CLARK SOLUTIONS

Rotary Gear Pumps

Technical Bulletin: Pump Selection Information

GENERAL PUMP SELECTION

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

1. TYPE OF SERVICE

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

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 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.

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.

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.

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.

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 0.433 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 for Distance of Lift.
b) Distance of Lift (feet) x Specific Gravity of liquid x 0.433 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. (Contact Clark for recommendations).

Suction Pipe Size

Having determined that Vertical Lift does not exceed 7.36 PSI, refer to Table 1, Recommended Suction Line Sizes, 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 2.
b) Refer to Table 4, Friction Loss Multipliers, 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 0.433

(STEP 3 Continued)

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 2 for equivalent Feet of Straight Pipe for Fittings). Add equivalent feet for valves and other accessories in discharge line to the foregoing.

Refer to Table 4, Friction Loss Multipliers, and find the multiplier (M) opposite pipe size and liquid viscosity at delivery required.

Friction Head (PSI) equals M x Spec. Gravity x Total 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

Table 1: Recommended Suction Line Sizes (when verticle lift does not exceed 7.36 psi or 15" Hg

GPM	Viscosity (SSU)								
	50	100	300	500	1000	1500	2000	5000	10.000
0.5	3/8	3/8	3/8	3/8	1/2	1/2	1/2	3/4	1
1	3/8	3/8	3/8	3/8	1/2	1/2	3/4	1	1
3	3/8	3/8	1/2	1/2	3/4	3/4	1	1 1/4	1 1/4
5	3/8	3/8	1/2	3/4	3/4	1	1	1 1/4	1 1/2
7	1/2	1/2	3/4	3/4	1	1	1	1 1/4	1 1/2
10	1/2	3/4	3/4	3/4	1	1 1/4	1 1/4	1 1/2	2
15	3/4	3/4	1	1	1 1/4	1 1/4	1 1/4	1 1/2	2
20	1	1	1	1	1 1/4	1 1/4	1 1/2	2	2
30	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2	2	2 1/2
50	1 1/4	1 1/4	1 1/4	1 1/4	1 1/2	-	-		-
80	1 1/4	1 1/2	1 1/2	1 1/2	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.

Table 2: Equivalent Feet of Straight Pipe for Fittings

	Pipe Sizes							
	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2
45º Elbow	0.6	0.8	1.0	1.3	1.7	2.0	2.5	3.0
90º 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	13.0	17.0	21.0	28.0	37.0	43.0	54.0	65.0
Gate Valve open	0.27	0.35	0.45	0.6	0.8	0.95	1.3	1.4
1/4 Closed	1.5	2.0	2.7	3.5	4.5	5.5	7.0	8.0
1/2 Closed	6.0	10.0	14.0	17.5	22.0	26.0	33.0	40.0
3/4 Closed	35.0	43.0	57.0	75.0	103.0	125.0	150.0	175.0

Table 3: GPM at One Foot per Second Velocity

Pipe Size	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2
GPM	0.18	0.32	0.60	0.95	1.66	2.69	4.65	6.35	10.5	14.9

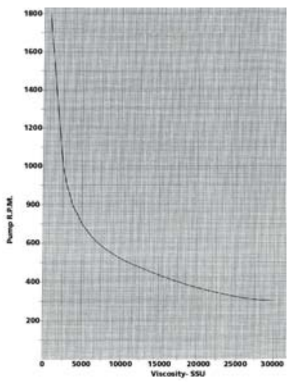
Data above is based on average piping conditions and is for approximate use only.

