PUMP SELECTION PROCEDURE

The following are general considerations only for the application of BSM pumps. It is recommended that unusual or difficult design and application problems be referred to BSM Pump Corp. for evaluation.

1. TYPE OF SERVICE

The majority of applications for BSM Pumps fall into the following categories: (a) Transfer, (b) Lubrication, (c) Hydraulic, (d) Coolant and (e) General.

Rotary Gear Pumps: Applicable to the handling of all reasonably clean liquids, preferably having some lubricating value. Also suitable for handling non-lubricating liquids under limited conditions of operation with grease fittings or carbon bearings.

Automatic Reversing Vane Pumps: Provide mounting flexibility for circulating clean liquids under low pressure, regardless of direction of rotation.

Motor Driven Centrifugal Pumps: Give long, trouble free performance handling coolants or liquids which may be contaminated with abrasive particles or other materials.

2. LIQUID TO BE HANDLED

Type: Lubricating, corrosive, abrasive or caustic qualities of the liquid to be handled affect selection of pump type and size and its materials of construction. Specific gravity and viscosity at operating temperature determine speed and horsepower requirements.

Lubricity: Rotary Gear and Vane Pumps depend upon the liquid being circulated for lubrication of moving parts. However, the addition of grease fittings will frequently assist in the handling of non-lubricating liquids. Centrifugal Pumps are specifically suited for handling non-lubricating liquids.

Temperature: Operating temperature at the pump is an important factor affecting overall performance. Consideration should be given to any combination of ambient and liquid temperatures plus the heat rise resulting from resistance in the system that will affect the liquid viscosity. Generally, the lowest temperature to be encountered should be used to determine power requirements.

3. DELIVERY AND PRESSURE

Operating Characteristics: Detailed characteristics over a wide range of operating conditions are given with Specifications and Operating Characteristics for specific pump types. Performance data is based on the specific viscosities given and ratings are for continuous duty. Pump capacities and performance other than those tabulated are available to meet a wide range of conditions. (Consult BSM for specific recommendations).

Factors in Selection: Determination of the required volume of liquid and operating pressure should include consideration of pipe sizes and pressure losses due to friction and height to which liquid must be raised. This is particularly important in the selection of Centrifugal pumps.

4. SPEED

Recommended drive speeds meet standard operating speeds for electric motors and other driving mechanisms and are usually applicable for the majority of installations. Considerable variation in operating speed is possible to maintain high efficiency in the handling of a wide range of viscosities. Consult BSM for special drive speed recommendations.

Horsepower: Power requirements should be computed on the basis of highest liquid viscosity and system pressure. Generally, when power requirements fall between standard motor or engine ratings, the larger unit is selected for safety. (See Specifications and Operating Characteristics for type of pump to be used.)

PUMP SELECTION PROCEDURE

STEP 1 - Determine Delivery Required in Gallons Per Minute (gpm) and Pressure Required at the Work in Pounds Per Square Inch (psi).
STEP 2 - Determine Pump Inlet Conditions Including Suction Pipe Size and Total Suction Head.
STEP 3 - Determine Pump Discharge Conditions Including Discharge Pipe Size and Total Head.
STEP 4 - Select the Pump and Determine Power Required.

STEP 1

Convert the quantity of liquid required to gpm and the amount of pressure required at the work to pounds per square inch (psi).

Conversion Factors

1 inch of mercury (Hg) equals 1.13 feet of water
15 inches of mercury (Hg) equals 17 feet of water
1 foot of water equals .433 pounds per square inch (psi)
1 pound per square inch (psi) equals 2.31 feet of water
17 feet of water or 15 inches of mercury equals 7.36 psi

STEP 2

Vertical Lift

Vertical Lift is the amount of pressure required to lift the liquid from its lowest level to the centerline of the pump.

a) Measure the vertical distance between lowest liquid level and centerline of pump, equals Distance of Lift.
b) Distance of Lift (feet) x Specific Gravity of liquid x.433 equals Vertical Lift (psi)

(A maximum Vertical Lift of 7.36 psi or 15 inches of mercury is recommended for normal applications. Higher lifts are permissible with reduced volume - Consult BSM Pump Corp. for recommendations).

Suction Pipe Size

Having determined that Vertical Lift does not exceed 7.36 psi, refer to Table, Recommended Suction Line Sizes, pg. 14.3, and select pipe size opposite nearest required delivery and viscosity.

To Find Total Suction Head

a) Measure entire length of suction pipe including fittings converted to equivalent feet of straight pipe. Refer to table on pg. 14.3.
b) Refer to Table Friction Loss Multipliers, pg.14.3, and find the multiplier (M) opposite pipe size and liquid viscosity at delivery required.

Total Suction Head (psi) equals (M x Total feet of suction pipe x Specific Gravity of liquid) plus or minus Vertical Lift (Add Vertical Lift when liquid level is below centerline of pump, and Subtract Vertical Lift when liquid level is above centerline of pump).

STEP 3

Assume a Discharge Pipe Size the same as Suction Pipe for calculating Friction Head. If smaller pipe is required, liquid velocity should not exceed 10 feet per second. Generally, a Discharge Pipe Size the same as Pump Outlet Connection will prove satisfactory.

Total Head

a) Find Static Head – (measure vertical distance between centerline of pump and highest point of discharge, equals Height of Lift).
   Static Head (psi) equals Height of Lift x Spec. Gravity x .433
b) Find Friction Head – (measure entire length of discharge pipe including fittings converted to equivalent feet of straight pipe from pump discharge connection to point of discharge. (See table Equivalent Feet of Straight Pipe for Fittings, pg. 14.3). Add equivalent feet for valves and other accessories in discharge line to the foregoing.

