	7.80	0.280	5.80	0.150	4.30	0.080	3.10	0.060	2.60	0.045
7000	15.60	28.49	9.11	20.07	3.74	10.60	0.560	9.00	0.370	6.70	0.190	4.80	0.100	3.50	0.070	2.80	0.050
8000	17.82	32.57	11.94	22.93	4.84	12.20	0.710	10.20	0.480	7.60	0.240	5.30	0.120	3.90	0.080	3.00	0.055
9000	20.05	36.65	15.21	25.79	6.09	13.80	0.880	11.40	0.600	8.40	0.290	5.80	0.140	4.10	0.090	3.10	0.060
10,000	22.28	40.73	18.94	28.66	7.46	15.40	1.080	12.60	0.740	9.20	0.340	6.30	0.160	4.30	0.100	3.20	0.065
12,000	26.74	48.87	23.11	34.40	10.7	18.60	1.400	15.20	0.960	10.80	0.410	7.10	0.190	4.80	0.120	3.50	0.075
14,000	31.19	57.01	27.76	40.15	14.1	21.80	1.750	17.80	1.180	12.40	0.490	7.90	0.220	5.10	0.140	3.70	0.085
16,000	35.65	65.15	32.91	45.90	17.6	24.40	2.100	19.40	1.400	13.00	0.570	8.30	0.250	5.40	0.160	3.80	0.095
18,000	40.10	73.29	38.46	51.65	21.1	27.00	2.450	21.00	1.600	13.60	0.650	8.70	0.280	5.70	0.180	3.90	0.105
20,000	44.56	81.43	44.01	57.40	24.6	29.60	2.800	22.60	1.800	14.20	0.730	9.10	0.310	6.00	0.200	4.00	0.115

For pipe lengths other than 100 feet, the pressure drop is proportional to the length. Thus, for 50 feet of pipe, the pressure drop is approximately one half the value given in the table or 300 feet, three times the given value, etc.

Velocity is a function of the cross sectional flow area; thus, it is constant for a given flow rate and is independent of pipe length.

Extracted from Technical Paper No. 410, Flow of Fluids, with permission of Crane Co.

Conversions, Equivalents, and Physical Data

Flow of Air Through Schedule 40 Steel Pipes										
FREE AIR Q ^M	COMPRESSED AIR	PRESSURE DROP OF AIR IN POUNDS PER SQUARE INCH PER 100 FEET OF SCHEDULE 40 PIPE FOR AIR AT 100 POUNDS PER SQUARE INCH GAUGE PRESSURE AND 60°F TEMPERATURE								
		1/8-Inch	1/4-Inch	3/8-Inch	1/2-Inch	3/4-Inch	1-Inch	1-1/4-Inch	1-1/2-Inch	2-Inch
Cubic Feet per Minute at 60°F and 14.7 psia	Cubic Feet per Minute at 60°F and 100 psig									
1	0.128	0.361	0.083	0.018						
2	0.256	1.31	0.285	0.064	0.020					
3	0.384	3.06	0.605	0.133	0.042					
4	0.513	4.83	1.04	0.226	0.071					
5	0.641	7.45	1.58	0.343	0.106	0.027				
6	0.769	10.6	2.23	0.408	0.148	0.037				
8	1.025	18.6	3.89	0.848	0.255	0.062	0.019			
10	0.282	28.7	5.96	1.26	0.356	0.094	0.029			
15	1.922	----	13.0	2.73	0.834	0.201	0.062			
20	2.563	----	22.8	4.76	1.43	0.345	0.102	0.026		
25	3.204	----	35.6	7.34	2.21	0.526	0.156	0.039	0.019	
30	3.845	----	----	10.5	3.15	0.748	0.219	0.055	0.026	
35	4.486	----	----	14.2	4.24	1.00	0.293	0.073	0.035	
40	5.126	----	----	18.4	5.49	1.30	0.379	0.095	0.044	
45	5.767	----	----	23.1	6.90	1.62	0.474	0.116	0.055	
50	6.408			28.5	8.49	1.99	0.578	0.149	0.067	0.019
60	7.690	2-1/2-Inch		40.7	12.2	2.85	0.819	0.200	0.094	0.027
70	8.971			----	16.5	3.83	1.10	0.270	0.126	0.036
80	10.25	0.019		----	21.4	4.96	1.43	0.350	0.162	0.046
90	11.53	0.023		----	27.0	6.25	1.80	0.437	0.203	0.058
100	12.82	0.029	3-Inch		33.2	7.69	2.21	0.534	0.247	0.070
125	16.02	0.044			----	11.9	3.39	0.825	0.380	0.107
150	19.22	0.062	0.021		----	17.0	4.87	1.17	0.537	0.151
175	22.43	0.083	0.028	3-1/2-Inch	----	23.1	6.60	1.58	0.727	0.205
200	25.63	0.107	0.036		----	30.0	8.54	2.05	0.937	0.264
225	28.84	0.134	0.045	0.022		37.9	10.8	2.59	1.19	0.331
250	32.04	0.164	0.055	0.027		----	13.3	3.18	1.45	0.404
275	35.24	0.191	0.066	0.032		----	16.0	3.83	1.75	0.484
300	38.45	0.232	0.078	0.037		----	19.0	4.56	2.07	0.573
325	41.65	0.270	0.090	0.043	4-Inch	----	22.3	5.32	2.42	0.673
350	44.87	0.313	0.104	0.050		----	25.8	6.17	2.80	0.776
375	48.06	0.356	0.119	0.057	0.030	----	29.6	7.05	3.20	0.887
400	51.26	0.402	0.134	0.064	0.034	----	33.6	8.02	3.64	1.00
425	54.47	0.452	0.151	0.072	0.038	----	37.9	9.01	4.09	1.13
450	57.67	0.507	0.168	0.081	0.042	----	----	10.2	4.59	1.26
475	60.88	0.562	0.187	0.089	0.047		----	11.3	5.09	1.40
500	64.08	0.623	0.206	0.099	0.052		----	12.5	5.61	1.55
550	70.49	0.749	0.248	0.118	0.062		----	15.1	6.79	1.87
600	76.90	0.887	0.293	0.139	0.073	5-Inch	----	18.0	8.04	2.21
650	83.30	1.04	0.342	0.163	0.086		----	21.1	9.43	2.60
700	89.71	1.19	0.395	0.188	0.099	0.032		24.3	10.9	3.00
750	96.12	1.36	0.451	0.214	0.113	0.036		27.9	12.6	3.44
800	102.5	1.55	0.513	0.244	0.127	0.041		31.8	14.2	3.90
850	108.9	1.74	0.576	0.274	0.144	0.046	6-Inch	35.9	16.0	4.40
900	115.3	1.95	0.642	0.305	0.160	0.051		40.2	18.0	4.91
950	121.8	2.18	0.715	0.340	0.178	0.057	0.023	----	20.0	5.47
1,000	128.2	2.40	0.788	0.375	0.197	0.063	0.025	----	22.1	6.06
1,100	141.0	2.89	0.948	0.451	0.236	0.075	0.030	----	26.7	7.29
1,200	153.8	3.44	1.13	0.533	0.279	0.089	0.035	----	31.8	8.63
1,300	166.6	4.01	1.32	0.626	0.327	0.103	0.041	----	37.3	10.1

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Conversions, Equivalents, and Physical Data

Flow of Air Through Schedule 40 Steel Pipes (continued)										
FREE AIR Q ^M	COMPRESSED AIR	PRESSURE DROP OF AIR IN POUNDS PER SQUARE INCH PER 100 FEET OF SCHEDULE 40 PIPE FOR AIR AT 100 POUNDS PER SQUARE INCH GAUGE PRESSURE AND 60°F TEMPERATURE								
Cubic Feet per Minute at 60°F and 14.7 psia	Cubic Feet per Minute at 60°F and 100 psig	2-1/2-Inch	3-Inch	3-1/2-Inch	4-Inch	5-Inch	6-Inch	8-Inch	10-Inch	12-Inch
1,400	179.4	4.65	1.52	0.718	0.377	0.119	0.047			11.8
1,500	192.2	5.31	1.74	0.824	0.431	0.136	0.054			13.5
1,600	205.1	6.04	1.97	0.932	0.490	0.154	0.061			15.3
1,800	230.7	7.65	2.50	1.18	0.616	0.193	0.075			19.3
2,000	256.3	9.44	3.06	1.45	0.757	0.237	0.094	0.023		23.9
2,500	320.4	14.7	4.76	2.25	1.17	0.366	0.143	0.035		37.3
3,000	384.5	21.1	6.82	3.20	1.67	0.524	0.204	0.051	0.016	
3,500	448.6	28.8	9.23	4.33	2.26	0.709	0.276	0.068	0.022	
4,000	512.6	37.6	12.1	5.66	2.94	0.919	0.358	0.088	0.028	12-Inch
4,500	576.7	47.6	15.3	7.16	3.69	1.16	0.450	0.111	0.035	
5,000	640.8	----	18.8	8.85	4.56	1.42	0.552	0.136	0.043	0.018
6,000	769.0	----	27.1	12.7	6.57	2.03	0.794	0.195	0.061	0.025
7,000	897.1	----	36.9	17.2	8.94	2.76	1.07	0.262	0.082	0.034
8,000	1025	----	----	22.5	11.7	3.59	1.39	0.339	0.107	0.044
9,000	1153	----	----	28.5	14.9	4.54	1.76	0.427	0.134	0.055
10,000	1282	----	----	35.2	18.4	5.60	2.16	0.526	0.164	0.067
11,000	1410	----	----	----	22.2	6.78	2.62	0.633	0.197	0.081
12,000	1538	----	----	----	26.4	8.07	3.09	0.753	0.234	0.096
13,000	1666	----	----	----	31.0	9.47	3.63	0.884	0.273	0.112
14,000	1794	----	----	----	36.0	11.0	4.21	1.02	0.316	0.129
15,000	1922	----	----	----	----	12.6	4.84	1.17	0.364	0.148
16,000	2051	----	----	----	----	14.3	5.50	1.33	0.411	0.167
18,000	2307	----	----	----	----	18.2	6.96	1.68	0.520	0.213
20,000	2563	----	----	----	----	22.4	8.60	2.01	0.642	0.260
22,000	2820	----	----	----	----	27.1	10.4	2.50	0.771	0.314
24,000	3076	----	----	----	----	32.3	12.4	2.97	0.918	0.371
26,000	3332	----	----	----	----	37.9	14.5	3.49	1.12	0.435
28,000	3588	----	----	----	----	----	16.9	4.04	1.25	0.505
30,000	3845	----	----	----	----	----	19.3	4.64	1.42	0.520

Extracted from Technical Paper No. 410, Flow of Fluids, with permission of Crane Co.

Conversions, Equivalents, and Physical Data

Average Properties of Propane	
Formula	C ₃ H ₈
Boiling Point, °F (°C)	-44 (-42)
Specific Gravity of Gas (Air = 1.00)	1.53
Pounds per Gallon of Liquid at 60°F (16°C)	4.24
BTU per Gallon of Gas at 60°F (16°C)	91,547
BTU per Pound of Gas	21,591
BTU per Cubic Foot of Gas at 60°F (16°)	2516
Cubic Feet of Vapor at 60°F (16°C) per Gallon of Liquid at 60°F (16°C)	36.39
Cubic Feet of Vapor at 60°F (16°C) per Pound of Liquid at 60°F (16°)	8.547
Latent Heat of Vaporization at Boiling Point, BTU per Gallon	785.0
Combustion Data	
Cubic Feet of Air Required to Burn 1 Cubic Foot of Gas	23.86
Flash Point, °F (°C)	-156 (-104)
Ignition Temperature in Air, °F (°C)	920 to 1020 (493 to 549)
Maximum Flame Temperature in Air, °F (°C)	3595 (1979)
Limits of Inflammability, Percentage of Gas in Air Mixture	
at Lower Limit	2.4%
at Upper Limit	9.6%
Octane Number (ISO Octane = 100)	Over 100

Standard Domestic Propane Tank Specifications			
CAPACITY	DIAMETER	LENGTH	TANK WEIGHT
Gallons (Liters)	Inches (mm)	Inches (mm)	Pounds (kg)
120 (454)	24 (610)	68 (1727)	288 (131)
150 (568)	24 (610)	84 (2134)	352 (160)
200 (757)	30 (762)	79 (2007)	463 (210)
250 (946)	30 (762)	94 (2387)	542 (246)
325 (1230)	30 (762)	119 (3023)	672 (305)
500 (1893)	37 (940)	119 (3023)	1062 (482)
1000 (3785)	41 (1041)	192 (4877)	1983 (900)

Approximate Vaporization Capacities of Propane Tanks		
BTU PER HOUR WITH 40% LIQUID IN DOMESTIC TANK SYSTEMS		
Tank Size Water Capacity	Prevailing Air Temperature	
	20°F (-7°C)	60°F (16°)
120	235,008	417,792
150	290,304	516,096
200	341,280	606,720
250	406,080	721,920
325	514,100	937,900
500	634,032	1,127,168
1000	1,088,472	1,978,051

Orifice Capacities for Propane			
ORIFICE OR DRILL SIZE	ORIFICE CAPACITY BTU PER HOUR, 11-INCHES W.C.	ORIFICE OR DRILL SIZE	ORIFICE CAPACITY BTU PER HOUR, 11-INCHES W.C.
0.008	519	51	36531
0.009	656	50	39842
0.010	812	49	43361
0.011	981	48	46983
0.012	1169	47	50088
80	1480	46	53296
79	1708	45	54641
78	2080	44	60229
77	2629	43	64369
76	3249	42	71095
75	3581	41	74924
74	4119	40	78029
73	4678	39	80513
72	5081	38	83721
71	5495	37	87860
70	6375	36	92207
69	6934	35	98312
68	7813	34	100175
67	8320	33	103797
66	8848	32	109385
65	9955	31	117043
64	10535	30	134119
63	11125	29	150366
62	11735	28	160301
61	12367	27	168580
60	13008	26	175617
59	13660	25	181619
58	14333	24	187828
57	15026	23	192796
56	17572	22	200350
55	21939	21	205525
54	24630	20	210699
53	28769	19	223945
52	32805	18	233466