Table 4: Friction Loss Multipliers

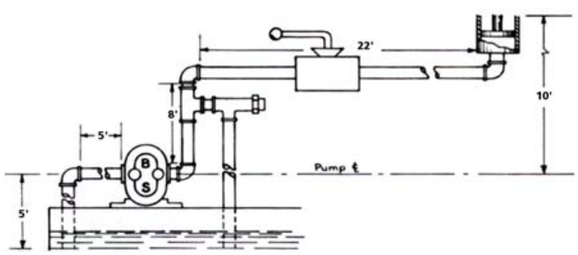
Del. GPM	Pipe Size (inches	Viscosity (SSU)							
		32	50	100	150	200	300	500	*1000
0.5	**3/8**	0.012	0.025	0.10	0.15	0.20	0.30	0.49	0.95
	1/2	0.004	0.009	0.02	0.03	0.04	0.06	0.10	0.20
	3/4	0.0005	0.001	0.006	0.009	0.013	0.02	0.04	0.08
	1	0.0003	0.0009	0.002	0.004	0.006	0.010	0.019	0.04
	1 1/4	0.0001	0.0004	0.001	0.0015	0.002	0.003	0.005	0.01
1	**3/8**	0.019	0.040	0.12	0.17	0.23	0.34	0.55	1.1
	1/2	0.006	0.015	0.04	0.06	0.08	0.11	0.21	0.41
	3/4	0.002	0.005	0.01	0.02	0.03	0.04	0.07	0.15
	1	0.001	0.002	0.005	0.007	0.01	0.015	0.025	0.06
	1 1/4	0.0002	0.0007	0.002	0.003	0.0035	0.005	0.009	0.02
5	**3/8**	0.30	0.51	0.52	0.77	1.0	1.6	2.7	5.4
	1/2	0.10	0.16	0.20	0.30	0.40	0.60	1.1	2.2
	3/4	0.025	0.045	0.07	0.11	0.15	0.21	0.35	0.70
	1	0.008	0.01	0.025	0.035	0.05	0.08	0.13	0.26
	1 1/4	0.002	0.003	0.01	0.015	0.02	0.03	0.05	0.10
10	**1/2**	0.45	0.60	0.85	1.0	1.15	1.5	2.1	4.4
	3/4	0.09	0.13	0.18	0.24	0.30	0.41	0.70	1.5
	1	0.03	0.04	0.05	0.07	0.10	0.15	0.25	0.50
	1 1/4	0.008	0.014	0.019	0.027	0.035	0.05	0.09	0.18
	1 1/2	0.003	0.006	0.009	0.015	0.02	0.03	0.05	0.10
15	**3/4**	0.18	0.30	0.40	0.49	0.58	0.75	1.08	2.2
	1	0.06	0.10	0.12	0.135	0.15	0.22	0.40	0.80
	1 1/4	0.016	0.026	0.032	0.045	0.05	0.08	0.14	0.27
	1 1/2	0.005	0.013	0.014	0.023	0.03	0.04	0.07	0.15
	2	0.002	0.003	0.005	0.008	0.01	0.015	0.03	0.05
20	**1**	0.05	0.15	0.20	0.205	0.21	0.30	0.50	1.1
	1 1/4	0.026	0.04	0.06	0.065	0.07	0.10	0.18	0.35
	1 1/2	0.012	0.021	0.025	0.032	0.04	0.06	0.10	0.20
	2	0.003	0.006	0.007	0.010	0.015	0.02	0.035	0.07
	2 1/2	0.001	0.002	0.003	0.005	0.007	0.011	0.018	0.036
30	**1 1/4**	0.06	0.10	0.12	0.135	0.15	0.18	0.26	0.52
	1 1/2	0.026	0.04	0.05	0.055	0.06	0.08	0.15	0.30
	2	0.007	0.013	0.016	0.018	0.02	0.03	0.05	0.10
	2 1/2	0.003	0.005	0.007	0.009	0.01	0.15	0.025	0.05
50	**1 1/4**	0.15	0.23	0.30	0.33	0.35	0.41	0.45	0.90
	1 1/2	0.06	0.10	0.13	0.135	0.14	0.14	0.23	0.46
	2	0.019	0.03	0.04	0.04	0.045	0.05	0.09	0.18
	2 1/2	0.008	0.013	0.017	0.0175	0.018	0.03	0.046	0.08
80	**1 1/4**	0.45	0.66	0.85	0.95	1.0	1.2	1.3	2.5
	1 1/2	0.18	0.30	0.35	0.36	0.40	0.42	0.50	1.0
	2	0.06	0.09	0.11	0.12	0.13	0.14	0.25	0.50
	2 1/2	0.02	0.04	0.04	0.04	0.045	0.045	0.06	0.13