Refer to Table Friction Loss Multipliers, pg. 14.3, and find the multiplier (M) opposite pipe size and liquid viscosity at delivery required.

Friction Head (psi) equals M x Spec. Gravity xTotal length of Discharge pipe.

STEP 4

Select Pump from Specifications and Operating Characteristics by determining which preliminary selection will meet requirements most efficiently. Power required is determined from Tabulated Power Requirements shown with Operating Characteristics and corrected for liquid viscosity.

ENGINEERING DATA FOR PUMP SELECTION

RECOMMENDED SUCTION LINE SIZES

when Vertical Lift does not exceed 7.36 psi or 15" Hg.

gpm	VISCOSITY (ssu) 50	100	300	500	1000	1500	2000	5000	10,000
.5	⅜	⅜	⅜	⅜	½	½	½	¾	1
1	⅜	⅜	⅜	⅜	½	½	¾	1	1
3	⅜	⅜	½	½	¾	¾	1	1¼	1¼
5	⅜	⅜	½	¾	¾	1	1	1¼	1½
7	½	½	¾	¾	1	1	1	1¼	1½
10	½	¾	¾	¾	1	1¼	1¼	1½	2
15	¾	¾	1	1	1¼	1¼	1¼	1½	2
20	1	1	1	1	1¼	1¼	1½	2	2
30	1¼	1¼	1¼	1¼	1¼	1½	1½	2	2½
50	1¼	1¼	1¼	1¼	1½				
80	1½	1½	1½	1½	2				

Table above represents best choice for optimum results. Smaller sizes can be used but with increased fluid velocity and the possibility of turbulence, noise and greater frictional resistance.

EQUIVALENT FEET OF STRAIGHT PIPE FOR FITTINGS

	PIPE SIZES ⅜	½	¾	1	1¼	1½	2	2½
45° elbow	.6	.8	1.0	1.3	1.7	2.0	2.5	3.0
90° std. elbow	1.3	1.6	2.2	2.8	3.7	4.4	5.2	6.4
std. tee	2.7	3.3	4.5	5.7	7.6	9.2	11.5	14.0
globe valve (open)	13.	17.	21.	28.	37.	43.	54.	65.
gate valve open	.27	.35	.45	.60	.80	.95	1.3	1.4
¼ closed	1.5	2.0	2.7	3.5	4.5	5.5	7.0	8.0
½ closed	6.0	10.	14.	17.5	22.	26.	33.	40.
¾ closed	35.	43.	57.	75.	103.	125.	150.	175.

gpm at one foot per second velocity

Pipe Size	⅛	¼	⅜	½	¾	1	1¼	1½	2	2½
gpm	.18	.32	.60	.95	1.66	2.69	4.65	6.35	10.5	14.9

Data above is based on average piping conditions and is for approximate use only.

FRICTION LOSS MULTIPLIERS

del. gpm	pipe size in.	VISCOSITY (ssu) 32	50	100	150	200	300	500	1000*
.5	⅜	.012	.025	.10	.15	.20	.30	.49	.95
	½	.004	.009	.02	.03	.04	.06	.10	.20
	¾	.0005	.001	.006	.009	.013	.02	.04	.08
	1	.0003	.0009	.002	.004	.006	.010	.019	.04
	1¼	.0001	.0004	.001	.0015	.002	.003	.005	.01
1	⅜	.019	.040	.12	.17	.23	.34	.55	1.1
	½	.006	.015	.04	.06	.08	.11	.21	.41
	¾	.002	.005	.01	.02	.03	.04	.07	.15
	1	.001	.002	.005	.007	.01	.015	.025	.06
	1¼	.0002	.0007	.002	.003	.0035	.005	.009	.02
5	⅜	.30	.51	.52	.77	1.0	1.6	2.7	5.4
	½	.10	.16	.20	.30	.40	.60	1.1	2.2
	¾	.025	.045	.07	.11	.15	.21	.35	.70
	1	.008	.01	.025	.035	.05	.08	.13	.26
	1¼	.002	.003	.01	.015	.02	.03	.05	.10
10	½	.45	.60	.85	1.0	1.15	1.5	2.1	4.4
	¾	.09	.13	.18	.24	.30	.41	.70	1.5
	1	.03	.04	.05	.07	.10	.15	.25	.50
	1¼	.008	.014	.019	.027	.035	.05	.09	.18
	1½	.003	.006	.009	.015	.02	.03	.05	.10
15	¾	.18	.30	.40	.49	.58	.75	1.08	2.2
	1	.06	.10	.12	.135	.15	.22	.40	.80
	1¼	.016	.026	.032	.045	.05	.08	.14	.27
	1½	.005	.013	.014	.023	.03	.04	.07	.15
	2	.002	.003	.005	.008	.01	.015	.03	.05
20	1	.05	.15	.20	.205	.21	.30	.50	1.1
	1¼	.026	.04	.06	.065	.07	.10	.18	.35
	1½	.012	.021	.025	.032	.04	.06	.10	.20
	2	.003	.006	.007	.010	.015	.02	.035	.07
	2½	.001	.002	.003	.005	.007	.011	.018	.036
30	1¼	.06	.10	.12	.135	.15	.18	.26	.52
	1½	.026	.04	.05	.055	.06	.08	.15	.30
	2	.007	.013	.016	.018	.02	.03	.05	.10
	2½	.003	.005	.007	.009	.01	.015	.025	.05
50	1¼	.15	.23	.30	.33	.35	.41	.45	.90
	1½	.06	.10	.13	.135	.14	.14	.23	.46
	2	.019	.03	.04	.04	.045	.05	.09	.18
	2½	.008	.013	.017	.0175	.018	.03	.046	.08
80	1¼	.45	.66	.85	.95	1.0	1.2	1.3	2.5
	1½	.18	.30	.35	.36	.40	.42	.50	1.0
	2	.06	.09	.11	.12	.13	.14	.25	.50
	2½	.02	.04	.04	.04	.045	.045	.06	.13

*Multipliers for higher viscosities are proportional, e.g. 2000 ssu for .5 gpm, ⅜" pipe is 1.9, 10,000 ssu is 9.5 etc.