BTU per cubic foot = 2516
 Specific Gravity = 1.52
 Pressure at orifice, inches of water column = 11
 Orifice Coefficient = 0.9

Conversions, Equivalents, and Physical Data

Pipe and Tubing Sizing													
PROPANE PIPE AND TUBING SIZING BETWEEN SINGLE OR SECOND STAGE LOW PRESSURE REGULATORS AND APPLIANCES													
Pipe or Tubing Length, Feet	Copper Tubing Size, Outside Diameter (Inside Diameter), Type L					Pipe or Tubing Length, Feet	Nominal Pipe Size, Outside Diameter (Inside Diameter), Schedule 40						
	3/8 (0.315)	1/2 (0.430)	5.8 (0.545)	3/4 (0.666)	7/8 (0.785)		1/2 (0.622)	3.4 (0.824)	1 (1.049)	1-1/4 (1.380)	1-1/2 (1.610)	2 (2.067)	
10	49	110	206	348	536	10	291	608	1146	2353	3525	6789	
20	34	76	151	239	368	20	200	418	788	1617	2423	4666	
30	27	61	114	192	296	30	161	336	632	1299	1946	3747	
40	23	52	97	164	253	40	137	282	541	1111	1665	3207	
50	20	46	86	146	224	50	122	557	480	985	1476	2842	
60	19	42	78	132	203	60	110	231	435	892	1337	2575	
70	17	39	72	121	187	80	94	198	372	764	1144	2204	
80	16	36	67	113	174	100	84	175	330	677	1014	1954	
90	15	34	63	106	163	125	74	155	292	600	899	1731	
100	14	32	59	100	154	150	67	141	265	544	815	1569	
150	11	26	48	80									

To convert to capacities in cubic feet per hour, divide by 2.5
 Note: Maximum undiluted propane capacities listed are based on 11-inches w.c. setting and a 0.5-inch w.c. pressure drop - Capacities in 1,000 BTU per hour.

Vapor Pressures of Propane							
TEMPERATURE	PRESSURE	TEMPERATURE	PRESSURE	TEMPERATURE	PRESSURE	TEMPERATURE	PRESSURE
°F (°C)	Psig (Bar)	°F (°C)	Psig (Bar)	°F (°C)	Psig (Bar)	°F (°C)	Psig (Bar)
130 (54)	257 (18)	70 (21)	109 (8)	20 (-7)	40 (2,8)	-20 (-29)	10 (0,69)
120 (49)	225 (16)	65 (18)	100 (6,9)	10 (-12)	31 (2)	-25 (-32)	8 (0,55)
110 (43)	197 (14)	60 (16)	92 (6)	0 (-17)	23 (2)	-30 (-34)	5 (0,34)
100 (38)	172 (12)	50 (10)	77 (5)	-5 (-21)	20 (1,4)	-35 (-37)	3 (0,21)
90 (32)	149 (10)	40 (4)	63 (4)	-10 (-23)	16 (1)	-40 (-40)	1 (0,069)
80 (27)	128 (9)	30 (-1)	51 (4)	-15 (-26)	13 (1)	-44 (-42)	0 (0)

Converting Volumes of Gas		
CFH TO CFH OR CFM TO CFM		
Multiply Flow of	By	To Obtain Flow of
Air	0.707	Butane
	1.290	Natural Gas
	0.808	Propane
Butane	1.414	Air
	1.826	Natural Gas
	1.140	Propane
Natural Gas	0.775	Air
	0.547	Butane
	0.625	Propane
Propane	1.237	Air
	0.874	Butane
	1.598	Natural Gas

BTU Comparisons		
COMMON FUELS	PER GALLON	PER POUND
Propane	91,547	21,591
Butane	102,032	21,221
Gasoline	110,250	20,930
Fuel Oil	134,425	16,960

Conversions, Equivalents, and Physical Data

Capacities of Spuds and Orifices																					
DRILL DESIGNATION	DIAMETER, INCHES	AREA, SQUARE INCHES	CAPACITIES IN CFH OF 0.6 GRAVITY HIGH PRESSURE NATURAL GAS AND AN ORIFICE COEFFICIENT OF 1.0																		
			Upstream Pressure, Psi Gauge																		
			1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	25	30	40	50
80	0.0135	0.000143	1.61	2.26	2.76	3.17	3.52	3.84	4.13	4.40	4.65	4.88	5.31	5.65	6.05	6.44	6.84	7.82	8.80	10.8	12.8
79	0.0145	0.000163	1.85	2.61	3.18	3.65	4.06	4.43	4.77	5.07	5.36	5.63	6.12	6.52	6.98	7.43	7.89	9.02	10.2	12.5	14.7
1/64"	0.0156	0.000191	2.14	3.02	3.68	4.23	4.70	5.13	5.52	5.87	6.20	6.51	7.09	7.55	8.08	8.61	9.13	10.5	11.8	14.4	17.1
78	0.0160	0.000201	2.26	3.18	3.88	4.45	4.94	5.40	5.81	6.18	6.53	6.85	7.46	7.95	8.50	9.05	9.61	11.0	12.4	15.2	17.9
77	0.0180	0.000234	2.85	4.02	4.90	5.62	6.25	6.82	7.34	7.81	8.25	8.66	9.42	10.1	10.8	11.5	12.2	13.9	15.7	19.2	22.7
76	0.0200	0.000314	3.53	4.97	6.05	6.95	7.72	8.43	9.07	9.65	10.2	10.8	11.7	12.5	13.3	14.2	15.0	17.2	19.4	23.7	28.0
75	0.0210	0.000346	3.89	5.48	6.67	7.65	8.51	9.29	10.0	10.7	11.3	11.8	12.9	13.7	14.7	15.6	16.6	19.0	21.3	26.1	30.9
74	0.0225	0.000398	4.47	7.08	7.67	8.80	9.78	10.7	11.5	12.4	13.0	13.6	14.8	15.8	16.9	18.0	19.1	21.8	24.5	30.0	35.5
73	0.0240	0.000452	5.08	7.16	8.71	10.0	11.2	12.2	13.1	13.9	14.7	15.4	16.8	17.9	19.1	20.4	21.6	24.7	27.6	34.1	40.3
72	0.0250	0.000491	5.52	7.78	9.46	10.9	12.1	13.2	14.2	15.1	16.0	16.8	18.3	19.4	20.8	22.1	23.5	26.9	30.3	37.0	43.8
71	0.0260	0.000531	5.97	8.41	10.3	11.8	13.1	14.3	15.4	16.4	17.3	18.1	19.7	21.0	22.5	23.9	25.4	29.1	32.7	40.0	47.3
70	0.0280	0.000616	6.92	9.75	11.9	13.7	15.2	16.6	17.8	19.0	20.0	21.0	22.9	24.4	26.1	27.8	29.5	33.8	38.0	46.4	54.9
69	0.0292	0.000670	7.53	10.6	13.0	14.9	16.5	18.0	19.4	20.0	21.8	22.9	24.9	26.5	28.4	30.2	32.1	36.7	41.3	50.5	59.7
68	0.0310	0.000735	8.48	12.0	14.6	16.7	18.6	20.3	21.9	23.2	24.5	25.8	28.0	29.9	32.0	34.0	36.1	41.3	46.5	56.9	67.3
1/32"	0.0313	0.000765	8.59	12.2	14.8	17.0	18.8	20.6	22.1	23.5	24.9	26.1	28.4	30.3	32.4	34.5	36.6	41.9	47.1	57.7	68.2
67	0.0320	0.000804	9.03	12.8	15.5	17.8	19.8	21.6	23.3	24.7	26.1	27.4	29.9	31.8	34.0	36.2	38.5	44.0	49.5	60.6	71.7
66	0.0330	0.000855	9.60	13.6	16.5	18.9	21.1	23.0	24.7	26.3	27.6	29.2	31.8	33.8	36.2	38.5	40.9	46.8	52.7	64.4	76.2
65	0.0350	0.000962	10.8	15.3	18.6	21.3	23.7	25.9	27.8	29.6	31.3	32.8	35.7	38.1	40.7	43.4	46.0	52.6	59.2	72.5	85.7
64	0.0360	0.001018	11.5	16.2	19.7	22.6	25.1	27.4	29.4	31.3	33.1	34.7	37.8	40.3	42.4	45.9	48.7	55.7	62.7	76.7	90.7
63	0.0370	0.001075	12.1	17.1	20.8	23.8	26.5	28.9	31.1	33.1	34.9	36.7	39.9	42.5	45.5	48.4	51.4	58.8	66.2	81.0	95.8
62	0.0380	0.001134	12.8	18.0	21.9	25.1	27.9	30.5	32.8	34.9	36.8	38.7	42.1	44.8	48.0	51.1	54.2	62.0	69.8	85.4	101
61	0.0390	0.001195	13.5	19.0	23.1	26.5	29.4	32.1	34.6	36.8	38.8	40.8	44.4	47.3	50.6	53.8	57.1	65.4	73.6	90.0	107
60	0.0400	0.001257	14.2	19.9	24.3	27.8	30.9	33.8	36.4	38.7	40.8	42.9	46.7	49.7	53.2	56.6	60.1	68.7	77.4	94.7	112
59	0.0410	0.001320	14.9	20.9	25.5	29.2	32.5	35.5	38.2	40.6	42.9	45.0	49.0	52.2	55.8	59.5	63.1	72.2	81.3	99.5	118
58	0.0420	0.001385	15.6	22.0	26.7	30.7	34.1	37.2	40.0	42.6	45.0	47.2	51.4	54.8	58.6	62.4	66.2	75.7	85.3	105	124
57	0.0430	0.001452	16.3	23.0	28.0	32.1	35.7	39.0	42.0	44.7	47.2	49.5	53.9	57.4	61.4	65.4	69.4	79.4	89.4	110	130
56	0.0465	0.001698	19.1	26.9	32.8	37.6	41.8	45.6	49.1	52.2	55.1	57.9	63.0	67.1	71.8	76.5	81.2	92.8	105	128	152
3/64"	0.0469	0.00173	19.5	27.4	33.4	38.3	42.6	46.5	50.0	53.2	56.2	59.0	64.2	68.4	73.2	77.9	82.7	94.6	107	131	155
55	0.0520	0.00212	23.8	33.6	40.9	46.9	52.1	57.0	61.3	65.2	68.8	72.3	78.7	83.8	89.6	95.5	102	116	131	160	189
54	0.0550	0.00238	26.8	37.7	45.9	52.7	58.5	63.9	68.8	73.2	77.3	81.1	88.3	94.1	101	108	114	132	147	180	212
53	0.0595	0.00278	31.1	44.0	53.6	61.5	68.4	74.7	80.3	85.4	90.3	94.7	104	110	118	126	133	152	172	210	248
1/16"	0.0625	0.00307	34.5	48.6	59.2	67.9	75.5	82.5	88.8	94.4	99.7	105	114	122	130	139	147	168	189	232	274
52	0.0635	0.00317	35.6	50.2	61.1	70.1	78.0	85.1	91.6	97.4	103	108	118	126	134	143	152	174	196	239	283
51	0.0670	0.00353	39.7	55.9	68.0	78.1	86.8	94.8	102	109	115	121	131	140	150	159	169	193	218	266	315
50	0.0700	0.00385	43.3	61.0	74.2	85.2	94.7	104	112	119	125	132	143	153	163	174	184	211	237	290	343
49	0.0730	0.00419	47.1	66.4	80.8	92.7	103	113	121	129	136	143	156	166	178	189	201	229	258	316	374
48	0.0760	0.00454	51.0	71.9	87.5	101	112	122	132	140	148	155	169	180	192	205	217	249	280	342	405
5/64"	0.0781	0.00479	53.8	75.9	92.3	106	118	129	134	148	156	164	178	190	203	216	229	262	295	361	427
47	0.0785	0.00484	54.4	76.6	93.3	107	119	130	140	149	158	165	180	192	205	218	232	265	298	365	432
46	0.0810	0.00515	57.9	81.6	99.2	114	127	139	149	159	168	176	191	204	218	232	246	282	317	388	459
45	0.0820	0.00528	59.3	83.6	102	117	130	141	153	163	172	180	196	209	224	238	253	289	325	398	471
44	0.0860	0.00582	65.3	92.1	113	129	143	157	169	179	189	199	216	230	246	262	278	319	359	439	519
43	0.0890	0.00622	69.9	98.5	120	138	153	167	180	192	202	212	231	246	263	280	298	340	383	469	555
42	0.0935	0.00687	77.2	109	133	152	169	185	199	212	223	234	255	272	291	310	329	376	423	518	612
3/32"	0.0937	0.00690	77.5	110	133	153	170	186	200	212	224	235	256	273	292	311	350	378	425	520	615
41	0.0960	0.00724	81.3	115	140	161	178	195	210	223	235	247	269	287	306	326	346	396	446	546	645
40	0.0980	0.00754	84.7	120	146	167	186	203	218	232	245	257	280	298	319	340	361	413	464	568	672
39	0.0995	0.00778	87.4	124	150	172	192	209	225	239	253	265	289	308	329	351	372	426	479	585	693
38	0.1015	0.00809	90.9	128	156	179	199	218	234	249	263	276	300	320	342	365	387	443	498	610	721
37	0.1040	0.00849	95.4	135	164	188	209	228	246	261	276	290	315	336	359	383	406	464	523	640	757

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Conversions, Equivalents, and Physical Data

