

CLARK SOLUTIONS

Rotary Gear Pumps

Technical Bulletin: Gear Pump Material Compatibility, Viscosity Conversion

The materials listed for use in the construction of pumps for different liquids are for general application only. In the selection of materials consideration should be given to general practice and the experience of the user in handling the liquids. In handling food, medicinal and similar products consideration must be given, also to laws and regulations in force at the locality where the pump is to be used.

Liquid	Conditions	Chemical Symbol	Materials Permissible
Acid, Acetic		CH ₃ COOH	All Bronze, Monel, Stainless Steel
Acid, Arsenic (Arsenic Penta-oxide)		As ₂ O ₄	All Iron, Stainless Steel
Acid, Carbolic		C ₄ H ₅ OH	All Iron
Acid, Carbolic in H ₂ O	Dil.		Standard Fitted
Acid, Cabonic in H ₂ O	Aqueous Sol.	CO ₂ H ₂ O	All Bronze
Acid, Hydrocyanic	Conc. (M.P. 105°F)	HCN	All Iron
Acid, Pyroligneous		CH ₃ CO ₃ H	All Bronze, Stainless Steel
Acid, Sulphuric, 93%	PH<4-5	H ₂ SO ₄	All Iron, Stainless Steel
Acid, Tannic (m-Digallic acid)		C ₄₄ H ₁₆ O ₉	All Bronze, Monel, Stainless Steel
Acetone		CH ₃ COCH ₃	All Iron
Alcohol, Grain (Ethanol)		CH ₃ CH ₂ OH	All Bronze
Alcohol, Wood (Methanol)		CH ₃ OH	All Bronze
Ammonia, Aqua		NH ₄ OH	All Iron
Ammonium Bicarbonate		NH ₄ HCO ₃	All Iron
Ammonium Chloride		NH ₄ Cl	All Iron, Stainless Steel
Ammonium Nitrate		NH ₄ NO ₃	All Iron, Stainless Steel
Ammonium Orthophosphate	Aqueous Sol.	(NH ₄) ₃ HPO ₄	All Iron, Stainless Steel
Ammonium Sulfate	Aqueous Sol.	(NH ₄) ₂ SO ₄	All Iron, Stainless Steel
Aniline	Aqueous Sol.	C ₆ H ₅ NH ₂	All Iron
Asphaltum	Aqueous Sol.		Standard Fitted
Barium Chloride	Aqueous Sol.	BaCl ₂	All Iron, Stainless Steel
Barium Nitrate		Ba(NO ₃) ₂	All Iron, Stainless Steel
Beer	Hot		All Bronze, Stainless Steel
Beer Wort			All Bronze, Stainless Steel
Beet Juice (thin)			All Bronze, Stainless Steel
Benzene (Benzol)		C ₆ H ₆	All Iron
Bitterwasser		CaCl ₂	All Bronze, Stainless Steel
Brine, Calcium Chloride	Aqueous Sol.		All Iron
Brine, Sodium Chloride	3% Salt		All Iron, All Bronze, Stainless Steel
Brine, Sodium Chloride	Over 3%		All Bronze, Monel, Stainless Steel
Brine, Sea Water			All Iron, All Bronze, Stainless Steel
Cachaza			Standard Fitted
Calcium Hypochlorite		Ca(OCl) ₂	All Iron, Stainless Steel
Calcium Magnesium Chloride			All Bronze
Cane Juice			Standard Fitted
Carbon Bisulfide		CS ₂	All Iron
Carbonate of Soda	(See Soda Ash)		
Carbon Tetrachloride		CCl ₄	All Iron
Caustic Potash	(See Potassium Hydroxide)		
Caustic Soda	(See Sodium Hydroxide)		
Chloride of Lime	(See Calcium Hypochlorite)		
Chlorobenzene		C ₆ H ₅ Cl	Standard Fitted, Stainless Steel
Copperas (Green Vitriol)	(See Ferrous Sulphate)		All Iron
Creosote			All Iron
Cresol, Meta		CH ₃ C ₆ H ₄ OH	All Iron
Cyanide	(See Sod, Cyanide & Pot. Cyanide)		All Iron
Cyanogen	In Water	C ₂ N ₂ (gas)	All Iron
Diphenyl	In Alcohol	C ₆ H ₅ C ₆ H ₅	All Iron, Stainless Steel
Ethyl Acetate		CH ₃ COOC ₂ H ₅	All Iron
Ferrous Sulphate		FeSO ₄	All Iron, Stainless Steel
Furfural		C ₄ H ₃ OCHO	Standard Fitted
Gasolene			Standard Fitted
Glaubers Salt	(See Sodium Sulfate)		Standard Fitted
Glue	Hot		All Bronze, Stainless Steel
Glycerol (Glycerin)			Standard Fitted
Heptane		CH ₂ (CH ₂) ₃ CH ₃	All Iron, Stainless Steel
Hydrogen Peroxide	Com'l	H ₂ O ₂	All Iron
Lard	Hot		All Iron
Lead, Molten			All Iron
Lime Water (Milk of Lime)		Ca(OH) ₂	All Iron, Stainless Steel
Lye, Caustic	(See Potassium & Sod. Hydroxide)		
Magnesium Sulfate (Epsom Salts)	Aqueous Sol.	Mg SO ₄	All Bronze, Stainless Steel
Magma (thick residue)			All Bronze, Stainless Steel
Magnesium Chloride	Aqueous Sol.	MnCl ₂	All Iron, All Bronze, Stainless Steel
Manganese Sulfate	Aqueous Sol.	MnSO ₄	All Bronze, Stainless Steel
Mash			All Iron
Methyl Chloride		CH ₃ Cl	All Iron, Stainless Steel
Methylene Chloride		CH ₂ Cl ₂	All Iron, Stainless Steel
Milk of Lime	(See Lime Water)		All Bronze Stainless Steel
Mine Water			Standard Fitted
Molasses			Standard Fitted
Naphtha			Standard Fitted