Multipliers are based on use of steel pipe, Schedule 40, or smooth bore rubber hose and have a safety factor of approximately 15%.

ENGINEERING DATA HELPFUL INFORMATION

A foothead of water represents .4331 lbs. per sq.in. at 60ºF. 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 $\frac{V^2}{64.4}$ 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. = WxH/33,000xE or .000584 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 40ºF. Thus at 40ºF, the specific gravity of water is 1.0. Material having a specific gravity of .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.

Conversion Table - Feet of Water to Inches of Mercury

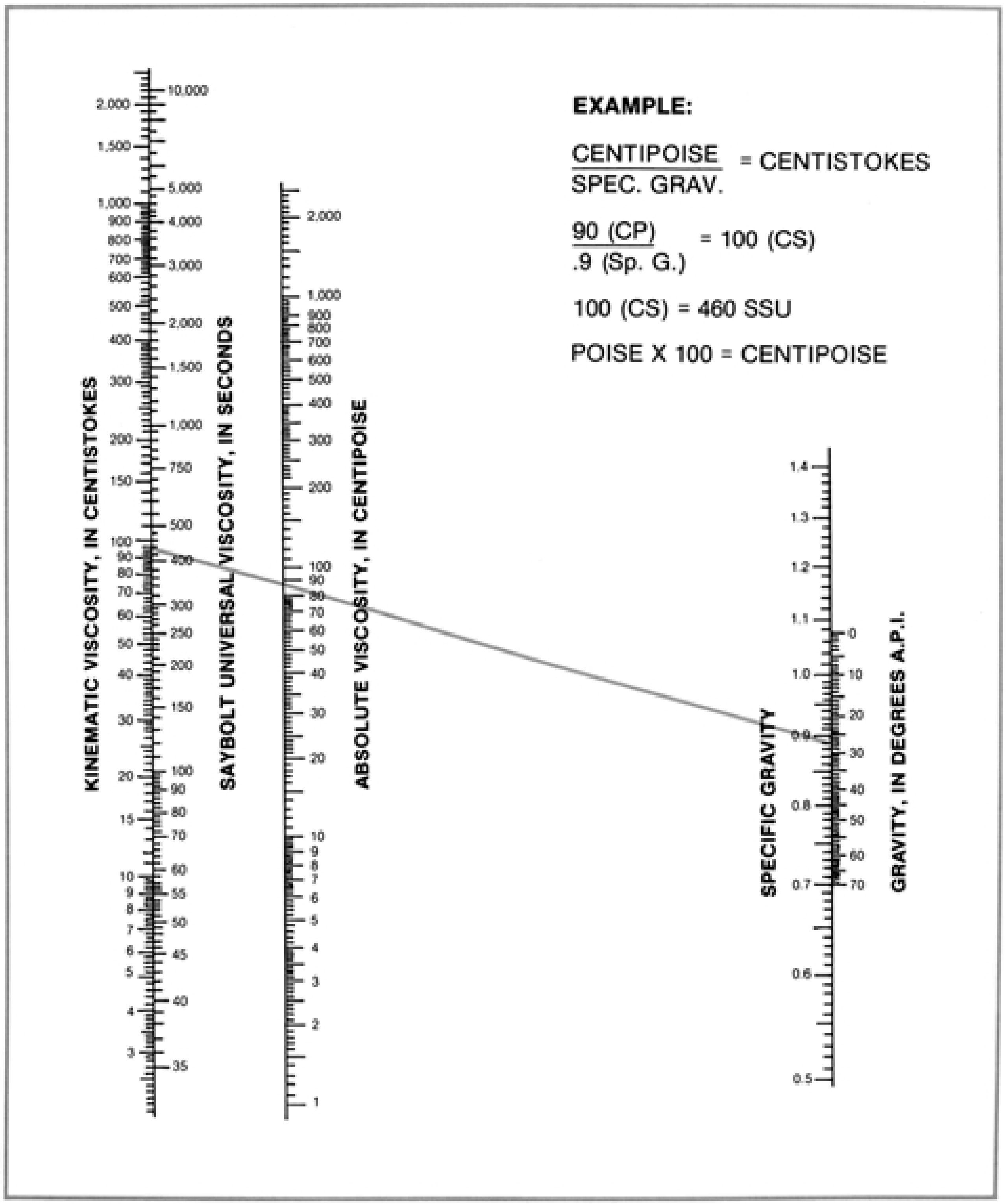
Feet	Inches, Hg	Feet	Inches, Hg	Feet	Inches, Hg	Feet	Inches, Hg
1	.885	8	7.08	15	13.27	23	20.35
2	1.77	9	7.96	16	14.15	24	21.24
3	2.65	10	8.85	17	15.05	25	22.12
4	3.54	11	9.74	18	15.93	26	23.00
5	4.42	12	10.62	19	16.81	27	23.90
6	5.30	13	11.50	20	17.70	28	24.78
7	6.20	14	12.39	21	18.59	29	25.66
				22	19.47	30	26.55

