

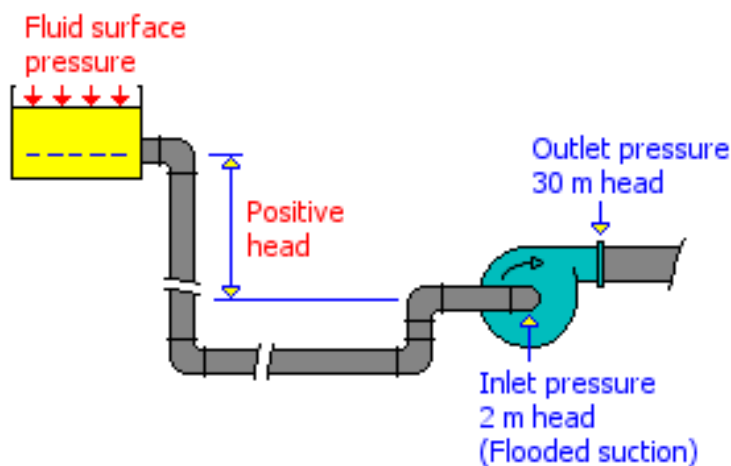
# Pumping Fluids and Getting Fluid to the Pump

## ***Pump suction***

The energy to move a fluid to the pump inlet is not provided by the pump. The popular view that a pump 'sucks' fluid from the supply source is false.

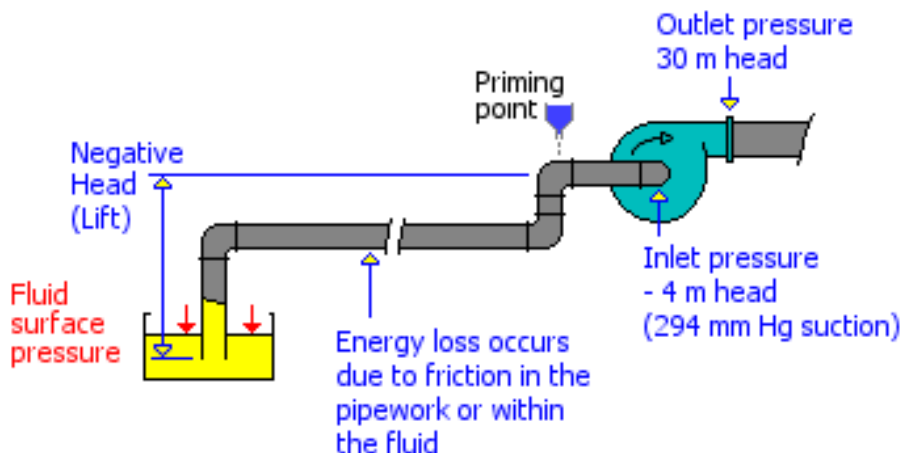
Consider the case of 'Flooded suction' where the supply container is positioned well above the pump inlet. If the 'suction' pipework has been designed properly the fluid head available will be sufficient to overcome the frictional resistance of the pipework allowing fluid to flow freely into the pump inlet.

If the pump inlet connection is removed the fluid will still flow out of the suction pipework.



In most instances where the fluid has to be 'lifted' the fluid pressure at the pump inlet will be lower than atmospheric pressure. The energy to move the fluid is provided by the pressure on the fluid surface. The frictional losses in the suction pipework and rises in the suction pipework system will reduce the fluid pressure at the pump inlet.

If the pump inlet connection is removed the fluid will not flow out of the suction pipework.



The pump moves fluid from the inlet port to the outlet port.

This action allows the external forces acting on the fluid intake system to push some of the fluid in the supply system into the pump inlet port.

If the pump type is not 'self-priming' it will be necessary to fill the system with fluid, to allow pumping to commence.

The supply pipework system must be designed to provide enough pressure at the pump inlet to avoid cavitation occurring within the pump.

See separate discussion about **Net Positive Suction Head**.

