SUBMERSIBLE PUMP SELECTION

A submersible pump consists of the following basic elements:

< Bowl Assembly
< Motor
< Cable
< Drop Pipe
< Surface Plate (with)(without) discharge elbow

DATA REQUIRED FOR SELECTION

< Capacity in GPM
< Static and Pumping Levels in Well
< Setting Required (drop pipe)
< Well I.D. Diameter
< Electric Characteristics

DETERMINATION OF TOTAL HEAD

Total head = H + P + F where:

H = Distance from surface to water level when pumping
P = Pressure (head) at pump discharge
F = Drop pipe friction (+) check valve(s) loss

BOWL ASSEMBLY SELECTION

Select impeller in exactly the same manner as for lineshaft type pump. Note comments under WELL SIZE.

DROP PIPE SELECTION

Size of drop pipe is selected based on the capacity to be pumped. Submersible pumps frequently require smaller drop pipe than do line shaft pumps since the full area of the pipe is used to deliver water to the surface.

Minimum velocity in drop pipe should not be less than 3.5Ft./Sec.

We recommend drop pipe size be selected to limit the maximum friction loss to 5’ per 100’ of pipe. Selection table is based upon this limitation. Smaller size drop pipe may be used when bowl assembly and motor are adequate for operation with the increased head and horsepower.

Pipe furnished by others must be standard pipe with 3/4 taper NPT threading throughout and to connect to the bowl assembly and surface plate.

CHECK VALVES

Where total head exceeds 200’, the use of a drop pipe check valve is recommended. Check valve should be located approximately 20’ above the bowl assembly. For settings over 600’, the use of two check valves are recommended, with the first valve approximately 100’ above bowl unit and the second located approximately 60% of the distance between the first valve and the surface plate.

CABLE SELECTION
Select a drop cable designed for use in water. The insulation on the conductors should be RW, RUW, TW, or their equivalent. DO NOT compromise on drop cable quality. Paying a little more will save you money in the long run. Cable selection chart is based on horsepower, voltage, and length of cable required. Cable sizes and lengths are maximum allowable. Higher operating efficiency will be obtained by using the next larger cable size when lengths approach listed limits. All size and cable lengths shown are for copper wire only.

NOTE: Use of smaller cable than recommended will void warranty.

Select cable length equal to length of setting plus an additional 10' or more to connect to starter at the surface, plus 1 additional foot for each 50' of length in the well to compensate for unavoidable slack in the installation.

SURFACE PLATE
Surface place consists of flat steel plate with connection for drop pipe, hole for entrance of cable, vent hole, hole for air line or water level gauge. Surface plate is supplied (with)(without) elbow. If elbow is furnished, it can be flanged or female thread. Surface plate is selected to match drop pipe size.

MOTOR SELECTION
Motor selection is based upon horsepower required, pump RPM, thrust load, well diameter, and power supply. Also, see comments under WELL SIZE and WATER TEMPERATURE.

STARTING EQUIPMENT
Selecting the proper overload protection is one of the most important factors in obtaining a successful submersible installation. Submersible motor starters should provide the following:

- < Positive motor protection against single phasing.
- < Positive motor protection against sustained overload in excess of 115% of motor rating.
- < Motor protection if rotor is stalled.
- < Tripping timers independent of ambient temperature; (Ambient Compensated Quick Trip Heaters).

NOTE: Failure to provide quick trip overload heaters will void warranty.

Also, note that under certain conditions of maximum load on the motor (use of the 1.15 service factor), a starter one size larger may be required.

LIGHTNING PROTECTION
Lightning and power surge damage are major causes of submersible motor failures, so a three-phase lightning arrestor is a must. The arrestor is mounted in the pump panel and grounded to both ground terminals onto pump panel and well head. If you use plastic pipe, the ground wire should also be connected to a stud on the motor to obtain good grounding and maximum benefit from the arrestor.

WARNING: Failure to ground this unit may result in serious electrical shock. A faulty motor or wiring can be a serious electrical shock hazard if it is accessible to human contact. To avoid this danger, connect the motor frame to the power supply grounding terminal with copper conductor no smaller than the circuit conductors. In all installations, connect above ground metal plumbing to the power supply ground per National Article 250-80 to prevent shock hazard.