Conversion Table - Feet of Water to Pounds Per Square Inch

Feet	P.S.I.	Feet	P.S.I.	Feet	P.S.I.	Feet	P.S.I.
1	.43	20	8.66	120	51.97	275	119.10
2	.87	30	12.99	130	56.30	300	129.93
3	1.30	40	17.32	140	60.63	325	140.75
4	1.73	50	21.65	150	64.96	350	151.58
5	2.17	60	25.99	160	69.29	400	173.24
6	2.60	70	30.32	170	73.63	500	216.55
7	3.03	80	34.65	180	77.96	600	259.85
8	3.40	90	38.98	190	83.29	700	303.16
9	3.90	100	43.31	200	86.62	800	346.47
10	4.33	110	47.64	225	97.45	900	389.78
				250	108.27	1000	433.09

VISCOSITY CONVERSION

CONVERTING KINEMATIC AND SAYBOLT VISCOSITY TO ABSOLUTE VISCOSITY

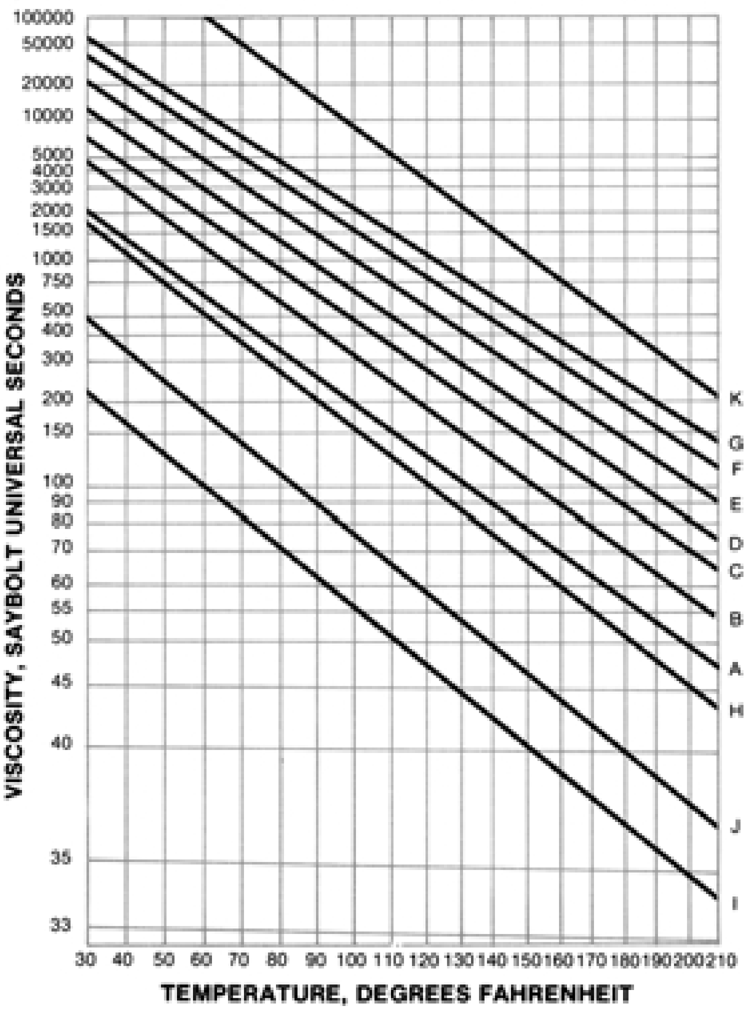


S.A.E. VISCOSITY CLASSIFICATION and VISCOSITIES OF OILS

S.A.E. Viscosity Classification

S.A.E. Viscosity Number	Viscosity Range, Saybolt Universal Viscosity (S.S.U.) At 130 Degrees Fahrenheit		At 210 Degrees Fahrenheit	
	Minimum	Maximum	Minimum	Maximum
10	90	Less than 120	-----	-----
20	120	Less than 185	-----	-----
30	185	Less than 255	-----	----
40	255	-----	-----	Less than 80
50	------	-----	80	Less than 105
60	-----	-----	105	Less than 125
70	-----	-----	125	Less than 150
80	-----	100,000 @ 0ºF	-----	-----
90	800	1500 @ 100ºF	-----	-----
140	-----	-----	120	Less than 200
250	-----	-----	200	-----

Chart Showing 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.
ºCelsius = (ºFahrenheit —32) x 5/9

MATERIALS REQUIRED FOR PUMPING VARIOUS LIQUIDS

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 inforce at the locality where the pump is to be used.

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.