Liquid	Conditions	Chemical Symbol	Materials Permissible
Nitre	(See Potassium Nitrate)		Standard Fitted
Oil, Crude (Asphalt Base)	Hot		Standard Fitted
Oil, Crude (Paraffin Base)			Standard Fitted
Oil, Fuel			Standard Fitted
Oil, Kerosene			Standard Fitted
Oil, Lubricating (Lt. Or Hy.)			Standard Fitted
Oil, Mineral			Standard Fitted
Oil, Vegetable			All Iron
Oil, Purifying			All Iron
Oil, Coal Tar			All Iron
Oil, Creosote			All Iron
Oil, Turpentine			All Iron
Oil, Linseed			All Iron, Stainless Steel, Monel
Oil, Rapeseed			All Bronze, Stainless Steel, Monel
Paraffin	Hot		Standard Fitted
Peroxide or Hydrogen	(See Hydrogen Peroxide)		
Petroleum Ether	(See Benzene)		
Phenol	(See Carbolic Acid)		
Potash	(See Potassium Carbonate)		
Potassium Bichromate	Aqueous Sol.	$K_2Cr_2O_7$	All Iron
Potassium Carbonate	Aqueous Sol.	K_2CO_3	All Iron
Potassium Chlorate	Aqueous Sol.	$KClO_3$	All Iron, Stainless Steel
Potassium Chloride	Aqueous Sol.	KCl	All Bronze, Stainless Steel
Potassium Cyanide	Aqueous Sol.	KCN	All Iron
Potassium Hydroxide	Aqueous Sol.	KOH	All Iron, Stainless Steel
Potassium Nitrate	Aqueous Sol.	KNO_3	All Iron, Stainless Steel
Potassium Sulfate	Aqueous Sol.	K_2SO_4	All Iron, All Bronze, Stainless Steel
Pyridine			All Iron
Salammoniac			
Salt Cake	Aqueous Sol.	$Na_2SO_4 + IMPURITIES$	All Iron, All Bronze, Stainless Steel
Salt Water	(See Brines)		
Sea Water	(See Brines)		
Sewage			Standard Fitted
Slop, Brewery			Standard Fitted
Soap Liquor	Thin		All Iron
Soda, Ash (Sodium Carbonate)	Aqueous Sol.	Na_2CO_3	All Iron
Sodium Bicarbonate		$NaHCO_3$	All Iron, Stainless Steel
Sodium Chloride	(See Brines)		
Sodium Cyanide	Aqueous Sol.	Na CN	All Iron, Stainless Steel
Sodium Hydroxide	Aqueous Sol.	NaOH	All Iron, Stainless Steel
Sodium Nitrate	Aqueous Sol.	$NaNO_3$	All Iron, Stainless Steel
Sodium Sulfate	Aqueous Sol.	Na_2SO_4	All Iron
Sodium Sulfide	Aqueous Sol.	Na_2S	All Iron, All Bronze, Stainless Steel
Sodium Sulfite	Aqueous Sol.	Na_2SO_3	All Bronze, Stainless Steel
Starch	Aqueous Sol.		Standard Fitted
Strontium Nitrate		$Sr(NO_3)_2$	All Iron, Stainless Steel
Sugar			All Bronze
Sulfur	In Water	S	All Iron, All Bronze
Sulfur Chloride	Cold	S_2Cl_2	All Iron
Syrup			All Bronze
Tanning Liquors (veg.)			All Bronze, Stainless Steel
Tar			All Iron
Tar and Ammonia	Aqueous Sol.		All Iron
Tetraethyl Lead		$Pb(C_2H_5)_4$	All Iron
Toluene (toluol)		$C_6H_5CH_3$	All Iron, Standard Fitted
Trichloroethylene		$CHCl_2 \cdot CCl_2$	All Iron
Varnish			All Bronze, Monel
Vinegar			All Bronze, Stainless Steel
Vitriol, Oil of	(See Acid, Sulfuric)		
Vitriol, White	(See Zinc Sulfate)		
Water (Fresh)			All Bronze
Water (Distilled)			All Bronze
Whiskey			All Bronze
Wine			All Bronze
Wood Pulp	Not Digested		All Bronze
Wood Vinegar	(See Pyrolygenous Acid)		
Wort			All Bronze
Yeast			All Bronze
Zinc Sulfate	Aqueous Sol.	$ZnSO_4$	All Bronze, Stainless Steel