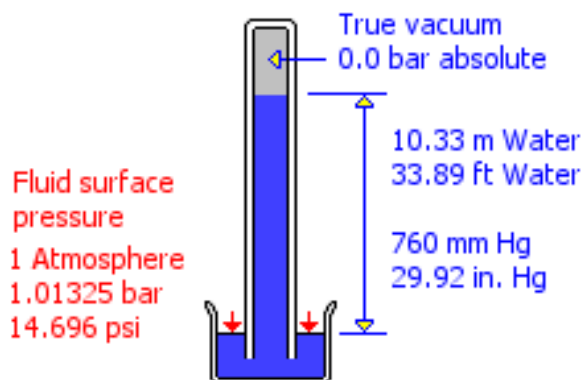
## ***Atmospheric pressure***

Standard pressure at sea level provided by the weight of the atmosphere is 101325 Pa. This value can be expressed as 0.0 bar gauge or 1.01325 bar absolute.

The equivalent imperial values are 0.0 psi g or 14.696 psi a.

Atmospheric pressure applied against a perfect vacuum can support a column of water of 10.33 m high (33.89 feet high).

Mercury has a much higher density than water so that atmospheric pressure will support a column of mercury 760 mm high (29.92 in. high) against a perfect vacuum.



## ***Getting fluid to the pump***

Atmospheric pressure on the fluid surface is the usual energy source used to push the fluid into the pump. The friction within the fluid and the pipework will oppose the fluid flow and reduce the pressure at the pump inlet.

If the suction pipework resistance is too high it may not be possible to deliver the full design flow rate to the pump, in these circumstances the system will operate at some reduced flow rate and cavitation may occur.

A good design guide is to size the pipework to give a pump suction velocity of between 0.75 m/sec and 1.25 m/sec (2.5 ft/sec and 4.0 ft/sec)

If the fluid has a high viscosity the resistance to flow may be mainly due to sliding between adjacent layers of fluid, the flow will probably be 'laminar' and the pipework friction will be negligible. In these instances the best solution is to raise the position of the supply container, to increase the positive head available.

If the supply container cannot be raised some positive pressure (above atmospheric) will need to be applied to the fluid surface.



Pressure



Vacuum

A sealed supply container could be pressurised to increase the force available to move the fluid. This pressurisation must be maintained as the container is emptied, otherwise the force to move the fluid will reduce.

## Pump power calculations

The work performed in pumping a fluid will depend on the volume flow rate, the density of the fluid, the additional head to be added to the fluid pressure and the efficiency of the pump.

Hydraulic power:

$$Kw = \text{Flow rate (m}^3/\text{s)} \times \text{m head} \times g \times \text{fluid density (kg/m}^3) \div 1000$$

$$Hp = \text{Flow rate (US gpm)} \times \text{ft head} \times \text{fluid density (lb/ft}^3) \times 231 \div 1728 \div 33000$$

Using the example of 'Flooded suction' shown above: The pump inlet pressure is 2 m head and the resistance to flow in the outlet system is 30 m head, so the pump would need to add the energy to raise the fluid pressure by 28 m head (91.86 ft head).

If the flow rate was 1136 litre/min (300 US gpm) and the fluid was water at 20°C (68°F) the hydraulic power required would be:

$$\begin{aligned} & 1136 \div 1000 \div 60 \times 28.0 \times 9.806 \times 998 \div 1000 = 5.188 \text{ Kw} \\ \text{or} & \quad 300 \times 91.89 \times 62.303 \times 231 \div 1728 \div 33000 = 6.955 \text{ Hp} \end{aligned}$$

If the efficiency of the pump was 70% the hydraulic power would have to be divided by 0.70 to give the actual power consumed of 7.41 Kw (9.936 Hp)

Where the fluid inlet pressure is a suction value, as the case shown above where the fluid has to be 'Lifted' the power provided by the pump must make up the difference between the suction value and the resistance to flow in the outlet system. In this instance the pump must add 34 m head (111.55 ft head).

If the flow rate was 30 litre/sec (475.5 US gpm) and the fluid was water at 10°C (50°F) the hydraulic power required would be:

$$\begin{aligned} & 30 \div 1000 \times 34.0 \times 9.806 \times 1000 \div 1000 = 10.002 \text{ Kw} \\ \text{or} & \quad 475.5 \times 111.55 \times 62.428 \times 231 \div 1728 \div 33000 = 13.414 \text{ Hp} \end{aligned}$$

If the efficiency of the pump was 63% the hydraulic power would have to be divided by 0.63 to give the actual power consumed of 15.876 Kw (21.292 Hp)