Liquid	Condition	Chemical Symbol	Materials Permissible
Acid, Acetic		CH_3COOH	All Bronze, Monel, Stainless Steel
Acid, Arsenic (Arsenic Penta-oxide)		AS_2O_4	All Iron, Stainless Steel
Acid, Carbolic	Dil.	C_4H_5OH	All Iron
Acid, Carbolicin H2O	Aqueous Sol.		Standard Fitted
Acid, Cabonicin H2O	Conc. (M.P. 105¡F)	CO_2H_2O	All Bronze
Acid, Hydrocyanic		HCN	All Iron
Acid, Pyroligneous	PH<4-5	CH_3CO_3H	All Bronze, Stainless Steel
Acid, Sulphuic, 93%		H_3SO_4	All Iron, Stainless Steel
Acid, Tannc (m-Digallic acid)		$C_{44}H_{16}O_9$	All Bronze, Monel, Stainless Steel
Acetone	66¡ Be Cold	CH_5COCH_3	All Iron
Alcohol, Grain (Ethanol)		CH_3CH_3OH	All Bronze
Alcohol, Wood (Methanol)		CH_3OH	All Bronze
Ammonia, Aqua		NH_4OH	All Iron
Ammonium Bicarbonate		NH_4HCO_3	All Iron
Ammonium Chloride		NH_4Cl	All Iron, Stainless Steel
Ammonium Nitrate	Aqueous Sol.	NH_4NO_3	All Iron, Stainless Steel
Ammonium Orthophosphate	Aqueous Sol.	$(NH_4)_3HPO_4$	All Iron, Stainless Steel
Ammonium Sulfate	Aqueous Sol.	$(NH_4)_2SO_4$	All Iron, Stainless Steel
Aniline	Aqueous Sol.	$C_4H_3NH_2$	All Iron
Asphaltum	Aqueous Sol.		Stanard Fitted
Barium Chloride		$BaCl_3$	All Iron, Stainless Steel
Barium Nitrate	Hot	$Ba(NO_3)_2$	All Iron, Stainless Steel
Beer			All Bronze, Stainless Steel
Beer Wort			All Bronze, Stainless Steel
Beet Juice (thin)			All Bronze, Stainless Steel

MATERIALS REQUIRED FOR PUMPING VARIOUS LIQUIDS

Liquid	Condition	Chemical Symbol	Materials Permissible
Benzene (Benzol)		C_4H_4	All Iron
Bitterwasser		$CaCl_3$	All Bronze, Stainless Steel
Brine, Calcium Chloride	Aqueous Sol.		All Iron
Brine, Calcium & Sodium Chloride		Na Cl	All Bronze, Stainless Steel
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		$Ca(OC_1)_8$	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_4H_3Cl	Standard Fitted, Stainless Steel
Copperas (Green Vitriol)	(See Ferrous Sulphate)		
Creosote			All Iron
Cresol, Meta		$CH_3C_4H_4OH$	All Iron
Cyanide	(See Sod, Cyanide & Pot. Cyanide)		All Iron
Cyanogen	In Water	C_2N_2 (gas)	All Iron
Diphenyl	In Alcohol	$C_4H_5C_4H_5$	All Iron
Ethyl Acetate		$CH_3COOC_2H_3$	All Iron, Stainless Steel
Ferrous Sulphate		$FeSO_4$	All Iron
Furfural		C_4H_3OCHO	All Iron, Stainless Steel
Gasolene			Standard Fitted
Glaubers Salt	(See Sodium Sulfate)		Standard Fitted
Glue	Hot		Standard Fitted
Glycerol (Glycerin)			All Bronze, Stainless Steel
Heptane		$CH_2(CH_2)_3CH_3$	Standard Fitted
Hydrogen Peroxide	Com'l	H_2O_2	All Iron, Stainless Steel
Lard	Hot		All Iron
Lead, Molten			All Iron
Lime Water (Milk of Lime)		$Ca(OH)_3$	All Iron
Lye, Caustic	(See Potassium & Sod. Hydroxide)		
Magnesium Sulfate (Epson Salts)	Aqueous Sol.	Mg SO_4	All Iron, Stainless Steel
Magma (thick residue)			All Bronze, Stainless Steel
Magnese Chloride	Aqueous Sol.	$MnCl_2$	All Bronze, Stainless Steel
Manganese Sulfate	Aqueous Sol.	$MnSO_4$	All Iron, All Bronze, Stainless Steel
Mash			All Bronze, Stainless Steel
Methyl Chloride		CH_3Cl	All Iron
Methylene Chloride		CH_3Cl_3	All Iron, Stainless Steel
Milk of Lime	(See Lime Water)		
Mine Water			All Bronze Stainless Steel
Molasses			Standard Fitted
Naphtha			Standard Fitted

MATERIALS REQUIRED FOR PUMPING VARIOUS LIQUIDS

Liquid	Condition	Chemical Symbol	Materials Permissible
Nitre	(See Potassium Nitrate)		
Oil, Crude(Asphalt Base)	Hot		Standard Fitted
Oil, Crude (Paraffine 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, Cresote			All Iron
Oil, Turpentine			All Iron
Oil. Linseed			All Iron, Stainless Steel, Monel
Oil, Rapeseed			All Bronze, Stainless Steel, Monel
Paraffine	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_3Cr_3O1	All Iron
Potassium Carbonate	Aqueous Sol.	K_3CO_3	All Iron
Potassium Chlorate	Aqueous Sol.	$KclO_8$	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_3SO_4	All Iron, All Bronze, Stainless Steel
Pyridine			All Iron
Salammoniac	(See Ammonium Chloride)		
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_3CO_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.	Na OH	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_3S	All Iron, All Bronze, Stainless Steel
Sodium Sulfite	Aqueous Sol.	Na_2SO_3	All Bronze, Stainless Steel
Starch			Standard Fitted
Stronfium Nitrate	Aqueous Sol.	$Sr(NO_3)_3$	All Iron, Stainless Steel
Sugar			All Bronze
Sulfur	In Water	S	All Iron, All Bronze
Sulfer Chloride	Cold	S_3Cl_2	All Iron