Capacities of Spuds and Orifices (continued)																					
DRILL DESIGNATION	DIAMETER, INCHES	AREA, SQUARE INCHES	CAPACITIES IN CFH OF 0.6 GRAVITY HIGH PRESSURE NATURAL GAS AND AN ORIFICE COEFFICIENT OF 1.0																		
			Upstream Pressure, Psi Gauge																		
			1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	25	30	40	50
36	0.1065	0.00891	100	141	172	197	219	240	258	274	290	304	331	352	377	402	426	487	549	671	794
7/64"	0.1094	0.00940	106	149	182	208	231	253	272	289	305	321	349	372	398	424	449	514	579	708	838
35	0.1100	0.00950	107	151	183	210	234	255	275	292	309	324	353	376	402	428	454	520	585	716	847
34	0.1110	0.00968	109	154	187	214	238	260	280	298	315	330	359	383	410	436	463	530	596	729	863
33	0.1130	0.01003	113	159	194	222	247	270	290	309	326	342	372	396	424	452	480	549	618	756	894
32	0.1160	0.01057	119	168	204	234	260	284	306	325	343	360	392	418	447	476	505	578	651	796	942
31	0.1200	0.01131	127	179	218	250	278	304	327	348	367	386	420	447	478	510	541	619	696	852	1010
1/8"	0.1250	0.01227	138	195	237	272	302	330	355	377	399	418	456	485	519	553	587	671	756	924	1100
30	0.1285	0.01296	146	206	250	287	319	348	375	399	421	442	481	512	548	584	620	709	798	976	1160
29	0.1360	0.01433	164	230	280	322	357	390	420	447	472	495	539	575	615	655	695	795	893	1100	1300
28	0.1405	0.01549	174	246	299	343	381	416	448	476	503	528	575	612	655	698	740	847	954	1170	1380
9/64"	0.1406	0.01553	175	246	300	344	382	417	449	478	504	529	576	614	657	700	742	849	956	1170	1390
27	0.1440	0.01629	183	258	314	361	401	438	471	501	529	555	605	644	689	734	779	891	1010	1230	1460
26	0.1470	0.01697	191	269	327	376	417	456	491	522	551	579	630	671	718	764	811	928	1050	1280	1520
25	0.1495	0.01755	197	278	339	388	432	472	507	540	570	598	651	694	742	790	839	960	1080	1330	1570
24	0.1520	0.01815	204	288	350	402	446	490	525	558	589	619	674	718	768	818	867	992	1120	1370	1620
23	0.1540	0.01863	210	295	359	412	458	501	539	573	605	635	691	737	788	839	890	1020	1150	1410	1660
5/32"	0.1562	0.01917	216	304	370	424	472	515	554	589	623	653	711	758	811	863	916	1050	1180	1450	1710
22	0.1570	0.01936	218	307	373	428	476	520	560	595	629	660	713	765	819	872	925	1060	1200	1460	1730
21	0.1590	0.01986	223	315	383	440	488	534	574	611	645	677	737	785	840	894	949	1090	1230	1500	1770
20	0.1610	0.02036	229	323	393	451	501	547	589	626	661	694	756	805	861	917	973	1120	1260	1540	1820
19	0.1660	0.02164	243	343	417	479	532	581	625	665	703	738	803	855	915	975	1040	1190	1340	1630	1930
18	0.1695	0.02256	254	358	435	499	555	606	652	694	733	769	837	892	954	1020	1080	1240	1390	1700	2010
11/64"	0.1719	0.02320	261	368	447	513	571	623	671	713	753	790	861	917	981	1050	1110	1270	1430	1750	2070
17	0.1730	0.02351	264	373	453	520	578	632	680	723	763	801	872	929	994	1060	1130	1290	1450	1770	2100
16	0.1770	0.02461	277	390	475	545	605	661	711	756	799	839	913	973	1040	1110	1180	1350	1520	1860	2200
15	0.1800	0.02345	286	403	491	563	626	684	736	782	826	868	944	1010	1080	1150	1220	1400	1570	1920	2270
14	0.1820	0.02602	293	412	502	576	640	699	752	800	845	887	965	1030	1100	1180	1250	1430	1610	1960	2320
13	0.1850	0.02688	302	426	518	595	661	722	777	826	873	916	997	1060	1140	1210	1290	1470	1660	2030	2400
3/16"	0.1875	0.02761	310	437	532	611	679	742	798	849	896	941	1030	1100	1170	1250	1320	1510	1700	2080	2460
12	0.1890	0.02806	315	445	541	621	690	754	811	862	911	956	1050	1110	1190	1270	1340	1540	1730	2120	2500
11	0.1910	0.02865	322	454	552	634	704	770	828	881	930	976	1070	1140	1220	1290	1370	1570	1770	2160	2560
10	0.1930	0.02940	331	466	567	650	723	790	850	904	955	1010	1090	1170	1250	1330	1410	1610	1810	2220	2620
9	0.1960	0.03017	339	478	582	667	742	810	872	927	980	1030	1120	1200	1270	1360	1450	1650	1860	2280	2690
8	0.1990	0.03110	350	493	600	688	765	835	899	956	1010	1060	1160	1230	1320	1400	1490	1700	1920	2350	2770
7	0.2010	0.03173	357	503	612	702	780	852	917	975	1030	1090	1180	1260	1350	1430	1520	1740	1960	2390	2830
13/64"	0.2031	0.03241	364	513	625	717	797	870	937	996	1060	1110	1210	1290	1370	1460	1550	1780	2000	2450	2890
6	0.2040	0.03269	367	518	630	723	804	878	945	1010	1070	1120	1220	1300	1390	1480	1570	1790	2020	2470	2920
5	0.2055	0.03317	373	525	639	734	816	891	959	1020	1080	1130	1230	1320	1410	1500	1590	1820	2050	2500	2960
4	0.2090	0.03431	386	543	661	739	844	921	991	1060	1120	1170	1280	1360	1450	1550	1640	1880	2120	2590	2770
3	0.2130	0.03563	400	564	687	788	876	959	1030	1100	1160	1220	1330	1410	1510	1610	1710	1950	2200	2690	2830
7/32"	0.2187	0.03758	422	595	724	831	924	1010	1090	1160	1220	1280	1400	1490	1590	1700	1800	2060	2320	2830	2890
2	0.2210	0.03836	431	608	739	849	943	1030	1110	1180	1250	1310	1430	1520	1630	1730	1840	2100	2370	2890	2920
1	0.2280	0.04083	459	647	787	903	1010	1100	1180	1260	1330	1400	1520	1620	1730	1840	1950	2240	2520	3080	2960
A	0.2340	0.04301	483	681	829	951	1060	1160	1250	1330	1400	1470	1600	1700	1820	1940	2060	2360	2650	3240	3060
15/64"	0.2344	0.04314	485	683	831	954	1060	1160	1250	1330	1400	1470	1600	1710	1830	1950	2070	2360	2660	3250	3180
B	0.2380	0.04449	500	705	857	984	1100	1200	1290	1370	1450	1520	1650	1760	1880	2010	2130	2440	2740	3350	3350
C	0.2420	0.04600	517	725	879	1010	1130	1240	1330	1420	1500	1570	1710	1820	1950	2080	2200	2520	2840	3470	3420
D	0.2460	0.04733	534	733	891	1020	1140	1250	1340	1430	1520	1600	1750	1860	2000	2120	2240	2560	2930	3580	3640
E=1/4"	0.2500	0.04909	552	777	946	1090	1210	1320	1420	1510	1600	1680	1830	1940	2080	2210	2350	2690	3030	3700	4380
F	0.2570	0.05187	583	821	1000	1150	1280	1400	1500	1600	1690	1770	1930	2050	2200	2340	2480	2840	3200	3910	4620
G	0.2610	0.05350	601	847	1040	1190	1320	1440	1550	1650	1740	1830	1990	2120	2270	2410	2560	2930	3300	4030	4770
17/64"	0.2656	0.05542	623	878	1070	1230	1370	1490	1610	1710	1810	1890	2060	2190	2350	2500	2650	3030	3410	4180	4940
H	0.2660	0.05557	624	880	1070	1230	1370	1500	1610	1710	1810	1900	2070	2200	2350	2510	2660	3040	3420	4190	4950

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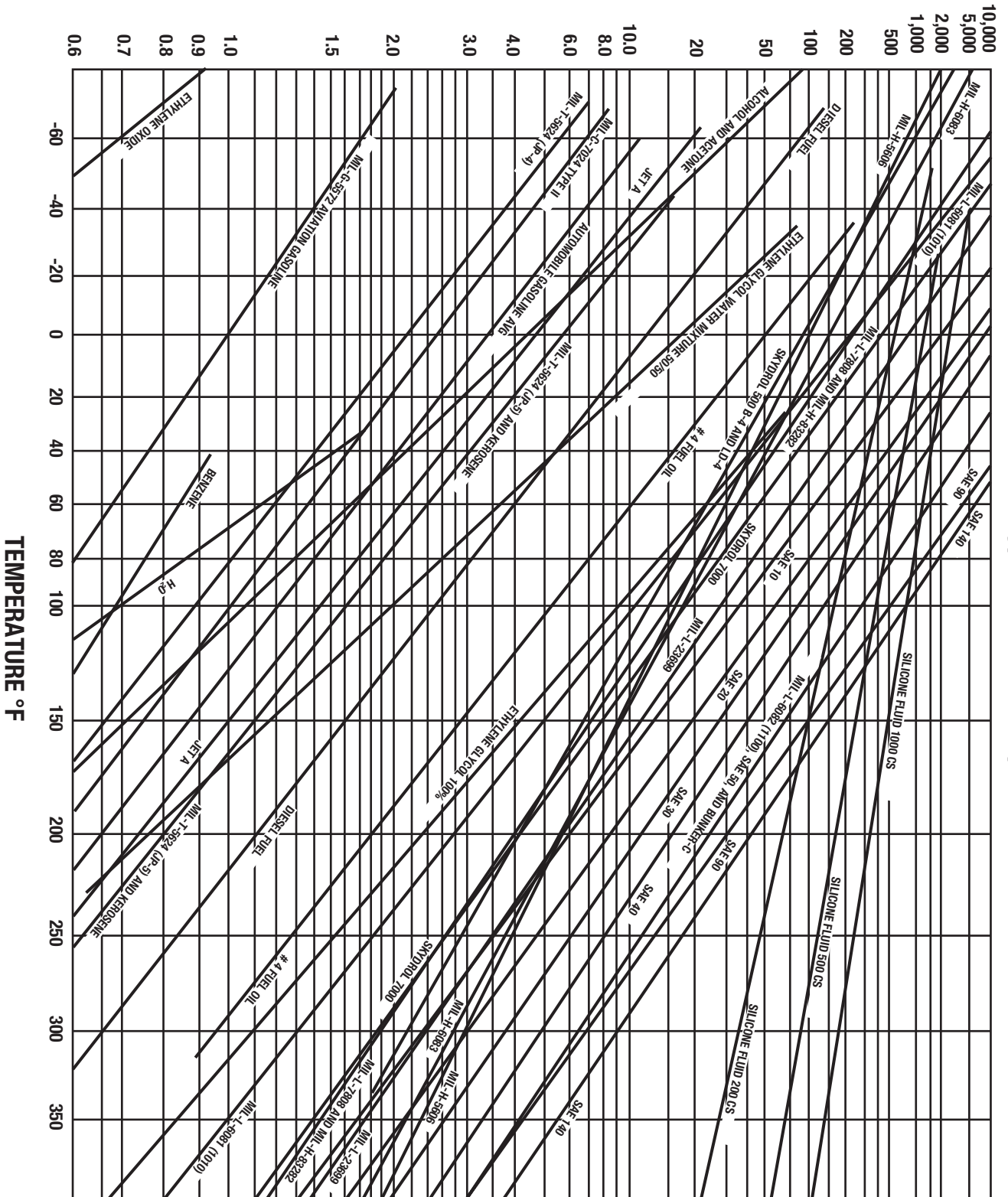
Conversions, Equivalents, and Physical Data