SELECTION PROCEDURE EXAMPLE

REQUIREMENTS:

Capacity..850 GPM
Head..140 Feet
Pumping Level...................................200 Feet
Well Diameter....................................12” Inside Diameter
Power Supply......................................3 Ph. / 60 Hertz / 480 Volts
Pumping Liquid...................................Fresh Water

1. DETERMINE TOTAL DYNAMIC HEAD: (TDH) = pumping level + head required + drop pipe friction loss + check valve(s) friction

TDH = a. Pumping level...200 Feet
b. Head required..140 Feet
c . 8” drop pipe friction head for 850 GPM is 2.2 feet per 100 feet.
200 feet of new 8” drop pipe has a total loss of 2.2 x 2.0 =..........4.4 Feet
d. Friction head loss in one 8” check valve =.....................................2.2 Feet

TOTAL Dynamic Head (TDH).. 346.6 Feet

2. IMPELLER SELECTION:

Since no speed was specified, use 3450 RPM. The S9XHC shows 76% efficiency, full diameter.

a. Number of stages required =

$$\text{No. Stg.} = \frac{\text{TDH}}{\text{Head/Stage}} = \frac{346.6}{125} = 2.78 \text{ USE 3 stages, 75.5\%}$$

b. Total Pump Thrust = TDH x Impeller Thrust Factor x Sp. Gr. + (Rotor weight per stage x number of stages)
(349.55 x 4.9 x 1) + (10.6 x 3) = 1744.6

c. Bowl Horsepower $= \frac{\text{GPM x TDH x Sp. Gr.}}{\text{3960 x Bowl Eff.}} = \frac{850 \text{ x } 346.6 \text{ x } 1}{3960 \text{ x } 75.5\%} = 98.54$ BHP

d. Pump Efficiency $= \frac{\text{GPM x TDH x Sp. Gr.}}{\text{3960 x Bowl H.P.}} = \frac{850 \text{ x } 346.6 \text{ x } 1}{3960 \text{ x } 98.54} = 75.5\%$

SELECTION PROCEDURE EXAMPLE (CONT.)

3. MOTOR SELECTION:
   a. Bowl Horsepower = 98.54
   b. Pump Operating Speed = 3450 RPM
   c. Total Pump Thrust = 1744.6
   d. 3 Phase, 60 Hertz, 460 Volts (nameplate)
   e. Thrust Bearing Loss $= \frac{.10 \times \text{Total Pump Thrust}}{1000} = \frac{.10 \times 1744.6}{1000} = .17$ H.P.
   f. Horsepower Loss in Cable:
      Total Cable Length = 200 feet + 10 + 4 = 214 feet
      Select #00 cable from Selection Chart
      100 H.P. motor current = 130 amps full load
      Horsepower loss in #00 cable $= \frac{\text{H.P. loss per 100' x Total Cable Length}}{100} = \frac{.65 \times 214}{100} = 1.39$HP
   g. Total Horsepower: = Bowl horsepower + Thrust HP loss + Cable horsepower loss = 98.54 + 1.39 + .17 = 100.10 H.P. (100 H.P. motor OK to use.)

4. CABLE SELECTION:
   a. Determine total cable length.
      Total Cable Length = Pumping Level + Surface Length + Slack = 200 + 10 + 4 = 214 feet
   b. Per Cable Selection Chart @ 460 volts horsepower, use #00 cable.