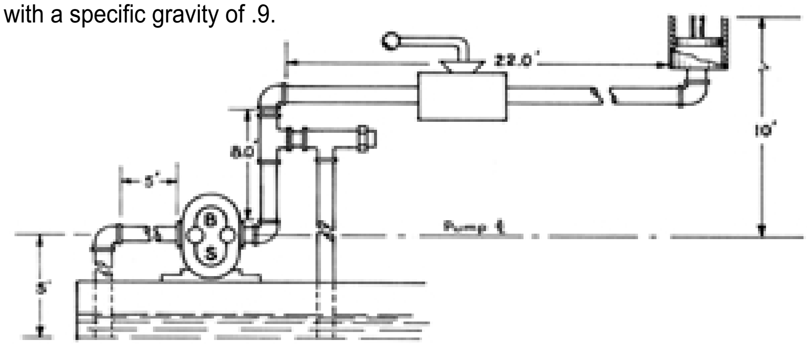
MATERIALS REQUIRED FOR PUMPING VARIOUS LIQUIDS

Liquid	Condition	Chemical Symbol	Materials Permissible
Syrup			All Bronze
Tanning Liquors (veg.)			All Bronze, Stainless Steel
Tar			All Iron
Tar and Ammonia	Aqueous Sol.		All Iron
Tetraethyl Lead		$Pb\ (C_2H_3)_4$	All Iron
Toluene (toluol)		$C_4H_3CH_2$	All Iron, Standard Fitted
Trichloroethylene		$CHC1:CCl_2$	All Iron
Varnish			All Bronze, Montel
Vinegar			All Bronze, Stainless Steel
Vitriol, Oil of	(See Acid, Sulfuric)		
Vitriol, White	(See Zinc Sulfate)		
Water (Distilled)			All Bronze
Water (Fresh)			All Bronze
Water (Salt and Sea)	(See Brines)		
Whiskey			All Bronze
Wine			All Bronze
Wood Pulp	Not Digested		All Bronze
Wood Vinegar	(See Pyroligenous Acid)		
Wort			All Bronze
Yeast			All Bronze
Zinc Sulfate	Aqueous Sol.	$ZnSO_4$	All Bronze, Stainless Steel

A TYPICAL HYDRAULIC APPLICATION

Problem:

Required: a pump to operate a hydraulic cylinder using a clean light hydraulic oil of 100 ssu viscosity at operating temperature of 120ºF with a specific gravity of .9.



Step 1 — CYLINDER REQUIREMENTS

5 inch diameter; 19.64 square inches cylinder area; 20inch stroke; 1.7 gallons displacement; travel 60 inches per minute (20 seconds per stroke); 11,500 pounds load; requires 5.17 gpm, 585 psi.

Step 2 — PUMP INLET CONDITIONS

Vertical Lift = Distance of Lift (5) x Spec. Gravity (.9) x .433
= 1.9 psi

Suction Pipe Size = 3/8 for 100 ssu at 5 gpm (from table, pg. 14.3).

Total Length of Suction Pipe = 10 feet plus 1.3 feet equivalent straight pipe for 90º elbow (from Table, pg. 14.3)
= 11.3 feet

Friction Loss Multiplier for 3/8 pipe and 100 ssu at 5 gpm (from Table, pg. 14.3)   M=.52

Total Suction Head = M (.52) x Total Length of Pipe (11.3) x Specific Gravity (.9) plus Vertical Lift (1.9 psi)
= 7.2 psi

Step 3 — PUMP DISCHARGE CONDITIONS

Discharge Pipe Size = 3/8 "

Static Head = Vertical distance between pump and cylinder (10) x .433 x Specific Gravity (.9)
= 3.9 psi.

Friction Head = Total Length of Straight pipe (30) plus 3-90º 3/8 elbows (3.9) plus estimated straight pipe for throw valve (1) or 34.9 x M (.52) x Spec. Gravity (.9)
= 16.3 psi

Total Head = Friction head (16.3 psi) plus Total Suction Head (7.2 psi) plus Working Pressure Required (585 psi)
= 608.5 psi

Step 4 — PUMP SELECTION

Requires 5.17 gpm and 610 psi. We find that Models 507 and 511 are satisfactory for Hydraulic Service, and are rated for 1000 psi service while discharge at 0 psi is sufficient to meet requirements. From Performance Data for these pumps on pg. 6.2, we find the #507 delivers 5.8 gpm at 610 psi and requires 2.9 horsepower at 1725rpm. (Capacity at 1140 rpm is insufficient to meet requirements). #511 delivers 5.1 gpm at 610 psi and requires 2.9 horsepower at 1140 rpm.

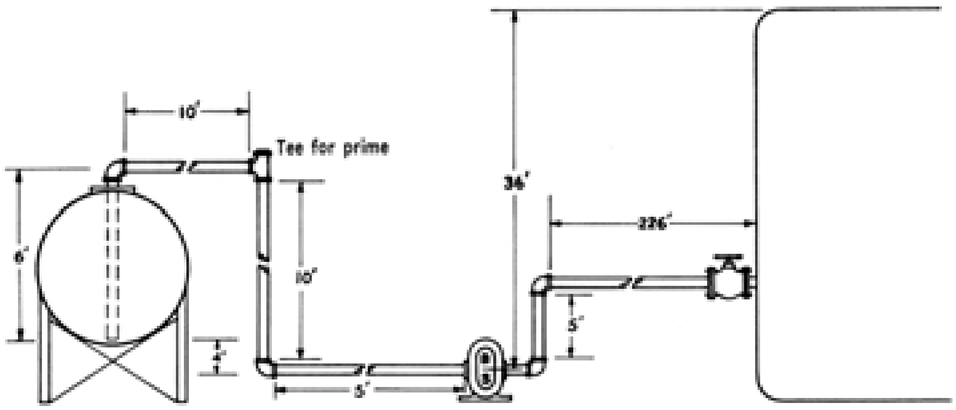
CONCLUSION

Select Pump #511 at lower speeds for long-life service. Select #507 at 1725 rpm for lower first cost.