Clark Gear Pumps:

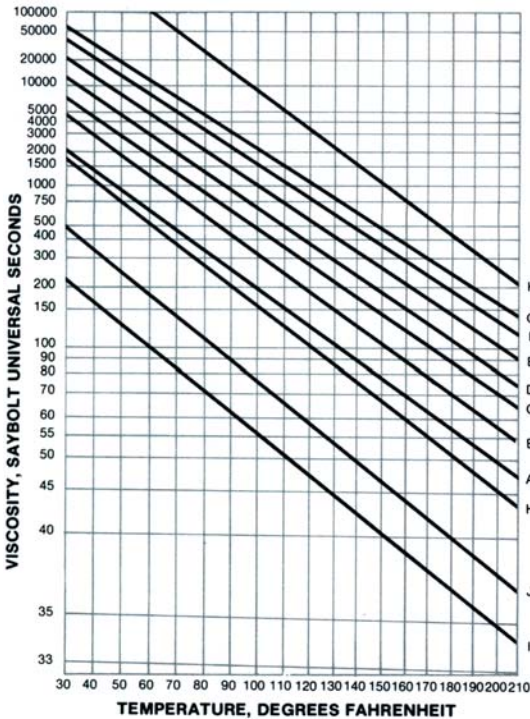
All Iron pumps are constructed with steel gears, iron casings, and iron bearings.

All Bronze pumps are constructed of bronze casings with bronze gears and shafts. For some applications the shafts of these pumps may be stainless steel.

Standard Fitted pumps are similar to All Iron pumps. If necessary, bronze or carbon bearings may be used instead of iron bearings.

Stainless Steel pumps are constructed of 316 stainless steel casings with 17-4 stainless steel gears and shafts.

Viscosities of Oils



- A.....S.A.E. #10 OIL
- B.....S.A.E. #20 OIL
- C.....S.A.E. #30 OIL
- D.....S.A.E. #40 OIL
- E.....S.A.E. #50 OIL
- F.....S.A.E. #60 OIL
- G.....S.A.E. #70 OIL
- H.....D.T.E. Light Hydraulic Oil
- I.....#2 Fuel Oil
(Maximum Viscosity)
- J.....#4 Fuel Oil
(Maximum Viscosity)
- K.....#6 Fuel Oil
(Maximum Viscosity)

Curves for S.A.E. numbered oils show average viscosities based on Dean and Davis viscosity index of 100.

Curves for fuel oil are based on oils having maximum allowable viscosities.

Curve for Light Hydraulic Oil is based on a commonly used viscosity.

$$^{\circ}\text{Celsius} = (^{\circ}\text{Fahrenheit} - 32) \times 5/9$$

Useful Pump Terminology

A foothead of water represents 0.4331 lbs. per sq. in. at 60°F. In common practice 1/2 lb. per sq. in. is used.

Mean atmospheric pressure at sea level is 14.7 lbs. per sq. in. and is equivalent to a column of mercury 29.92 inches high or a column of water 33.97 ft. high.

Doubling the diameter of a pipe increases its capacity per unit length 4 times. Friction of low viscosity liquids such as water varies approximately as the square of the velocity. Friction of viscous liquids such as oil varies under normal conditions directly as the velocity.

Static Suction Head is the vertical distance from liquid level to center line of pump in feet when level is higher than pump.

Static Suction Lift is the vertical distance from liquid level to center line of pump in feet when level is lower than pump. Friction Head is the resistance to flow caused by contact between liquid and pipe and, in addition, other frictional losses within the liquid itself as it moves in the pipe.

Discharge Head is the vertical distance between center line of pump and point of discharge.

Velocity Head is the pressure required to produce the velocity of the liquid and is equal to $V^2/64.4$ when V equals feet per second velocity.

Total Head is the sum of total of the suction, friction, discharge and velocity head.

Power required for pumping may be computed by use of the following formula:

$H.P. = W \times H / 33,000 \times E$ or $0.000584 \times QP/E$, where W is the weight of the liquid pumped per min. in pounds, H is the total head in feet (including frictional losses) and E is the efficiency of the pump. Q=gals per min.; P=lbs. per sq. in.

Viscosity is that property of a liquid which resists any force tending to produce flow. The greater the resistance to flow, the higher the viscosity. Thus, molasses has a higher viscosity than water. Viscosity is usually expressed in Saybolt Universal Seconds (S.S.U.) although there are various other systems.

Specific gravity is the ratio of the weight of a known volume of a material to the weight of an equal volume of water at 40°F. Thus at 40°F, the specific gravity of water is 1.0. Material having a specific gravity of 0.90 has a weight per unit volume of 90% that of water. When handling heavy liquids or liquid of a high viscosity, it is recommended that the pump speed be reduced and pipe sizes increased.

Converting Kinematic and Saybolt Viscosity to Absolute Viscosity