*Multipliers for higher viscosities are proportional, e.g. 2000 SSU for 0.5 GPM, 3/8" pipe is 1.9, 10,000 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%.

Recommended Max Speed vs Max Viscosity



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 120°F with a specific gravity of 0.9.

Step 1 —

CYLINDER REQUIREMENTS: 5 inch diameter; 19.64 square inches cylinder area; 20 inch 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 (0.9) x 0.433 = 1.9 PSI

Suction Pipe = 3/8 for 100 SSU at 5 GPM (Table 1)

Total Length of Suction Pipe = 10 feet plus 1.3 feet equivalent straight pipe for 90° elbow (from Table 2) = 11.3 feet

Friction Loss Multiplier for 3/8 pipe and 100 SSU at 5 GPM (from Table 4), M=0.52

Total Suction Head= M (0.52) x Total Length of Pipe (11.3) x Specific Gravity (0.9) 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 0.433 x Specific Gravity (0.9)= 3.9 PSI.

Friction Head = Total Length of Straight pipe (30) plus 3-90° 3/8 elbows (3.9) plus estimated straight pipe for throw valve (1) or 34.9 x M (0.52) x Spec. Gravity(0.9) = 16.3 PSI

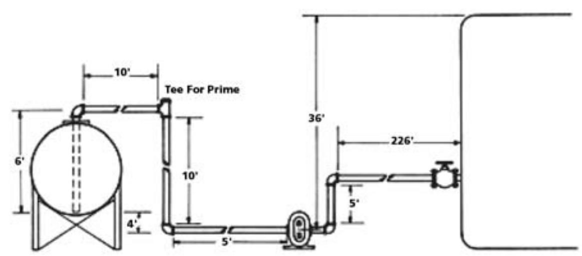
TYPICAL HYDRAULIC APPLICATION CONT'D

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, we find the #507 delivers 5.8 GPM at 610 PSI and requires 2.9 horsepower at 1725 RPM. (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. 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 0.88

Step 1 —

CAPACITY REQUIRED: 20 bbls. per hr x 42 gals. per bbl. ÷ 60=14 GPM

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 (0.88) x 0.433 = 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 0.04 (from Table 3. Suction = M (0.04) x 31 (total length of pipe plus 18' equivalent straight pipe for 2-90° elbows and 1-Tee) x Specific Gravity (0.88) = 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 0.88 Specific Gravity x 0.433 = 13.7 PSI

Friction Loss Multiplier (M) for 1 1/2" pipe at 15 GPM and 300 SSU is 0.04 (from Table 4).

(TYPICAL TRANSFER APPLICATION CONT'D)

Friction Head = M (0.04) x 231 (Total Length of Discharge Pipe, plus 2-90° elbows (8.8') plus 0.95 equiv. for gate valve normally open) x 0.88 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 is 14 GPM and 22.4 PSI We find that Rotary Gear 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 0.83 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 0.8 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.

TROUBLESHOOTING TIPS

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

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 0.002 with the power source shaft. Shaft ends should have a gap of 1/8 minimum.

Shaft seal leaking?
- Seal worn or damaged - • Replace seals
- Excessive pressure on seals - • Check for restriction or blockage of internal backdrain to the seal of the pump head. Inlet pressure should not exceed 5 PSI. Make certain that the hole through the drive shaft is clear.

Housing 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 160°F 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 wear.