TYPICAL TRANSFER APPLICATION

Problem:

To deliver oil at 20 barrels per hour from a storage tank to a treater tank, using 1 1/2" new iron pipe. Assume viscosity of 300 ssu. Specific Gravity is .88



Step 1 — CAPACITY REQUIRED

20 bbls. per hr x 42 gals. per bbl. ÷ 60=14gpm

Step 2 — PUMP INLET CONDITIONS

Find Total Suction Head
Suction Pipe Size is given as 1 1/2"

Vertical Lift = Distance of Lift (4) x Spec. Gravity (.88) x .433 = 1.52 psi

In this case, Vertical Lift is a positive factor since the bottom of the tank is higher than the pump inlet) Friction loss Multiplier (M) for 1 1/2 pipe at 15 gpm for 300 ssu viscosity is .04 (from Table, pg.14.3).

Suction = M (.04) x (31 total length of pipe plus 18' equivalent straight pipe for 2-90º elbows and 1-Tee) x Specific Gravity (.88) = 1.7 psi

Total Suction Head = 1.7 minus Vertical Lift (1.5)
= 0.2 psi

Step 3 — PUMP DISCHARGE CONDITIONS

Find Total Head
Discharge Pipe Size is given as 1 1/2"

Static Head = 36" maximum height of lift x .88 Specific Gravity x .433
= 13.7 psi

Friction Loss Multiplier (M) for 1 1/2" pipe at 15 gpm and 300 ssu is .04 (from Table, pg. 14.3).

Friction Head = M (.04) x (231 Total Length of Discharge Pipe, plus 2-90º elbows (8.8') plus .95 equiv. for gate valve normally open) x .88 Spec. Gravity = 8.5 psi

Total Head = Static head (13.7 psi) plus
Friction Head (8.5 psi) plus
Suction Head (0.2 psi)
= 22.4 psi

Step 4 — PUMP SELECTION

Required 14 gpm and 22.4 psi We find that Rotary Geared Pumps Nos. 3, 3S 13, 23, 53 and 525 all nominally meet requirements. In checking Performance Data for these pumps we can eliminate #13 which is reversible and has approx. the same capacity as #3 and #23 which is of bronze construction. Pump #3 delivers 17.0 gpm at 50 psi and 900 rpm and requires .83 hp. Pump #3S delivers 16.1 gpm at 50 psi and 1725 rpm requires 1.4 hp. Pump #53 delivers 14.9 gpm at 50 psi and1140 rpm and requires .8 hp . Pump #525 delivers 16.3 gpm at 50 psi and 1140 rpm and requires 1.0 hp.

While any of these pumps is capable of performing the job satisfactorily, #53 requires the least amount of power and operates at a standard motor speed.

Note: Given pipe size and pump port may differ and require reducer connection at pump.

A TYPICAL COOLANT APPLICATION

Problem:

Required: a pump to deliver 15 gpm of coolant having a viscosity of 32 ssu at operating temperature and using 3/4" piping. Specific Gravity is 1.0

Step 1 — (Given)

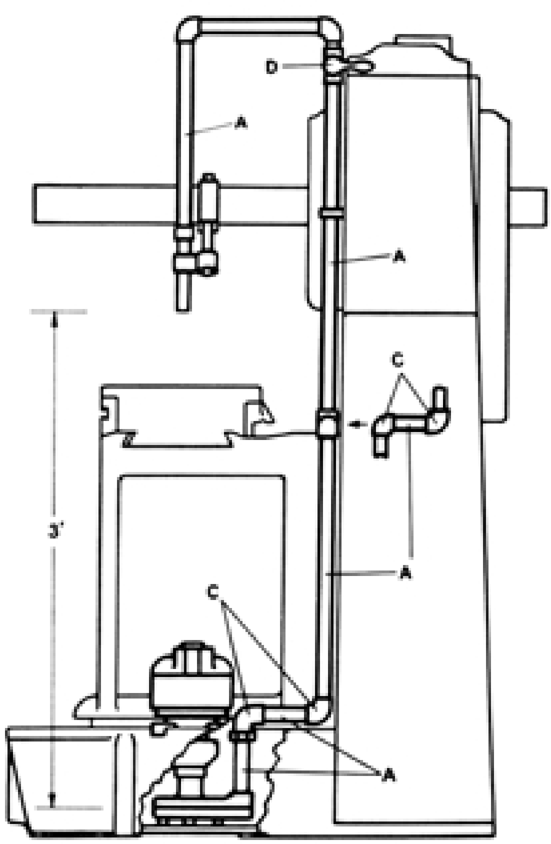
15 gpm required

Step 2 — PUMP INLET CONDITIONS

Since this problem involves the use of a Submersible Type Centrifugal Pump, we can assume that no inlet losses are present.

Step 3 — PUMP DISCHARGE

Discharge Pipe Size is given as 3/4”Static Head Vertical Distance between pump and point of discharge (3) x .433 = 1.3 psi (Specific Gravity being 1.0 need not be calculated).



Friction Loss Multiplier for 3/4 pipe at 15 gpm for 32 ssu (from Table, pg.120 is .18.