Capacities of Spuds and Orifices (continued)																					
DRILL DESIGNATION	DIAMETER, INCHES	AREA, SQUARE INCHES	CAPACITIES IN CFH OF 0.6 GRAVITY HIGH PRESSURE NATURAL GAS AND AN ORIFICE COEFFICIENT OF 1.0																		
			Upstream Pressure, Psi Gauge																		
			1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	25	30	40	50
I	0.2720	0.005811	653	916	1120	1290	1430	1560	1680	1790	1890	1980	2160	2300	2460	2620	2780	3180	3580	4380	5180
J	0.2770	0.006026	677	957	1170	1340	1490	1620	1750	1860	1960	2060	2240	2390	2550	2720	2880	3300	3710	4540	5370
K	0.2810	0.006102	697	983	1200	1380	1530	1670	1800	1910	2020	2120	2300	2450	2630	2800	2970	3390	3820	4680	5530
9/32"	0.2812	0.006113	698	984	1200	1380	1530	1670	1800	1910	2020	2120	2310	2460	2630	2800	2970	3400	3830	4680	5540
L	0.2900	0.006605	742	1050	1280	1460	1630	1780	1910	2030	2150	2250	2450	2610	2800	2980	3160	3610	4070	4980	5890
M	0.2930	0.006835	768	1090	1320	1520	1680	1840	1980	2100	2220	2330	2540	2710	2890	3080	3270	3740	4210	5150	6090
19/64"	0.2969	0.006922	778	1100	1340	1530	1710	1860	2000	2130	2250	2360	2570	2740	2930	3120	3310	3790	4260	5220	6170
N	0.3020	0.007163	805	1140	1380	1590	1760	1930	2070	2210	2330	2440	2660	2830	3030	3230	3430	3920	4410	5400	6390
5/16"	0.3125	0.007670	862	1220	1480	1700	1890	2060	2220	2360	2490	2620	2850	3030	3250	3460	3670	4200	4720	5780	6840
O	0.3160	0.007843	881	1250	1520	1740	1930	2110	2270	2410	2550	2660	2910	3100	3320	3540	3750	4290	4830	5910	6990
P	0.3230	0.008194	920	1300	1580	1820	2020	2200	2370	2520	2660	2800	3040	3240	3470	3690	3920	4480	5050	6180	7300
21/64"	0.3281	0.008456	950	1340	1630	1870	2080	2270	2450	2600	2750	2890	3140	3350	3580	3810	4040	4630	5210	6370	7540
Q	0.3320	0.008657	972	1370	1670	1920	2130	2330	2500	2660	2810	2950	3210	3420	3660	3900	4140	4740	5330	6520	7720
R	0.3390	0.009026	1020	1430	1740	2000	2220	2430	2607	2780	2930	3080	3350	3570	3820	4070	4320	4940	5560	6800	8040
11/32"	0.3437	0.009281	1050	1470	1790	2060	2290	2500	2690	2860	3020	3170	3450	3670	3930	4180	4440	5080	5720	6990	8270
S	0.3480	0.009511	1070	1510	1840	2110	2340	2530	2750	2930	3090	3240	3530	3760	4020	4290	4550	5200	5860	7170	8480
T	0.3580	0.01006	1130	1600	1940	2230	2480	2710	2910	3100	3270	3430	3740	4000	4260	4530	4810	5500	6200	7580	8970
23/64"	0.3594	0.01014	1140	1610	1960	2250	2500	2730	2930	3120	3300	3460	3770	4010	4290	4570	4850	5550	6240	7640	9040
U	0.3680	0.01065	1200	1690	2050	2360	2620	2860	3080	3270	3460	3630	3950	4210	4500	4790	5050	5820	6550	8020	9480
3/8"	0.3750	0.01105	1240	1750	2130	2450	2720	2970	3200	3400	3590	3770	4100	4370	4670	4980	5280	6040	6800	8330	9850
V	0.3770	0.01116	1260	1770	2150	2470	2750	3000	3230	3430	3630	3810	4140	4410	4720	5030	5340	6100	6870	8410	9950
W	0.3860	0.01170	1320	1860	2260	2590	2900	3200	3380	3600	3800	3990	4340	4630	5000	5270	5590	6350	7200	8820	10400
25/64"	0.3960	0.01198	1350	1900	2310	2650	2950	3220	3460	3680	3890	4090	4450	4740	5100	5400	5730	6550	7380	9030	10700
X	0.3970	0.01238	1390	1960	2390	2740	3050	3330	3580	3810	4020	4220	4600	4900	5240	5580	5920	6770	7620	9330	11100
Y	0.4040	0.01282	1440	2030	2470	2840	3150	3450	3710	3940	4160	4370	4760	5070	5420	5780	6130	7010	7890	9660	11500
13/32"	0.4062	0.01295	1460	2060	2500	2870	3190	3480	3750	3990	4210	4420	4810	5120	5480	5840	6200	7090	7980	9760	11600
Z	0.4130	0.01340	1510	2130	2590	2970	3300	3600	3870	4130	4350	4570	4970	5300	5670	6040	6400	7330	8250	10100	12000
27/64"	0.4219	0.01398	1570	2220	2700	3100	3440	3760	4040	4300	4540	4770	5190	5530	5910	6300	6680	7650	8610	10600	12500
7/16"	0.4375	0.01503	1690	2380	2900	3330	3700	4040	4350	4620	4880	5120	5580	5940	6360	6770	7200	8220	9250	11400	13400
29/64"	0.4531	0.01613	1820	2560	3110	3570	4000	4230	4660	5000	5140	5500	5990	6380	6820	7270	7700	8820	9930	12200	14400
15/32"	0.4687	0.01726	1940	2740	3330	3820	4250	4640	4990	5310	5610	5880	6410	6820	7300	7770	8300	9440	10700	13000	15400
31/64"	0.4844	0.01843	2070	3280	3550	4080	4530	4950	5330	5670	5990	6280	6840	7280	7790	8300	8800	10100	11400	13900	16400
1/2"	0.5000	0.01964	2210	3110	3790	4350	4830	5280	5680	6340	6380	6690	7290	7760	8310	8850	9400	10800	12100	14800	17500
33/64"	0.5156	0.02088	2350	3310	4030	4620	5140	5610	6040	6420	6780	7120	7750	8250	8490	9400	10000	11500	12900	15800	18600
17/32"	0.5313	0.02217	2490	3510	4280	4910	5450	5960	6410	6820	7200	7560	8230	8760	9370	9980	10600	12200	13700	16700	19800
35/64"	0.5469	0.02349	2640	3720	4530	5200	5780	6310	6790	7220	7630	8010	8720	9290	9930	10600	11300	12900	14500	17700	21000
9/16"	0.5625	0.02485	2790	3940	4770	5500	6110	6680	7180	7640	8070	8470	9220	9820	10500	11200	11900	13600	15300	18800	22000
37/64"	0.5781	0.02625	2950	4160	5060	5810	6450	7050	7590	8070	8520	8950	9740	10370	11100	11900	12600	14400	16200	19800	23400
19/32"	0.5938	0.2769	3110	4390	5340	6130	6810	7440	8000	8510	8990	9440	10300	10940	11700	12500	13300	15200	17100	20900	24700
39/64"	0.6094	0.2917	3280	4620	5620	6450	7170	7830	8430	8970	9470	9940	10900	11600	12400	13200	14000	16000	18000	22000	26000
5/8"	0.6250	0.3068	3450	4860	5910	6790	7540	8240	8870	9430	9960	10500	11400	12200	13000	13900	14700	16800	18900	23100	27400
41/64"	0.6406	0.3223	3620	5110	6210	7130	7920	8660	9310	9910	10500	11000	12000	12800	13700	14600	15400	17700	19900	24300	28800
21/32"	0.6562	0.3382	3800	5360	6520	7480	8320	9080	9770	10400	11000	11600	12600	13400	14300	15300	16200	18500	20900	25500	30200
43/64"	0.6719	0.3545	3980	5620	6830	7840	8720	9520	10300	10900	11500	12100	13200	14000	15000	16000	17000	19400	21900	26700	31600
11/16"	0.6875	0.3712	4170	5880	7150	8210	9130	9970	10600	11200	11800	12400	13600	14400	15500	16500	17500	20000	22600	27600	32600
23/32"	0.7188	0.4057	4560	6430	7820	8970	9970	10900	11800	12500	13200	13900	15100	16100	17200	18300	19400	22000	25000	30600	36200
3/4"	0.7500	0.4418	4960	7000	8510	9770	10900	11900	12800	13600	14400	15100	16400	17500	18700	19900	21200	24000	27200	33000	39400
25/32"	0.7812	0.4794	5390	7590	9240	10600	11800	12900	13900	14800	15600	16400	17800	19000	20300	21600	22900	26000	29500	36100	42800
13/16"	0.8125	0.5185	5830	8210	9990	11500	12800	14000	15000	16000	16900	17700	19300	20500	22000	23400	24800	28400	32000	39100	46200
27/32"	0.8438	0.5591	6280	8850	10800	12400	13800	15000	16200	17200	18200	19100	20800	22100	23700	25200	26700	30600	34400	42100	49800
7/8"	0.8750	0.6013	6760	9520	11600	13300	14800	16200	17400	18500	19600	20500	22300	23800	25500	27100	28800	32900	37000	45300	53600
29/32"	0.9062	0.6450	7250	10200	12400	14300	15900	17400	18700	19900	21000	22000	24000	25500	27400	29100	30900	35300	39700	48600	57500
15/16"	0.9375	0.6903	7750	10900	13300	15300	17000	18600	20000	21200	22400	23600	25600	27200	29100	31000	33000	37800	42500	52000	61500
31/32"	0.9688	0.7371	8280	11700	14200	16300	18200	19900	21300	22700	24000	25200	27400	29100	31200	33200	35300	40300	45400	55600	65700
1.0"	1.0000	0.7854	8820	12400	15100	17400	19300	21100	22700	24200	25500	26800	29200	31100	33200	35400	37600	43000	48400	59200	70000

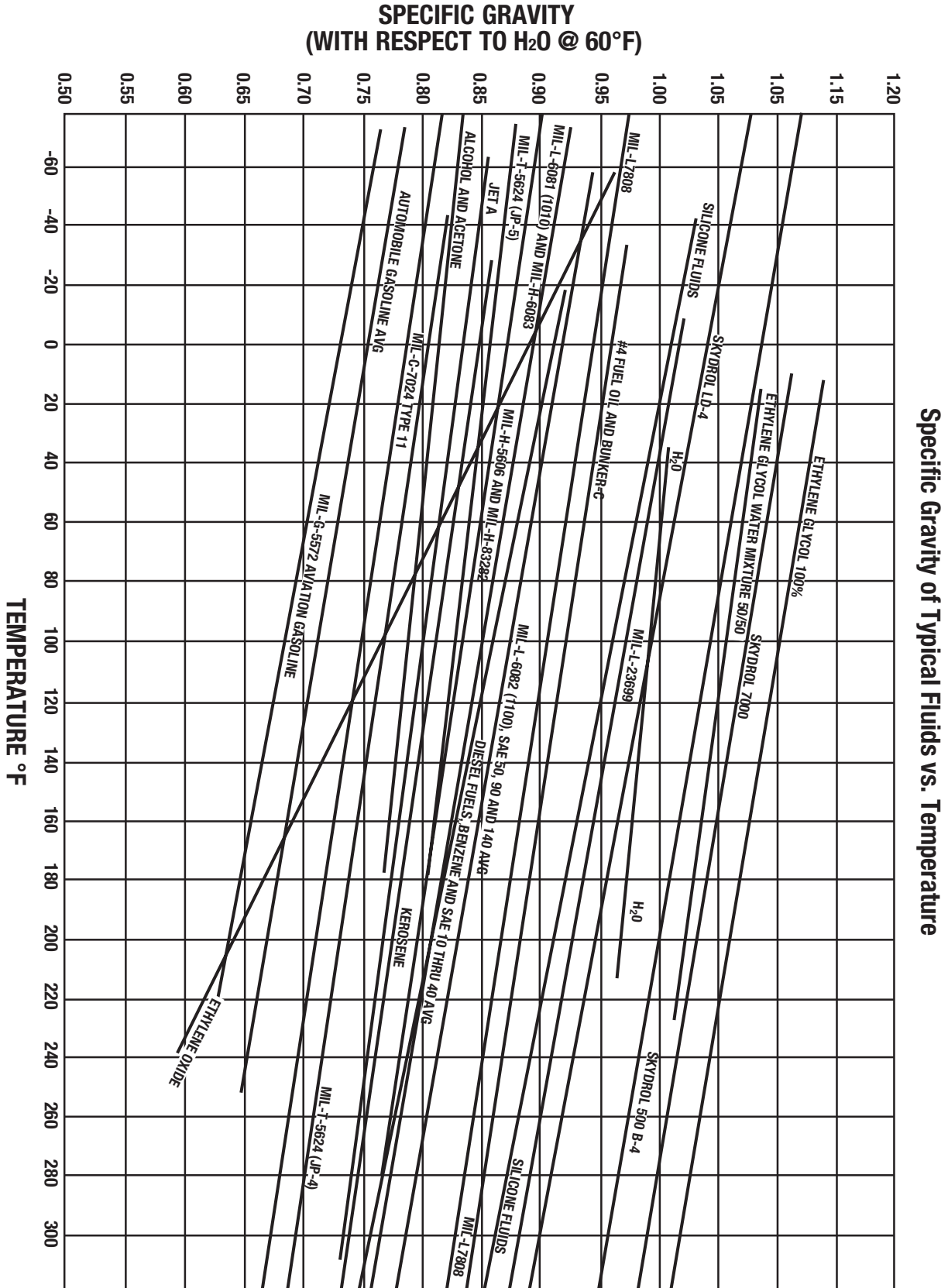
Conversions, Equivalents, and Physical Data