5. SURFACE PLATE:
   Use 8” surface plate.

6. CHECK VALVE:
   One 8” check valve required.

7. CALCULATION OF FIELD PERFORMANCE:
   To determine field head and overall pump efficiency:
   a. Field Head = laboratory head minus total friction loss.
      (1) Total friction loss = loss in drop pipe + check valve(s)
   b. Overall Pump Efficiency $= \frac{\text{Water HP x (motor eff. \% - cable loss \%)}}{\text{Laboratory H.P.}}$
   c. Water Horsepower $= \frac{\text{GPM x Head}}{3960}$
   d. Laboratory Horsepower $= \frac{\text{GPM x Head x Sp. Gr.}}{3960 \text{ x Pump Eff.}}$

Calculations for other values of power consumption can be carried out per equations noted below:

   e. Wire to Water Efficiency - same as Overall Efficiency.
   f. Input Horsepower $= \frac{\text{Pump Brake Horsepower}}{\text{Motor Efficiency - Cable Loss}}$
   g. Wire to Water Horsepower = Same as Input Horsepower
   h. Kilowatt Hours per 100 Gallons $= \frac{\text{Field head x .00314}}{\text{Overall Efficiency}}$
   i. Kilowatts Input = Input Horsepower x 0.746
   j. Gallons per Kilowatt Hour $= \frac{\text{Overall Efficiency x 1000}}{\text{Field Head x .00314}}$

DETERMINATION OF FIELD PERFORMANCE

GENERAL INSTRUCTIONS

1. Select drop pipe size from selection chart.
   (NOTE: 5' per 100' friction loss is maximum; 3.5'/Sec. velocity is minimum.)

   a. Calculate drop pipe friction loss

      $$\text{Friction per 100 feet} \times \frac{\text{drop pipe length}}{100} + \text{check valve friction loss}$$

   b. Calculate Total Dynamic Head (TDH)

      TDH = Pumping level + discharge head required at surface + check valve friction loss + drop pipe friction loss

2. Impeller Selection: From performance curves with known capacity and speed, select the bowl assembly that has its peak efficiency as close as possible to desired capacity. Well I.D. must be larger than bowl diameter. If speed is unknown, the speed should be as high as possible for a given capacity.

   a. $$\text{Number of stages required} = \frac{\text{TDH}}{\text{Head/stage}} = \text{Number of stages}$$

   b. Total Pump Thrust = (TDH x Impeller Thrust Factor x Sp. Gr.) + (rotor weight per stage x number of stages)

   c. $$\text{Bowl Horsepower} = \frac{\text{GPM} \times \text{TDH} \times \text{Sp. Gr.}}{3960 \times \text{Bowl Eff.}}$$

   d. $$\text{Pump Efficiency} = \frac{\text{GPM} \times \text{TDH} \times \text{Sp. Gr.}}{3960 \times \text{Bowl H.P.}}$$

SUBMERSIBLES

DETERMINATION OF FIELD PERFORMANCE (CONT.)

3. MOTOR SELECTION:

   Select the proper electric motor from the following:

   a. Bowl Horsepower
   b. Pump Operating Speed
   c. Total Pump Thrust
   d. Electric Power Supply Available
   e. Thrust Bearing Loss in H.P.
      Horsepower loss per 1000# thrust (given by manufacturer is approx. .09 per 1000# thrust; use .10 H.P. per 1000#) =

$$\frac{.10 \times \text{total pump thrust \#}}{1000\#}$$

   f. Horsepower loss in cable (from Cable Loss Chart) to determine horsepower loss per 100 feet.

$$\text{Total horsepower loss in cable} = \text{horsepower loss per 100'} \times \frac{\text{Total Cable Length}}{100}$$

      NOTE: Total cable length = pumping level + distance from well at surface to starter panel + allowance for slack.

   g. Total Horsepower:

      Total H.P. = bowl horsepower + thrust horsepower loss + cable horsepower loss

4. Cable Selection:

   a. Determine total cable length.

      Total cable length = pumping level + surface distance to starter panel + allowance for slack

      NOTE: (1) Slack cable, allow 2 feet per 100 feet
      (2) 10 foot minimum for surface cable to starter

   b. From cable selection chart under proper voltage, select cable under motor full load amps for length of cable used.

      NOTE: If full load amps fall between amps on chart, go to next larger size.

5. SURFACE PLATE: Select the same size as drop pipe diameter.

6. CHECK VALVE: Select the same size as drop pipe diameter (if required by Technical Data).

7. ACCESSORIES:

   a. Pump Panel
   b. Air Line and Gauge
   c. Banding Tools
   d. Banding Supplies
   e. Cable