Friction Head = Total Length of straight pipe A (8.5) plus 6-90º elbows (13.2) plus estimated equiv. straight pipe for straight cock(1') or 22.7 x M (.18)
= 4.08 psi

Velocity Head = $\frac{V^2}{64.4}$ (Velocity Head is that pressure required to produce the velocity of the liquid and is equal to the formula at the left when V equals feet per second velocity)

1 foot per second velocity for 3/4" pipe = 1.66 gpm (from Table, pg.14.3)

Velocity for 15gpm = $\frac{15}{1.66}$ = 9.03 feet per second

Velocity Head = $\frac{(9.03)^2}{64.4}$ x .433 = .56 psi

Total Head = Static Head (1.3 psi) plus Friction Head (4.08 psi) plus Velocity Head (.56 psi)
= 5.94 psi

To convert Total Head to Feet of Oil:
Total Head = 5.94 x 2.31 x Spec Gravity (1.0)
= 13.72 feet

Step 4 — PUMP SELECTION

Required 15 gpm and 13.72 Total head. We find the Motor Driven Centrifugal Pump #208 will meet delivery requirements and has a maximum head of 16 feet. Performance Data, pg. 12.3, shows that Pump #208 will deliver 19 gpm at 13 feet Total Head and has a 1/4 hp electric motor operating at 1725 rpm. This selection will provide a safety margin to meet coolant supply requirements in the event that head is increased because of contamination of the fluid.

TROUBLE SHOOTING

IT MIGHT BE ONE OF THESE	TO FIX IT
Not delivering fluid properly?	
• *Pump may be driven in the wrong direction of rotation -*	• Stop immediately to prevent seizure. Check direction of drive rotation (proper rotation direction is indicated by arrow on the head).
• *Drive shaft broken, or shaft key sheared (direct drive) -*	• Remove pump from mounting and determine internal damage. Replace parts if necessary.
• *Intake pipe from reservoir blocked or viscosity too heavy to prime -*	• Drain system. Add clean fluid of proper viscosity and specifications. Filter as recommended. Check system filter for cleanliness.
• *Intake air leaks (foam in oil) -*	• Check intake connections. Tighten securely. Squirt oil around seal. If foam in discharge line stops, seal is leaking and must be replaced.
• *Pump not priming -*	• Loosen connection in outlet line. Bleed air until fluid flows. Check direction of rotation and suction conditions. Check for air leaks as above.
• *Fluid level too low -*	• Reservoir fluid level must be above the opening of the intake pipe. (The system should always be checked at initial start-up to make certain it is filled with fluid).
System pressure too low?	
• *Relief valve set too low -*	• Adjust the relief valve, check setting with a pressure gage.
• *Worn pump parts causing extreme internal leakage -*	• Replace gears and take required corrective steps after examination internal leakage of pumps parts.
Not delivering fluid properly?	
• *Partly clogged intake strainer or restricted intake pipe -*	• Pump must receive intake fluid freely or cavitation results. Drain system, clean the intake pipe, and clean or replace the strainer. Add new fluid and strain by recommended procedures.
• *Defective bearing -*	• Replace cap or head as required (bearings available only as Assembled in cap and head). Inspect the shafts and replace if necessary.
• *Air leak at pump intake pipe joints or shaft seal -*	• Pour fluid on joints and around the drive shaft seal while listening for a change in sound. Tighten joints as required. Replace the shaft seal if necessary.
• *Drive speed too fast or too slow -*	• Drive pump within its recommended speed range.
• *Drive shaft misalignment -*	• Check the bearings and seal. Replace pump if necessary and realign the shafts. Always check before start up. Shaft must not be out of line more than .002 with the power source shaft. Shaft ends should have a gap of 1/8 minimum.

TROUBLE SHOOTING

IT MIGHT BE ONE OF THESE	TO FIX IT
Shaft seal leaking?	
• Seal worn or damaged -	• Replace seals (See Reassembly)
• Excessive pressure on seals -	• Check for restriction or blockage of internal backdrain to the seal of the pump head. Inlet pressure should not exceed 5psi. Make certain that the hole through the drive shaft is clear.
House leaking?	
• Pipe fitting too tight -	• Check pump cap for warping. Inspect cap, housing and head for flatness and replace as necessary
• Dirt in joints, housing scored -	• Clean cap, housing and head. Carefully remove scoring by lightly Tapping or stoning
Excessive heat?	
• Discharge or pump temperature -	• When over 160ºF or hot in comparison with circuit lines, pump should be shut down immediately. Inspect for excessive wear or bearing failure. Before restarting, insure that fluid cooling capacity is adequate to remove system generated heat.
Rapid wear?	• Inspect fluid for grit and dirt. Check pipe fittings; over tightening will warp cap and cause premature water.

BSM ROTARY GEAR PUMPS

APPLICATION WORKSHEET

By: ___________________________________

Date: ___________________________________

Customer: ____

____

____

Contact: ____

Phone / Fax: ____

Type of Pump: ____

Type of Service: ____

____

____

____

____

A. Gallons per minute: ______________

B. Type of liquid: __________________

C. Viscosity _________________SSU at ______________ºF Temperature.

D. Operating temperature: Max. _______ºF Min _________ºF Norm__________ºF

E. Operating pressure: ____________psi or _____________ Head Feet

F. Motor: _________Volts _________ Phase _________ Cycles _________ Open Drip Proof

___________ Tot. Enclosed ___________ Explosion Proof

Quantities to quote: ____