KINEMATIC VISCOSITY - CENTISTOKES

Viscosities of Typical Fluids vs. Temperature

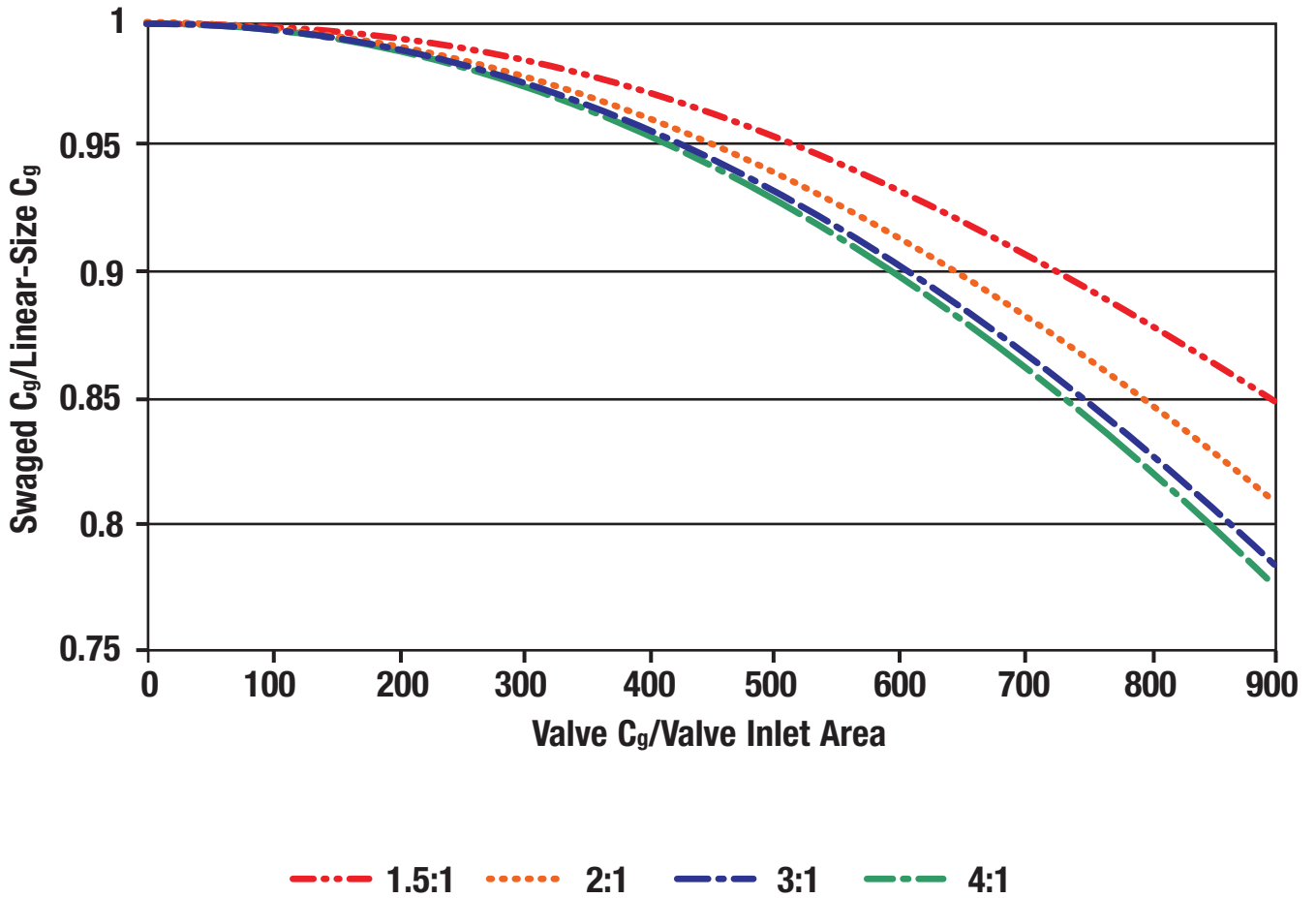


Conversions, Equivalents, and Physical Data



Conversions, Equivalents, and Physical Data

Effect of Inlet Swage On Critical Flow C_g Requirements



Conversions, Equivalents, and Physical Data

Seat Leakage Classifications (In Accordance with ANSI/FCI 70-3-2004)		
LEAKAGE CLASS DESIGNATION	DESCRIPTION	MAXIMUM LEAKAGE ALLOWABLE
I	A modification of any Class II, III or IV regulator where the design intent is the same as the basic class, but by agreement between user and supplier, no test is required.	----
II	This class establishes the maximum permissible leakage generally associated with commercial double-seat regulators with metal-to-metal seats.	0.5% of maximum Cv
III	This class establishes the maximum permissible leakage generally associated with Class II, but with a higher degree of seat and seal tightness.	0.1% of maximum Cv
IV	This class establishes the maximum permissible leakage generally associated with commercial unbalanced single-seat regulators with metal-to-metal seats.	0.01% of maximum Cv
VI	This class establishes the maximum permissible seat leakage generally associated with resilient seating regulators either balanced or unbalanced with O-rings or similar gapless seals.	Leakage per following table as expressed in ml per minute versus seat diameter.
VII	This class establishes the maximum permissible seat leakage generally associated with Class VI, but with test performed at the maximum operating differential pressure.	Leakage per following table as expressed in ml per minute versus seat diameter.

Nominal Port Diameter and Leak Rate		
NOMINAL PORT DIAMETER	LEAK RATE	
Millimeters (Inches)	Standard ml per Minute ⁽³⁾	Bubbles per Minute ⁽¹⁾
≤25 (≤1) ⁽²⁾	0,15	1 ⁽²⁾
38 (1.5)	0,30	2
51 (2)	0,45	3
64 (2.5)	0,60	4
76 (3)	0,90	6
102 (4)	1,70	11
152 (6)	4,00	27
203 (8)	6,75	45
250 (10)	11,1	----
300 (12)	16,0	----
350 (14)	21,6	----
400 (16)	28,4	----

- Bubbles per minute as tabulated are an easily measured suggested alternative based on a suitable calibrated measuring device in this case a 0.24 inch (6 mm) O.D. x 0.04 inch (1 mm) wall tube submerged in water to a depth of from 0.12 to 0.24 inch (3 to 6 mm). The tube end shall be cut square and smooth with no chamfers or burrs and the tube axis shall be perpendicular to the surface of the water. Other apparatus may be constructed and the number of bubbles per minute may differ from those shown as long as they correctly indicate the flow in ml per minute.
- If valve seat diameter differs by more than 0.08 inch (2 mm) from one of the valves listed, the leakage rate may be obtained by interpolation assuming that the leakage rate varies as the square of the seat diameter.
- Standard millimeters based on 60 °F (16 °C) and 14.73 psia (1,016 bar a).

Conversions, Equivalents, and Physical Data

Flange, Valve Size, and Pressure-Temperature Rating Designations

Sizes of ASME flanges are designated as NPS (for “nominal pipe size”). The nominal size is based on inches, but the units are not required in the designation. For example: NPS 2 is the size. Pressure ratings are designated by class. For example, CL150 is the rating. ASME designations replace ANSI designations.

Sizes of EN and ISO flanges are designated with DN (for “nominal diameter”). The nominal diameter is based on millimeters, but the units are not included in the designation. For example: DN 50 is the size. Pressure ratings are designated by PN (for “nominal pressure”). For example PN 40 is the pressure rating. EN and ISO designations replace DIN designations through PN 100.

ASME B16.5 flanges will mate with EN 1759 flanges but not with EN 1092 flanges (formerly DIN flanges). ASME B16.5 flanges will mate with most ISO 7005 flanges.

Common size designations in wide use are shown in the table below.

A summary of flange terminology is shown in the table below, and equivalency of flanges is shown in the table on the following page.

Pipe Thread Standards

There are three pipe thread standards that are accepted globally:

- NPT, ASME B1.20.1: General-purpose pipe threads (inches).
- G Series, ISO 228-1: Pipe threads for use where pressure-tight joints are not made on the threads. The internal and external threads are not tapered but are parallel or straight.
- R Series, ISO 7/1: Pipe threads for use where pressure-tight joints are made on the threads. The internal thread is parallel (straight) or tapered; external is always tapered.

Notes

Japanese (JIS) valves and flanges are designated according to JIS standards.

European Norm flange types, such as flat-face and raised-face are designated Type A, Type B, Type C. These types do not correspond to the DIN 2526 Form A, Form D, etc., designations.

Common Size Designations																	
NPS	1/2	3/4	1	1-1/2	2	2-1/2	3	4	6	8	10	12	14	16	18	20	24
DN	15	20	25	40	50	65	80	100	150	200	250	300	350	400	450	500	600

Summary of Flange Terminology			
	ASME	EUROPEAN NORM	EXAMPLE OF PRINTED PRESENTATION
Pressure Rating	CLASS	PN	CL300 or CL300, PN 40
Size	NPS	DN	NPS 2, DN 50
Pipe Threads (Internal or External)	NPT	NPT, G (Straight), R (Tapered)	G 1/4, 1/4 NPT, 1/4 NPT Internal (or External)

Conversions, Equivalents, and Physical Data

Equivalency Table					
	ISO	ASME	DIN	EUROPEAN NORM	LIMITATIONS
ASME and European Norm Only	----	Class Flanges ASME B16.5	----	EN 1759-1	Specifies ASTM materials but also permits European materials per EN 1092-1.
European Norm Only		----		EN 1092	Through PN 100 ⁽¹⁾
DIN Only		----	DIN ⁽²⁾	----	Above PN 100 ⁽¹⁾
ISO and ASME Only	ISO 7005	Class Flanges ASME B16.5		----	A few sizes are compatible to previous DIN standards. An older version contained flange designations that do not appear in the current standard.

1. DIN is no longer used except for pressure ratings above PN 100.
2. DIN standards 2628, 2629, 2638, 2548, 2549, 2550, and 2551.

Standard Pressure-Temperature Ratings for ASME CL150 Valve Bodies ⁽¹⁾					
SERVICE TEMPERATURE, °F (°C)	WORKING PRESSURE, PSIG (bar)				
	LCB	LCC/WCC	WCB	CF8 or 304	CF8M/CF3M
-20 to 100 (-29 to 38) 200 (93)	265 (18,3) 255 (17,6)	290 (20,0) 260 (17,9)	285 (19,7) 260 (17,9)	275 (19,0) 230 (15,9)	275 (19,0) 235 (16,2)
300 (149) 400 (204)	230 (15,9) 200 (13,8)	230 (15,9) 200 (13,8)	230 (15,9) 200 (13,8)	205 (14,1) 190 (13,1)	215 (14,8) 195 (13,4)
500 (260) 600 (316)	170 (11,7) 140 (9,7)	170 (11,7) 140 (9,7)	170 (11,7) 140 (9,7)	170 (11,7) 140 (9,7)	170 (11,7) 140 (9,7)
650 (343) 700 (371)	125 (8,6) 110 (7,6)	125 (8,6) 110 (7,6)	125 (8,6) 110 (7,6)	125 (8,6) 110 (7,6)	125 (8,6) 110 (7,6)

1. Table information is extracted from the Valve-Flanged, Threaded, and Welding End, ASME Standard B16.34-2004. These tables must be used in accordance with the ASME standard.

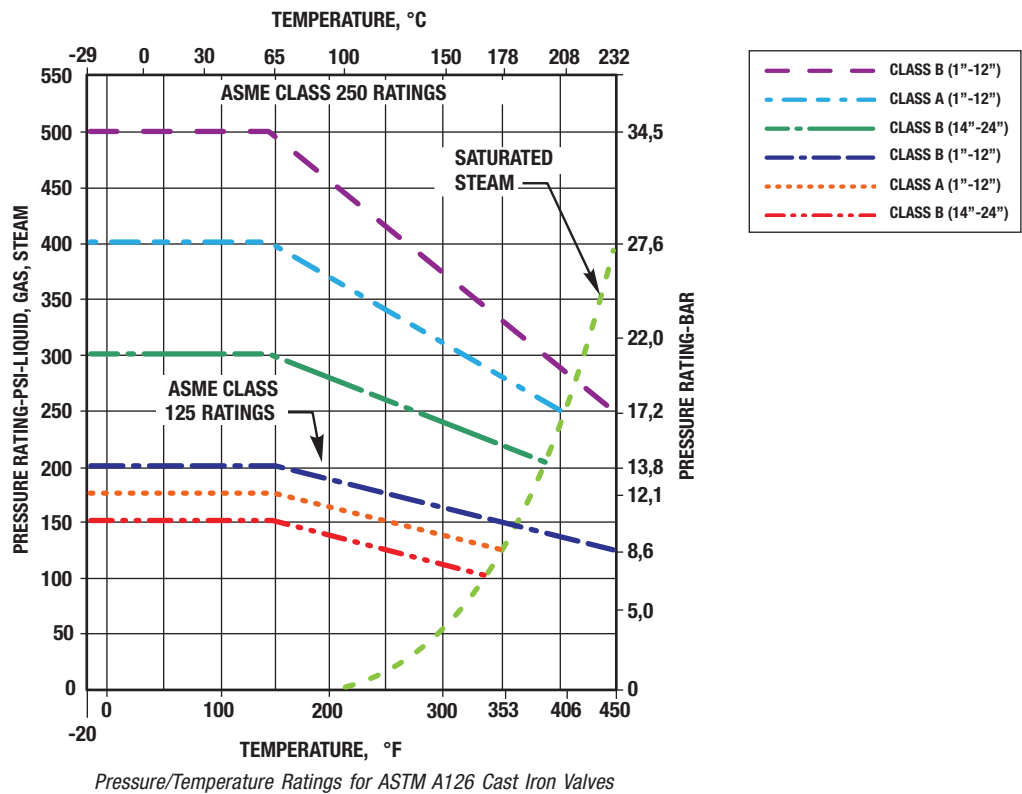
Standard Pressure-Temperature Ratings for ASME CL300 Valve Bodies ⁽¹⁾					
SERVICE TEMPERATURE, °F (°C)	WORKING PRESSURE, PSIG (bar)				
	LCB	LCC/WCC	WCB	CF8 or 304	CF8M/CF3M
-20 to 100 (-29 to 38) 200 (93)	695 (47,9) 660 (45,5)	750 (51,7) 750 (51,7)	740 (51,0) 680 (46,9)	720 (49,6) 600 (41,4)	720 (49,6) 620 (42,7)
300 (149) 400 (204)	640 (44,1) 615 (42,4)	730 (50,3) 705 (48,6)	655 (45,2) 635 (43,8)	540 (37,2) 495 (34,1)	560 (38,6) 515 (35,5)
500 (260) 600 (316)	585 (40,3) 550 (37,9)	665 (45,9) 605 (41,7)	605 (41,7) 570 (39,3)	465 (32,1) 440 (30,3)	480 (33,1) 450 (31,0)
650 (343) 700 (371)	535 (36,8) 510 (35,2)	590 (40,7) 555 (38,3)	550 (38,0) 530 (36,5)	430 (29,6) 420 (29,0)	440 (30,3) 435 (30,0)

1. Table information is extracted from the Valve-Flanged, Threaded, and Welding End, ASME Standard B16.34-2004. These tables must be used in accordance with the ASME standard.

