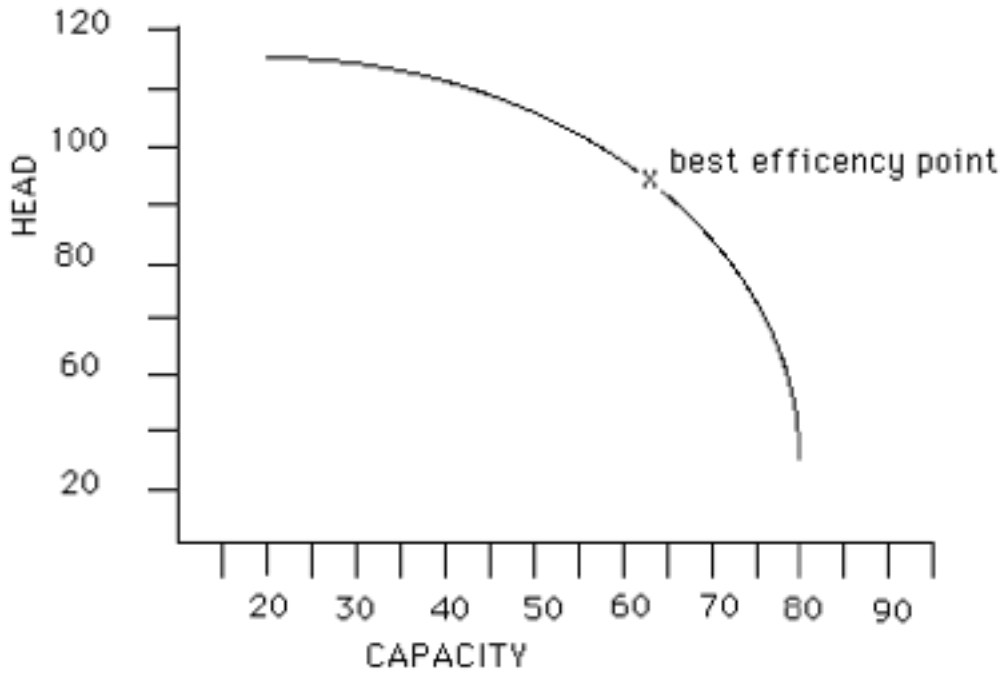


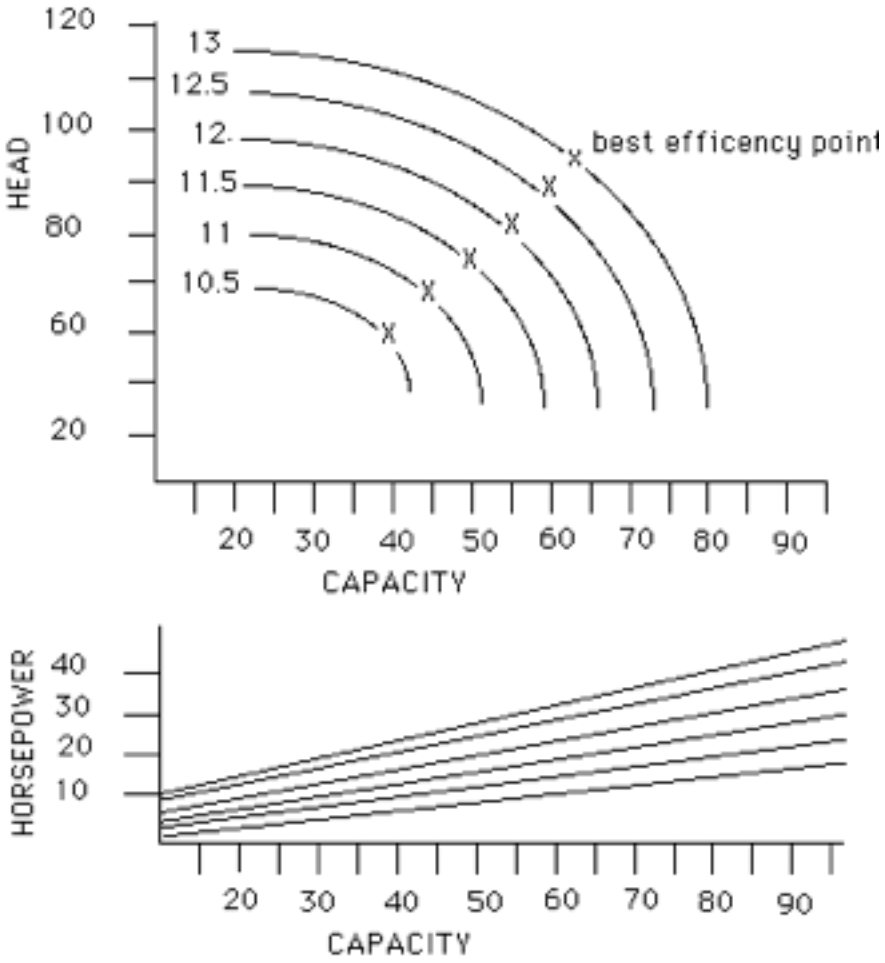
Please look at the above illustration. Note the head of the pump against its capacity. The head of a pump is read in feet or meters. The capacity units will be either gallons per minute, liters per minute, or cubic meters per hour.