Conversions, Equivalents, and Physical Data

Standard Pressure-Temperature Ratings for ASME CL600 Valve Bodies ⁽¹⁾					
SERVICE TEMPERATURE, °F (°C)	WORKING PRESSURE, PSIG (bar)				
	LCB	LCC/WCC	WCB	CF8 or 304	CF8M/CF3M
-20 to 100 (-29 to 38) 200 (93)	1395 (96,2) 1320 (91,0)	1500 (103) 1500 (103)	1480 (102) 1360 (93,7)	1440 (99,3) 1200 (82,7)	1440 (99,3) 1240 (85,5)
300 (149) 400 (204)	1275 (87,9) 1230 (84,8)	1455 (100) 1405 (97,0)	1310 (90,3) 1265 (87,2)	1075 (74,1) 995 (68,6)	1120 (77,2) 1025 (70,7)
500 (260) 600 (316)	1175 (81,0) 1105 (76,2)	1330 (91,7) 1210 (83,4)	1205 (83,1) 1135 (78,3)	930 (64,1) 885 (61,0)	955 (65,8) 900 (62,1)
650 (343) 700 (371)	1065 (73,4) 1025 (70,7)	1175 (81,0) 1110 (76,5)	1100 (75,8) 1060 (73,1)	865 (59,6) 845 (58,3)	885 (61,0) 870 (60,0)

1. Table information is extracted from the Valve-Flanged, Threaded, and Welding End, ASME Standard B16.34-2004. These tables must be used in accordance with the ASME standard.



Conversions, Equivalents, and Physical Data

Diameter of Bolt Circles						
NOMINAL PIPE SIZE, INCHES	ASMECL125 (CAST IRON) OR CL150 (STEEL) ⁽¹⁾	ASME CL250 (CAST IRON) OR CL300 (STEEL) ⁽²⁾	ASME CL600	ASME CL900	ASME CL1500	ASME CL2500
1	3.12	3.50	3.50	4.00	4.00	4.25
1-1/4	3.50	3.88	3.88	4.38	4.38	5.12
1-1/2	3.88	4.50	4.50	4.88	4.88	5.75
2	4.75	5.00	5.00	6.50	6.50	6.75
2-1/2	5.50	5.88	5.88	7.50	7.50	7.75
3	6.00	6.62	6.62	7.50	8.00	9.00
4	7.50	7.88	8.50	9.25	9.50	10.75
5	8.50	9.25	10.50	11.00	11.50	12.75
6	39.50	10.62	11.50	12.50	12.50	14.50
8	11.75	13.00	13.75	15.50	15.50	17.25
10	14.25	15.25	17.00	18.50	19.00	21.75
12	17.00	17.75	19.25	21.00	22.50	24.38
14	18.75	20.25	20.75	22.00	25.00	----
16	21.25	22.50	23.75	24.25	27.75	----
18	22.75	24.75	25.75	27.00	30.50	----
20	25.00	27.00	28.50	29.50	32.75	----
24	29.50	32.00	33.00	35.50	39.00	----
30	36.00	39.25	----	----	----	----
36	42.75	46.00	----	----	----	----
42	49.50	52.75	----	----	----	----
48	56.00	60.75	----	----	----	----

1. Sizes 1 through 12-inches also apply to ASME Class 150 bronze flanges.
2. Sizes 1 through 8-inches also apply to ASME Class 300 bronze flanges.

ASME Face-To-Face Dimensions for Flanged Regulators						
BODY SIZE, INCHES	ASME CLASS AND END CONNECTIONS (INCH DIMENSIONS ARE IN ACCORDANCE WITH ISA S4.01.1-1997)					
	CL125 FF (Cast Iron) CL150 RF (Steel), Inches (mm)	CL250 RF (Cast Iron) CL300 RF (Steel), Inches (mm)	CL150 RJT (Steel), Inches (mm)	CL300 RJT (Steel), Inches (mm)	CL600 RF (Steel), Inches (mm)	CL600 RJT (Steel), Inches (mm)
1	7.25 (184)	7.75 (197)	7.75 (197)	8.25 (210)	8.25 (210)	8.25 (210)
1-1/4	7.88 (200)	8.38 (213)	8.38 (213)	8.88 (226)	9.00 (229)	9.00 (229)
1-1/2	8.75 (222)	9.25 (235)	9.25 (235)	9.75 (248)	9.88 (251)	9.88 (251)
2	10.00 (254)	10.50 (267)	10.50 (267)	11.12 (282)	11.25 (286)	11.38 (289)
2-1/2	10.88 (276)	11.50 (292)	11.38 (289)	12.12 (308)	12.25 (311)	12.38 (314)
3	11.75 (298)	12.50 (317)	12.25 (311)	13.12 (333)	13.25 (337)	13.38 (340)
4	13.88 (353)	14.50 (368)	14.38 (365)	15.12 (384)	15.50 (394)	15.62 (397)
6	17.75 (451)	18.62 (473)	18.25 (464)	19.25 (489)	20.00 (508)	20.12 (511)
8	21.38 (543)	22.38 (568)	21.88 (556)	23.00 (584)	24.00 (610)	24.12 (613)
10	26.50 (673)	27.88 (708)	27.00 (686)	28.50 (724)	29.62 (752)	29.75 (756)
12	29.00 (737)	30.50 (775)	29.50 (749)	31.12 (790)	32.25 (819)	32.38 (822)
16	40.00 (1016)	41.62 (1057)	40.50 (1029)	42.25 (1073)	43.62 (1108)	43.75 (1111)

FF—Flat-faced, RF—Raised-faced, and RJT—Ring Type Joint

Conversions, Equivalents, and Physical Data

Wear and Galling Resistance Chart of Material Combinations							
MATERIAL	304 STAINLESS STEEL	316 STAINLESS STEEL	BRONZE	INCONEL®	MONEL®	HASTELLOY® C	NICKEL
304 Stainless Steel	P	P	F	P	P	F	P
316 Stainless Steel	P	P	F	P	P	F	P
Bronze	F	F	S	S	S	S	S
Inconel®	P	P	S	P	P	F	F
Monel®	P	P	S	P	P	F	F
Hastelloy® C	F	F	S	F	F	F	F
Nickel	P	P	S	P	F	F	P
Alloy 20	P	P	S	F	F	F	P
Type 416 Hard	F	F	F	F	F	F	F
Type 440 Hard	F	F	F	F	F	F	F
17-4PH	F	F	F	F	F	F	F
ENC ⁽¹⁾	F	F	F	F	F	F	F
Cr Plate	F	F	F	F	F	S	S
Al Bronze	F	F	F	S	S	S	S

1. Electroless Nickel Coating
F - Fair

S - Satisfactory
P - Poor

- continued -

Wear and Galling Resistance Chart of Material Combinations (continued)							
MATERIAL	ALLOY 20	TYPE 416 HARD	TYPE 440 HARD	17-4PH	ENC ⁽¹⁾	Cr PLATE	Al BRONZE
304 Stainless Steel	P	F	F	F	F	F	F
316 Stainless Steel	P	F	F	F	F	F	F
Bronze	S	F	F	F	F	F	F
Inconel®	F	F	F	F	F	F	S
Monel®	F	F	F	F	F	F	S
Hastelloy® C	F	F	F	F	F	S	S
Nickel	P	F	F	F	F	F	S
Alloy 20	P	F	F	F	F	F	S
Type 416 Hard	F	F	F	F	S	S	S
Type 440 Hard	F	S	F	S	S	S	S
17-4PH	F	F	S	P	S	S	S
ENC ⁽¹⁾	F	S	S	S	P	P	S
Cr Plate	S	S	S	S	S	S	S
Al Bronze	S	S	S	S	S	S	P

1. Electroless Nickel Coating
F - Fair

S - Satisfactory
P - Poor

Equivalent Lengths of Pipe Fittings and Valves																			
TYPE OF FITTING OR VALVE	LENGTHS IN FEET OF STANDARD PIPE																		
	Nominal Pipe Size in Inches																		
	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	6	8	10	12	14 O.D.	16 O.D.	18 O.D.	20 O.D.	24 O.D.	30 O.D.
Standard tee with entry or discharge through side	3.4	4.5	5.5	7.5	9.0	12	14	17	22	33	43	55	65	78	85	105	115	135	170
Standard elbow or run ⁽¹⁾ of tee reduced 1/2 ⁽²⁾	1.7	2.2	2.7	3.7	4.3	5.5	6.5	8	12	16	20	26	31	36	42	47	52	64	80
Medium sweep elbow or run ⁽¹⁾ of tee reduced 1/4 ⁽²⁾	1.3	1.8	2.3	3.0	3.7	4.6	5.4	6.8	9.0	14	18	22	26	30	35	40	43	55	67
Long sweep elbow or run ⁽¹⁾ of standard tee or butterfly valve	1	1.3	1.7	2.3	2.7	3.5	4.2	5.3	7	11	14	17	20	23	26	31	34	41	52
45° elbow	0.8	1.0	1.2	1.6	2.0	2.5	3.0	3.7	5.0	7.5	10	12	15	17	20	22	24	30	37
Close return bend	3.7	5.1	6.2	8.5	10	13	15	19	24	37	49	62	75	86	100	110	125	150	185
Globe valve, wide-open	0.6	22	27	40	43	45	65	82	120	170	240	290	340	400	440	500	550	680	850
Angle valve, wide-open	8.2	11	14	18	21	28	33	42	56	85	112	145	165	190	220	250	280	340	420
Swing check valve, wide-open	4.0	5.2	6.6	9.0	11	14	16	19	26	39	52	66	78	92	106	120	130	145	160
Gate valve, wide-open, or slight bushing reduction	0.4	0.5	0.6	0.8	0.9	1.2	1.3	1.7	2.3	3.5	4.5	5.7	6.7	8.0	9.0	11	12	14	17

1. A fluid is said to flow through the run of a tee when the flow is straight through the tee with no change of direction.
2. A tee is said to be reduced 1/4 if the internal area of the smaller connecting pipe is 25% less than the internal area of the larger connecting pipe.

Conversions, Equivalents, and Physical Data

Pipe Data: Carbon and Allow Steel—Stainless Steel											
NOMINAL PIPE SIZE (INCHES)	OUTSIDE DIAMETER (INCHES)	IDENTIFICATION			WALL THICKNESS (t) (INCHES)	INSIDE DIAMETER (d) (INCHES)	AREA OF METAL (SQ. INCHES)	TRANSVERSE INTERNAL AREA		WEIGHT PIPE (POUNDS PER FOOT)	WEIGHT WATER (POUNDS PER FOOT OF PIPE)
		Steel		Stainless Steel Schedule No.				(a) (Square Inches)	(A) (Square Feet)		
		Iron Pipe Size	Schedule No.								
1/8	0.405	----	----	10S	0.049	0.307	0.0548	0.0740	0.00051	0.19	0.032
		STD	40	40S	0.068	0.269	0.0720	0.0568	0.00040	0.24	0.025
		XS	80	80S	0.095	0.215	0.0925	0.0365	0.00025	0.31	0.016
1/4	0.540	----	----	10S	0.065	0.410	0.0970	0.1320	0.00091	0.33	0.057
		STD	40	40S	0.088	0.364	0.1250	0.1041	0.00072	0.42	0.045
		XS	80	80S	0.119	0.302	0.1574	0.0716	0.00050	0.54	0.031
3/8	0.675	----	----	10S	0.065	0.545	0.1246	0.2333	0.00162	0.42	0.101
		STD	40	40S	0.091	0.493	0.1670	0.1910	0.00133	0.57	0.083
		XS	80	80S	0.126	0.423	0.2173	0.1405	0.00098	0.74	0.061
1/2	0.840	----	----	5S	0.065	0.710	0.1583	0.3959	0.00275	0.54	0.172
		----	----	10S	0.083	0.674	0.1974	0.3568	0.00248	0.67	0.155
		STD	40	40S	0.109	0.622	0.2503	0.3040	0.00211	0.85	0.132
		XS	80	80S	0.147	0.546	0.3200	0.2340	0.00163	1.09	0.102
		----	160	----	0.187	0.466	0.3836	0.1706	0.00118	1.31	0.074
		XXS	----	----	0.294	0.252	0.5043	0.050	0.00035	1.71	0.022
3/4	1.050	----	----	5S	0.065	0.920	0.2011	0.6648	0.00462	0.69	0.288
		----	----	10S	0.083	0.884	0.2521	0.6138	0.00426	0.86	0.266
		STD	40	40S	0.113	0.824	0.3326	0.5330	0.00371	1.13	0.231
		XS	80	80S	0.154	0.742	0.4335	0.4330	0.00300	1.47	0.188
		----	160	----	0.219	0.612	0.5698	0.2961	0.00206	1.94	0.128
		XXS	----	----	0.308	0.434	0.7180	0.148	0.00103	2.44	0.064
1	1.315	----	----	5S	0.065	1.185	0.2553	1.1029	0.00766	0.87	0.478
		----	----	10S	0.109	1.097	0.4130	0.9452	0.00656	1.40	0.409
		STD	40	40S	0.133	1.049	0.4939	0.8640	0.00600	1.68	0.375
		XS	80	80S	0.065	0.957	0.6388	0.7190	0.00499	2.17	0.312
		----	160	----	0.250	0.815	0.8365	0.5217	0.00362	2.84	0.230
		XXS	----	----	0.358	0.599	1.0760	0.282	0.00196	3.66	0.122
1-1/4	1.660	----	----	5S	0.065	1.530	0.3257	1.839	0.01277	1.11	0.797
		----	----	10S	0.109	1.442	0.4717	1.633	0.01134	1.81	0.708
		STD	40	40S	0.140	1.380	0.6685	1.495	0.01040	2.27	0.649
		XS	80	80S	0.191	1.278	0.8815	1.283	0.00891	3.00	0.555
		----	160	----	0.250	1.160	1.1070	1.057	0.00734	3.76	0.458
		XXS	----	----	0.382	0.896	1.534	0.630	0.00438	5.21	0.273
1-1/2	1.900	----	----	5S	0.065	1.770	0.3747	2.461	0.01709	1.28	1.066
		----	----	10S	0.109	1.682	0.6133	2.222	0.01543	2.09	0.963
		STD	40	40S	0.145	1.610	0.7995	2.036	0.01414	2.72	0.882
		XS	80	80S	0.200	1.500	1.068	1.767	0.01225	3.63	0.765
		----	160	----	0.281	1.338	1.429	1.406	0.00976	4.86	0.608
		XXS	----	----	0.400	1.100	1.885	0.950	0.00660	6.41	0.42
2	2.375	----	----	5S	0.065	2.245	0.4717	3.958	0.02749	1.61	1.72
		----	----	10S	0.109	2.157	0.7760	3.654	0.02538	2.64	1.58
		STD	40	40S	0.154	2.067	1.075	3.355	0.02330	3.65	1.45
		XS	80	80S	0.218	1.939	1.477	2.953	0.02050	5.02	1.28
		----	160	----	0.344	1.687	2.190	2.241	0.01556	7.46	0.97
		XXS	----	----	0.436	1.503	2.656	1.774	0.01232	9.03	0.77

Identification, wall thickness and weights are extracted from ASME B36.10 and B39.19. The notations STD, XS, and XXS indicate Standard, Extra Strong, and Double Extra Strong pipe, respectively. Transverse internal area values listed in "square feet" also represent volume in cubic feet per foot of pipe length.