According to the above illustration, this pump will pump a 40 capacity to about a 110 head, or a 70 capacity to approximately a 85 head.

The maximum head of this pump is 115 units. This is called the maximum shutoff head of the pump. Also note that the best efficiency point (BEP) of this impeller is between 80% and 85% of the shutoff head. This 80% to 85% is typical of centrifugal pumps, but if you want to know the exact best efficiency point you must refer to the manufacturers pump curve.

Ideally a pump would run at its best efficiency point all of the time, but we seldom hit ideal conditions. As you move away from the BEP the shaft will deflect and the pump will experience some vibration. You'll have to check with your pump manufacturer to see how far you can safely deviate from the BEP and still get satisfactory operation (a maximum of 10% either side is typical).

Now look at the following illustration:



These curves show what happens when you change the diameter of the impeller.

Impeller diameter is measured in either inches or millimeters. If we wanted to pump at the best efficiency point with a 11.5 impeller we would have to pump a capacity of 50 to a 75 head.

The bottom half of the illustration shows the power consumption at various capacities and impeller diameters. For the power consumption we will use horsepower, but in the metric system it would be called kilowatts.

Each of the lines represents an impeller diameter. The top line would be for the 13 impeller the second for the 12.5 etc. If we were pumping a capacity of 70 with a 13 impeller it would take about 35 horsepower. A capacity of 60 with the 12 impeller would take about 20 horsepower.

Most pump curves would show you the percent of efficiency at the best efficiency point . The number varies with impeller design and numbers from 60% to 80% are normal.

When you look at an actual pump curve you will note that the curve will usually show an additional piece of information and that is NPSHR which stands for net positive suction head required to prevent the pump from cavitating.

Depending upon the pump curve you might find a 10 foot (3.0 meter) NPSH required head at a capacity of 480 Gallons per minute (110 cubic meters per hour) if you were using a 13 inch (330 mm.) diameter impeller.

You should keep in mind that the manufacture assumed you were pumping 20° C (68° F) fresh water and the N.P.S.H. required was tested using this assumption. If you are pumping water at a different temperature or if you are pumping a different fluid, you are going to have to add the vapor pressure of that product to the N.P.S.H. Required. The rule is that Net Positive Suction Head Available minus the Vapor Pressure of the product you are pumping (converted to head) must be equal to or greater than Net Positive Suction Head Required by the manufacturer.

N.P.S.H. Available
- Vapor Pressure converted to head
= N.P.S.H. Required

Suppose we wanted to pump some liquid Butane at 32 degrees Fahrenheit (0 degrees Centigrade) with this pump. If we look at the curve for Butane on a vapor pressure chart similar to the one shown in the charts and graphs section of this web site you will note that Butane at 32°F needs at least 15 psi (1,0 Bar) to stay in a liquid state. To convert this pressure to head we use the standard formula :

$$\text{Head} = \frac{\text{Pressure (psi)} \times 2.31}{\text{Specific Gravity}} \quad \text{or} \quad \frac{\text{Pressure (bars)} \times 10.2}{\text{Specific Gravity}}$$

The specific gravity of butane at 32 degrees F (0 C) = 0.6, so;

$$\text{Head} = \frac{15 \times 2.31}{0.6} = 57.8 \text{ feet} \quad \text{or} \quad \frac{1.0 \text{ bar} \times 10.2}{0.6} = 17.0 \text{ meters}$$

N.P.S.H. required by pump mfg.	10.0 feet	or	3.0 Meters
Vapor pressure of butane converted	57.8 feet		17.0 Meters
Minimum N.P.S.H. needed	67.8 feet		20.0 Meters

In other words Butane at this temperature would not vaporize as long as I had the above absolute heads available at the suction side of the pump.

Feet Head	PSI		Feet Head	PSI
1	0.43		100	43.31
2	0.87		110	47.64
3	1.3		120	51.97
4	1.73		130	56.3
5	2.17		140	60.63
6	2.6		150	64.96
7	3.03		160	69.29
8	3.46		170	73.63
9	3.9		180	77.96
10	4.33		200	86.62
15	6.5		250	108.27
20	8.66		300	129.93
25	10.83		350	151.58
30	12.99		400	173.24
40	17.32		500	216.55
50	21.65		600	259.85
60	25.99		700	303.16
70	30.32		800	346.47
80	34.65		900	389.78
90	38.98		1000	433

Note: One foot of water at 62 degrees F = 0.433 PSI. To find the PSI for any feet of head not listed, multiply the feet of head by 0.433.