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Conversions, Equivalents, and Physical Data

Pipe Data: Carbon and Allow Steel—Stainless Steel (continued)											
NOMINAL PIPE SIZE (INCHES)	OUTSIDE DIAMETER (INCHES)	IDENTIFICATION			WALL THICKNESS (t) (INCHES)	INSIDE DIAMETER (d) (INCHES)	AREA OF METAL (SQ. INCHES)	TRANSVERSE INTERNAL AREA		WEIGHT PIPE (POUNDS PER FOOT)	WEIGHT WATER (POUNDS PER FOOT OF PIPE)
		Steel		Stainless Steel Schedule No.				(a) (Square Inches)	(A) (Square Feet)		
		Iron Pipe Size	Schedule No.								
2-1/2	2.875	----	----	5S	0.083	2.709	0.7280	5.764	0.04002	2.48	2.50
		----	----	10S	0.120	2.635	1.039	5.453	0.03787	3.53	2.36
		STD	40	40S	0.203	2.469	1.704	4.788	0.03322	5.79	2.07
		XS	80	80S	0.279	2.323	2.254	4.238	0.02942	7.66	1.87
		----	160	----	0.375	2.125	2.945	3.546	0.02463	10.01	1.54
		XXS	----	----	0.552	1.771	4.028	2.464	0.01710	13.69	1.07
3	3.500	----	----	5S	0.083	3.334	0.8910	8.730	0.06063	3.03	3.78
		----	----	10S	0.120	3.260	1.274	8.347	0.05796	4.33	3.62
		STD	40	40S	0.216	3.068	2.228	7.393	0.05130	7.58	3.20
		XS	80	80S	0.300	2.900	3.016	6.605	0.04587	10.25	2.86
		----	160	----	0.438	2.624	4.205	5.408	0.03755	14.32	2.35
		XXS	----	----	0.600	2.300	5.466	4.155	0.02885	18.58	1.80
3-1/2	4.000	----	----	5S	0.083	3.834	1.021	11.545	0.08017	3.48	5.00
		----	----	10S	0.120	3.760	1.463	11.104	0.07711	4.97	4.81
		STD	40	40S	0.226	3.548	2.680	9.886	0.06870	9.11	4.29
		XS	80	80S	0.318	3.364	3.678	8.888	0.06170	12.50	3.84
4	4.500	----	----	5S	0.083	4.334	1.152	14.75	0.10245	3.92	6.39
		----	----	10S	0.120	4.260	1.651	14.25	0.09898	5.61	6.18
		STD	40	40S	0.237	4.026	3.174	12.73	0.08840	10.79	5.50
		XS	80	80S	0.337	3.826	4.407	11.50	0.07986	14.98	4.98
		----	120	----	0.438	3.624	5.595	10.31	0.0716	19.00	4.47
		----	160	----	0.531	3.438	6.621	9.28	0.0645	22.51	4.02
XXS	----	----	0.674	3.152	8.101	7.80	0.0542	27.54	3.38		
5	5.563	----	----	5S	0.109	5.345	1.868	22.44	0.1558	6.36	9.72
		----	----	10S	0.134	5.295	2.285	22.02	0.1529	7.77	9.54
		STD	40	40S	0.258	5.047	4.300	20.01	0.1390	14.62	8.67
		XS	80	80S	0.375	4.813	6.112	18.19	0.1263	20.78	7.88
		----	120	----	0.500	4.563	7.953	16.35	0.1136	27.04	7.09
		----	160	----	0.625	4.313	9.696	14.61	0.1015	32.96	6.33
XXS	----	----	0.750	4.063	11.340	12.97	0.0901	38.55	5.61		
6	6.625	----	----	5S	0.109	6.407	2.231	32.24	0.2239	7.60	13.97
		----	----	10S	0.134	6.357	2.733	31.74	0.2204	9.29	13.75
		STD	40	40S	0.280	6.065	5.581	28.89	0.2006	18.97	12.51
		XS	80	80S	0.432	5.761	8.405	26.07	0.1810	28.57	11.29
		----	120	----	0.562	5.501	10.70	23.77	0.1650	36.39	10.30
		----	160	----	0.719	5.187	13.32	21.15	0.1469	45.35	9.16
XXS	----	----	0.864	4.897	15.64	18.84	0.1308	53.16	8.16		
9	8.625	----	----	5S	0.109	8.407	2.916	55.51	0.3855	9.93	24.06
		----	----	10S	0.148	8.329	3.941	54.48	0.3784	13.40	23.61
		----	20	----	0.250	8.125	6.57	51.85	0.3601	22.36	22.47
		----	30	----	0.277	8.071	7.26	51.16	0.3553	24.70	22.17
		STD	40	40S	0.322	7.981	8.40	50.03	0.3474	28.55	21.70
		----	60	----	0.406	7.813	10.48	47.94	0.3329	35.64	20.77
		XS	80	80S	0.500	7.625	12.76	45.66	0.3171	43.39	19.78
		----	100	----	0.594	7.437	14.96	43.46	0.3018	50.95	18.83
		----	120	----	0.719	7.187	17.84	40.59	0.2819	60.71	17.59
		----	140	----	0.812	7.001	19.93	38.50	0.2673	67.76	16.68
XXS	----	----	0.875	6.875	21.30	37.12	0.2578	72.42	16.10		
----	160	----	0.906	6.813	21.97	36.46	0.2532	74.69	15.80		
10	10.750	----	----	5S	0.134	10.482	4.36	86.29	0.5992	15.19	37.39
		----	----	10S	0.165	10.420	5.49	85.28	0.5922	18.65	36.95
		----	20	----	0.250	10.250	8.24	82.52	0.5731	28.04	35.76
		----	30	----	0.307	10.136	10.07	80.69	0.5603	34.24	34.96
		STD	40	40S	0.365	10.020	11.90	78.86	0.5475	40.48	34.20
		XS	60	80S	0.500	9.750	16.10	74.66	0.5185	54.74	32.35
		----	80	----	0.594	9.562	18.92	71.84	0.4989	64.43	31.13
		----	100	----	0.719	9.312	22.63	68.13	0.4732	77.03	29.53
		----	120	----	0.844	9.062	26.24	64.53	0.4481	89.29	27.96
		XXS	140	----	1.000	8.750	30.63	60.13	0.4176	104.13	26.06
----	160	----	1.125	8.500	34.02	56.75	0.3941	115.64	24.59		

Identification, wall thickness and weights are extracted from ASME B36.10 and B39.19.
 The notations STD, XS, and XXS indicate Standard, Extra Strong, and Double Extra Strong pipe, respectively.
 Transverse internal area values listed in "square feet" also represent volume in cubic feet per foot of pipe length.

Conversions, Equivalents, and Physical Data

American Pipe Flange Dimensions						
ASME CLASS FLANGE DIAMETER - INCHES, PER ASME B16.1, B16.5, AND B16.24						
Nominal Pipe Size	125 (Cast Iron) or 150 (Steel) ⁽¹⁾	250 (Cast Iron) or 300 (Steel) ⁽²⁾	600	900	1500	2500
1	4.25	4.88	4.88	5.88	5.88	6.25
1-1/4	4.62	5.25	5.25	6.25	6.25	7.25
1-1/2	5.00	6.12	6.12	7.00	7.00	8.00
2	6.00	6.50	6.50	8.50	8.50	9.25
2-1/2	7.00	7.50	7.50	9.62	9.62	10.50
3	7.50	8.25	8.25	9.50	10.50	12.00
4	9.00	10.00	10.75	11.50	12.25	14.00
5	10.00	11.00	13.00	13.75	14.75	16.50
6	11.00	12.50	14.00	15.00	15.50	19.00
8	13.50	15.00	16.50	18.50	19.00	21.75
10	16.00	17.50	20.00	21.50	23.00	26.50
12	19.00	20.50	22.00	24.00	26.50	30.00
14	21.00	23.00	23.75	25.25	29.50	----
16	23.50	25.50	27.00	27.75	32.50	----
18	25.00	28.00	29.25	31.00	36.00	----
20	27.50	30.50	32.00	33.75	38.75	----
24	32.00	36.00	37.00	41.00	46.00	----
30	38.75	43.00	----	----	----	----
36	46.00	50.00	----	----	----	----
42	53.00	57.00	----	----	----	----
48	59.50	65.00	----	----	----	----

1. Sizes 1 through 12-inch also apply to ASME Class 150 bronze flanges.
2. Sizes 1 through 8-inch also apply to ASME Class 300 bronze flanges.

American Pipe Flange Dimensions												
ASME CLASS, NUMBER OF STUD BOLTS AND HOLE DIAMETER IN INCHES, PER ASME B16.1, B16.5, AND B16.24												
Nominal Pipe Size	125 (Cast Iron) or 150 (Steel) ⁽¹⁾		250 (Cast Iron) or 300 (Steel) ⁽²⁾		600		900		1500		2500	
	No.	Ø	No.	Ø	No.	Ø	No.	Ø	No.	Ø	No.	Ø
1	4	0.50	4	0.62	4	0.62	4	0.88	4	0.88	4	0.88
1-1/4	4	0.50	4	0.62	4	0.62	4	0.88	4	0.88	4	1.00
1-1/2	4	0.50	4	0.75	4	0.75	4	1.00	4	1.00	4	1.12
2	4	0.62	8	0.62	8	0.62	8	0.88	8	0.88	8	1.00
2-1/2	4	0.62	8	0.75	8	0.75	8	1.00	8	1.00	8	1.12
3	4	0.62	8	0.75	8	0.75	8	0.88	8	1.12	8	1.25
4	8	0.62	8	0.75	8	0.75	8	0.12	8	1.25	8	1.50
5	8	0.75	8	0.75	8	1.00	8	1.25	8	1.50	8	1.75
6	8	0.75	12	0.75	12	1.00	12	1.12	12	1.38	8	2.00
8	8	0.75	12	0.88	12	1.12	12	1.38	12	1.62	12	2.00
10	12	0.88	16	1.00	16	1.25	16	1.38	12	1.88	12	2.50
12	12	0.88	16	1.12	20	1.25	20	1.38	16	2.00	12	2.75
14	12	1.00	20	1.12	20	1.38	20	1.50	16	2.25	-----	-----
16	16	1.00	20	1.25	20	1.50	20	1.62	16	2.50	-----	-----
18	16	1.12	24	1.25	20	1.62	20	1.88	16	2.75	-----	-----
20	20	1.12	24	1.25	24	1.62	20	2.00	16	3.00	-----	-----
24	20	1.25	24	1.50	24	1.88	20	2.50	16	3.50	-----	-----
30	28	1.25	28	1.75	-----	-----	-----	-----	-----	-----	-----	-----
36	32	1.50	32	2.00	-----	-----	-----	-----	-----	-----	-----	-----
42	36	1.50	36	2.00	-----	-----	-----	-----	-----	-----	-----	-----
48	44	1.50	40	2.00	-----	-----	-----	-----	-----	-----	-----	-----

1. Sizes 1 through 12-inch also apply to ASME Class 150 bronze flanges.
2. Sizes 1 through 8-inch also apply to ASME Class 300 bronze flanges.

EN 1092-1 Cast Steel Flange Standard-PN 16 (Nominal Pressure 16 bar)							
NOMINAL BORE, mm	PIPE THICKNESS, mm	FLANGE, mm			BOLTING, mm		
		Outside Diameter	Thickness	Bolt Circle Diameter	Number of Bolts	Thread	Bolt Hole Diameter
10	6	90	16	60	4	M12	14
15	6	95	16	65	4	M12	14
20	6,5	105	18	75	4	M12	14
25	7	115	18	85	4	M12	14
32	7	140	18	100	4	M16	18
40	7,5	150	18	110	4	M16	18
50	8	165	20	125	4	M16	18
65	8	185	18	145	4	M16	18
80	8,5	200	20	160	8	M16	18
100	9,5	220	20	180	8	M16	18
125	10	250	22	210	8	M16	18
150	11	285	22	240	8	M20	23
175	12	315	24	270	8	M20	23
200	12	340	24	295	12	M20	23
250	14	405	26	355	12	M24	27
300	15	460	28	410	12	M24	27
350	16	520	30	470	16	M24	27
400	18	580	32	525	16	M27	30
500	21	715	36	650	20	M30	33
600	23	840	40	770	20	M33	36
700	24	910	42	840	24	M33	36
800	26	1025	42	950	24	M36	39
900	27	1125	44	1050	28	M36	39
1000	29	1255	46	1170	28	M39	42
1200	32	1485	52	1390	32	M45	48
1400	34	1685	58	1590	36	M45	48
1600	36	1930	64	1820	40	M52	56
1800	39	2130	68	2020	44	M52	56
2000	41	2345	70	2230	48	M56	62
2200	43	2555	74	2440	52	M56	62

EN 1092-1 Cast Steel Flange Standard-PN 25 (Nominal Pressure 25 bar)							
NOMINAL BORE, mm	PIPE THICKNESS, mm	FLANGE, mm			BOLTING, mm		
		Outside Diameter	Thickness	Bolt Circle Diameter	Number of Bolts	Thread	Bolt Hole Diameter
10	6	90	16	60	4	M12	14
15	6	95	16	65	4	M12	14
20	6,5	105	18	75	4	M12	14
25	7	115	18	85	4	M12	14
32	7	140	18	100	4	M16	18
40	7,5	150	18	110	4	M16	18
50	8	165	20	125	4	M16	18
65	8,5	185	22	145	8	M16	18
80	9	200	24	160	8	M16	18
100	10	235	24	190	8	M20	23
125	11	270	26	220	8	M24	27
150	12	300	28	250	8	M24	27
175	12	330	28	280	12	M24	27
200	12	360	30	310	12	M24	27
250	14	425	32	370	12	M27	30
300	15	485	34	430	16	M27	30
350	16	555	38	490	16	M30	33
400	18	620	40	550	16	M33	36
500	21	730	44	660	20	M33	36
600	23	845	46	770	20	M36	39
700	24	960	50	875	24	M39	42
800	26	1085	54	990	24	M45	48
900	27	1185	58	1090	28	M45	48
1000	29	1320	62	1210	28	M52	56
1200	32	1530	70	1420	32	M52	56
1400	34	1755	76	1640	36	M56	62
1600	37	1975	84	1860	40	M56	62
1800	40	2195	90	2070	44	M64	70
2000	43	2425	96	2300	48	M64	70

Conversions, Equivalents, and Physical Data

EN 1092-1 Cast Steel Flange Standard—PN 40 (Nominal Pressure 40 Bar)							
NOMINAL BORE, mm	PIPE THICKNESS, mm	FLANGE, mm			BOLTING, mm		
		Outside Diameter	Thickness	Bolt Circle Diameter	Number of Bolts	Thread	Bolt Hole Diameter
10	6	90	16	60	4	M12	14
15	6	95	16	65	4	M12	14
20	6,5	105	18	75	4	M12	14
25	7	115	18	85	4	M12	14
32	7	140	18	100	4	M16	18
40	7,5	150	18	110	4	M16	18
50	8	165	20	125	4	M16	18
65	8,5	185	22	145	8	M16	18
80	9	200	24	160	8	M16	18
100	10	235	24	190	8	M20	23
125	11	270	26	220	8	M24	27
150	12	300	28	250	8	M24	27
175	13	350	32	295	12	M27	30
200	14	375	34	320	12	M27	30
250	16	450	38	385	12	M30	33
300	17	515	42	450	16	M30	33
350	19	580	46	510	16	M33	36
400	21	660	50	585	16	M36	39
450	21	685	50	610	20	M36	39
500	21	755	52	670	20	M39	42
600	24	890	60	795	20	M45	48
700	27	995	64	900	24	M45	48
800	30	1140	72	1030	24	M52	56
900	33	1250	76	1140	28	M52	56
1000	36	1360	80	1250	28	M52	56
1200	42	1575	88	1460	32	M56	62
1400	47	1795	98	1680	36	M56	62
1600	54	2025	108	1900	40	M64	70

EN 1092-1 Cast Steel Flange Standard—PN 63 (Nominal Pressure 63 Bar)							
NOMINAL BORE, mm	PIPE THICKNESS, mm	FLANGE, mm			BOLTING, mm		
		Outside Diameter	Thickness	Bolt Circle Diameter	Number of Bolts	Thread	Bolt Hole Diameter
10	10	100	20	70	4	M12	14
15	10	105	20	75	4	M12	14
25	10	140	24	100	4	M16	18
32	12	155	24	110	4	M20	23
40	10	170	28	125	4	M20	22
50	10	180	26	135	4	M20	22
65	10	205	26	160	8	M20	22
80	11	215	28	170	8	M20	22
100	12	250	30	200	8	M24	26
125	13	295	34	240	8	M27	30
150	14	345	36	280	8	M30	33
175	15	375	40	310	12	M30	33
200	16	415	42	345	12	M33	36
250	19	470	46	400	12	M33	36
300	21	530	52	460	16	M33	36
350	23	600	56	525	16	M36	39
400	26	670	60	585	16	M39	42
500	31	800	68	705	20	M45	48
600	35	930	76	820	20	M52	56
700	40	1045	84	935	24	M52	56
800	45	1165	92	1050	24	M56	62
900	50	1285	98	1170	28	M56	62
1000	55	1415	108	1290	28	M64	70
1200	64	1665	126	1530	32	M72X6	78

EN 1092-1 Cast Steel Flange Standard—PN 100 (Nominal Pressure 100 Bar)															
NOMINAL BORE, mm	PIPE THICKNESS, mm	FLANGE, mm			BOLTING, mm			NOMINAL BORE, mm	PIPE THICKNESS, mm	FLANGE, mm			BOLTING, mm		
		Outside Diameter	Thickness	Bolt Circle Diameter	Number of Bolts	Thread	Bolt Hole Diameter			Outside Diameter	Thickness	Bolt Circle Diameter	Number of Bolts	Thread	Bolt Hole Diameter
10	10	100	20	70	4	M12	14	150	18	355	44	290	12	M30	33
15	10	105	20	75	4	M12	14	175	20	385	48	320	12	M30	33
25	10	140	24	100	4	M16	18	200	21	430	52	360	12	M33	36
32	12	155	24	110	4	M20	23	250	25	505	60	430	12	M36	39
40	10	170	28	125	4	M20	22	300	29	585	68	500	16	M39	42
50	10	195	30	145	4	M24	26	350	32	655	74	560	16	M45	48
65	11	220	34	170	8	M24	26	400	36	715	78	620	16	M45	48
80	12	230	36	180	8	M24	26	500	44	870	94	760	20	M52	56
100	14	265	40	210	8	M27	30	600	51	990	104	875	20	M56	62
125	16	315	40	250	8	M30	33	700	59	1145	120	1020	24	M64	70

EN 1092-1 Pressure/Temperature Ratings for Cast Steel Flanges									
PN	MATERIAL GROUP	MAXIMUM ALLOWABLE PRESSURE, PSIG (bar) ⁽¹⁾							
		14 to 212°F (-10 to 100°C)	302°F (150°C)	392°F (200°C)	482°F (250°C)	572°F (300°C)	662°F (350°C)	707°F (375°C)	752°F (400°C)
16	1C1	232 (16,0)	226 (15,6)	219 (15,1)	209 (14,4)	194 (13,4)	186 (12,8)	180 (12,4)	157 (10,8)
	1C2	218 (15,0)	218 (15,0)	218 (15,0)	225 (15,5)	216 (14,9)	206 (14,2)	199 (13,7)	157 (10,8)
25	1C1	363 (25,0)	354 (24,4)	344 (23,7)	326 (22,5)	303 (20,9)	290 (20,0)	281 (19,4)	245 (16,9)
	1C2	363 (25,0)	363 (25,0)	363 (25,0)	363 (25,0)	338 (23,3)	322 (22,2)	310 (21,4)	245 (16,9)
40	1C1	580 (40,0)	567 (39,1)	550 (37,9)	522 (36,0)	486 (33,5)	463 (31,9)	451 (31,1)	392 (27,0)
	1C2	580 (40,0)	580 (40,0)	580 (40,0)	580 (40,0)	540 (37,2)	516 (35,6)	496 (34,2)	392 (27,0)
63	1C1	914 (63,0)	892 (61,5)	864 (59,6)	824 (56,8)	764 (52,7)	730 (50,3)	711 (49,0)	616 (42,5)
	1C2	914 (63,0)	914 (63,0)	914 (63,0)	914 (63,0)	851 (58,7)	812 (56,0)	780 (53,8)	616 (42,5)
100	1C1	1450 (100)	1417 (97,7)	1374 (94,7)	1307 (90,1)	1252 (86,3)	1157 (79,8)	1128 (77,8)	979 (67,5)
	1C2	1450 (100)	1450 (100)	1450 (100)	1450 (100)	1350 (93,1)	1289 (88,9)	1239 (85,4)	979 (67,5)

1. These ratings apply only for flange types 05, 11, 12, 13, and 21 having nominal sizes up and including DN 600.

Conversions, Equivalents, and Physical Data

Drill Sizes for Pipe Taps			
NOMINAL PIPE SIZE, (INCHES)	TAP DRILL SIZE, (INCHES)	NOMINAL PIPE SIZE, (INCHES)	TAP DRILL SIZE, (INCHES)
1/8	11/32	1-1/2	1-23/32
1/4	7/16	2	2-3/16
3/8	19/32	2-1/2	2-9/16
1/2	23/32	3	3-3/16
3/4	15/16	4	4-3/16
1	1-5/32	5	5-5/16
1-1/4	1-1/2	6	6-5/16

Standard Twist Drill Sizes								
DESIGNATION	DIAMETER (IN.)	AREA (SQ. IN.)	DESIGNATION	DIAMETER (IN.)	AREA (SQ. IN.)	DESIGNATION	DIAMETER (IN.)	AREA (SQ. IN.)
1/2	0.5000	0.1963	3	0.213	0.03563	3/32	0.0938	0.00690
31/64	0.4844	0.1843	4	0.209	0.03431	42	0.0935	0.00687
15/32	0.4688	0.1726	5	0.2055	0.03317	43	0.0890	0.00622
29/64	0.4531	0.1613	6	0.204	0.03269	44	0.0860	0.00581
7/16	0.4375	0.1503	13/64	0.2031	0.03241	45	0.0820	0.00528
27/64	0.4219	0.1398	7	0.201	0.03173	46	0.0810	0.00515
Z	0.413	0.1340	8	0.199	0.03110	47	0.0785	0.00484
13/32	0.4063	0.1296	9	0.196	0.03017	5/64	0.0781	0.00479
Y	0.404	0.1282	10	0.1935	0.02940	48	0.0760	0.00454
Z	0.397	0.1238	11	0.191	0.02865	49	0.0730	0.00419
25/64	0.3906	0.1198	12	0.189	0.02806	50	0.0700	0.00385
W	0.386	0.1170	3/16	0.1875	0.02861	51	0.0670	0.00353
V	0.377	0.1116	13	0.185	0.02688	52	0.0635	0.00317
3/8	0.375	0.1104	14	0.182	0.02602	1/16	0.0625	0.00307
U	0.368	0.1064	15	0.1800	0.02554	53	0.0595	0.00278
23/64	0.3594	0.1014	16	0.1770	0.02461	54	0.0550	0.00238
T	0.358	0.1006	17	0.1730	0.02351	55	0.0520	0.00212
S	0.348	0.09511	11/64	0.1719	0.02320	3/64	0.0473	0.00173
11/32	0.3438	0.09281	18	0.1695	0.02256	56	0.0465	0.001698
R	0.339	0.09026	19	0.1660	0.02164	57	0.0430	0.001452
Q	0.332	0.08657	20	0.1610	0.02036	58	0.0420	0.001385
21/64	0.3281	0.08456	21	0.1590	0.01986	59	0.0410	0.001320
P	0.323	0.08194	22	0.1570	0.01936	60	0.0400	0.001257
O	0.316	0.07843	5/32	0.1563	0.01917	61	0.039	0.001195
5/16	0.3125	0.07670	23	0.1540	0.01863	62	0.038	0.001134
N	0.302	0.07163	24	0.1520	0.01815	63	0.037	0.001075
19/64	0.2969	0.06922	25	0.1495	0.01755	64	0.036	0.001018
M	0.295	0.06835	26	0.1470	0.01697	65	0.035	0.000962
L	0.29	0.06605	27	0.1440	0.01629	66	0.033	0.000855
9/32	0.2813	0.06213	9/64	0.1406	0.01553	67	0.032	0.000804
K	0.281	0.06202	28	0.1405	0.01549	1/32	0.0313	0.000765
J	0.277	0.06026	29	0.1360	0.01453	68	0.031	0.000755
I	0.272	0.05811	30	0.1285	0.01296	69	0.0292	0.000670
H	0.266	0.05557	1/8	0.1250	0.01227	70	0.028	0.000616
17/64	0.2656	0.05542	31	0.1200	0.01131	71	0.026	0.000531
G	0.261	0.05350	32	0.1160	0.01057	72	0.025	0.000491
F	0.257	0.05187	33	0.1130	0.01003	73	0.024	0.000452
E 1/4	0.2500	0.04909	34	0.1110	0.00968	74	0.0225	0.000398
D	0.246	0.04753	35	0.1100	0.00950	75	0.021	0.000346
C	0.242	0.04600	7/64	0.1094	0.00940	76	0.020	0.000314
B	0.238	0.04449	36	0.1065	0.00891	77	0.018	0.000254
15/64	0.2344	0.04314	37	0.1040	0.00849	78	0.016	0.000201
A	0.234	0.04301	38	0.1015	0.00809	1/64	0.0156	0.000191
1	0.228	0.04083	39	0.0995	0.00778	79	0.0145	0.000165
2	0.221	0.03836	40	0.0980	0.00754	80	0.0135	0.000143
7/32	0.2188	0.03758	41	0.0960	0.00724	----	----	----

Note: Designations are in fractions of an inch, in standard twist drill letters, or in standard twist drill numbers, the latter being the same as steel wire gauge numbers.