The siphon
J. Chaurette, September 2013
www.pumpfundamentals.com

A syphon allows a fluid to move upward as if defying gravity before it again moves downwards discharging to a low point.

If a solid were to do that we would have to claim that a miracle had just occurred. What are the conditions that constitute a siphon?

1. The liquid must start from a high elevation and exit at a lower elevation;
2. It must be completely full of liquid
3. The liquid must first go upwards from its storage location before it goes downward.

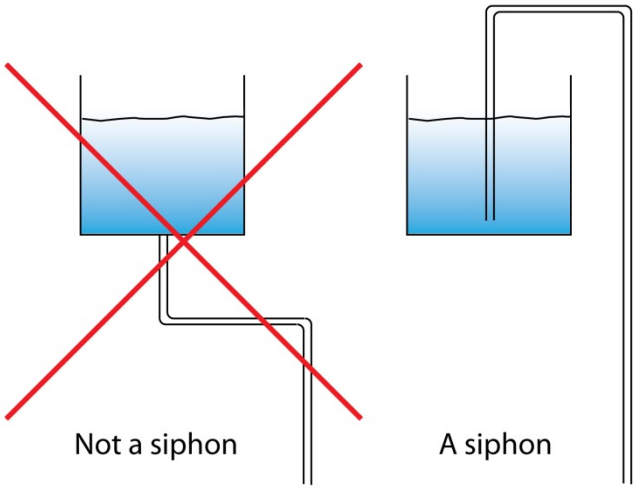

Figure 1. What is and is not a siphon.

There is one solid that can do this trick and it's a rope.

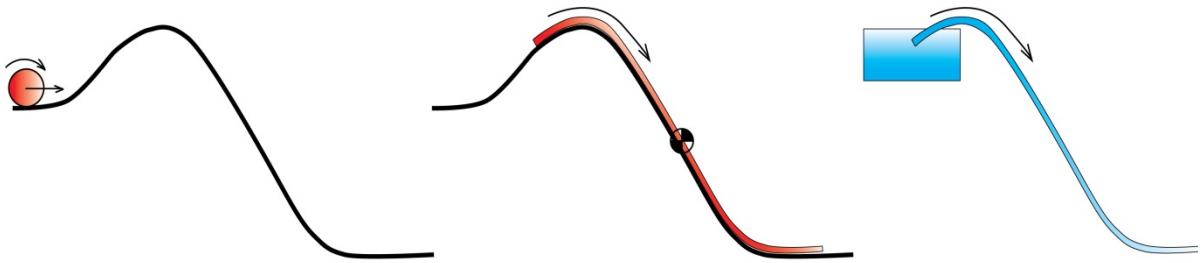

Figure 2. Comparison between a siphon and a rope.

Fibers connect the rope from one end to the other and in the case of the liquid the molecules are connected together by pressure which is made possible by the surrounding tube.

The conventional representation of a siphon is a tank at high elevation that supplies the liquid and a tube that first goes up and then discharges the liquid at a low elevation.

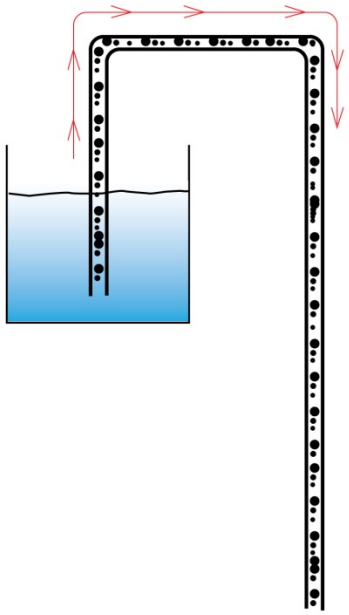

Figure 3. The conventional depiction of a siphon.

Let's get rid of the tank since its only function is to supply water and I don't want to obscure the functioning part of the siphon which is the tube.

Let's build our siphon up step by step; you can follow along with some tubing. First we fill a tube with water and then we block the bottom end. The pressure at the bottom end will correspond to the height of liquid times the density. Next we bend the tube in the position shown in step 2 keeping the bottom end blocked, point 1 is where our water source would be connected if we had one.

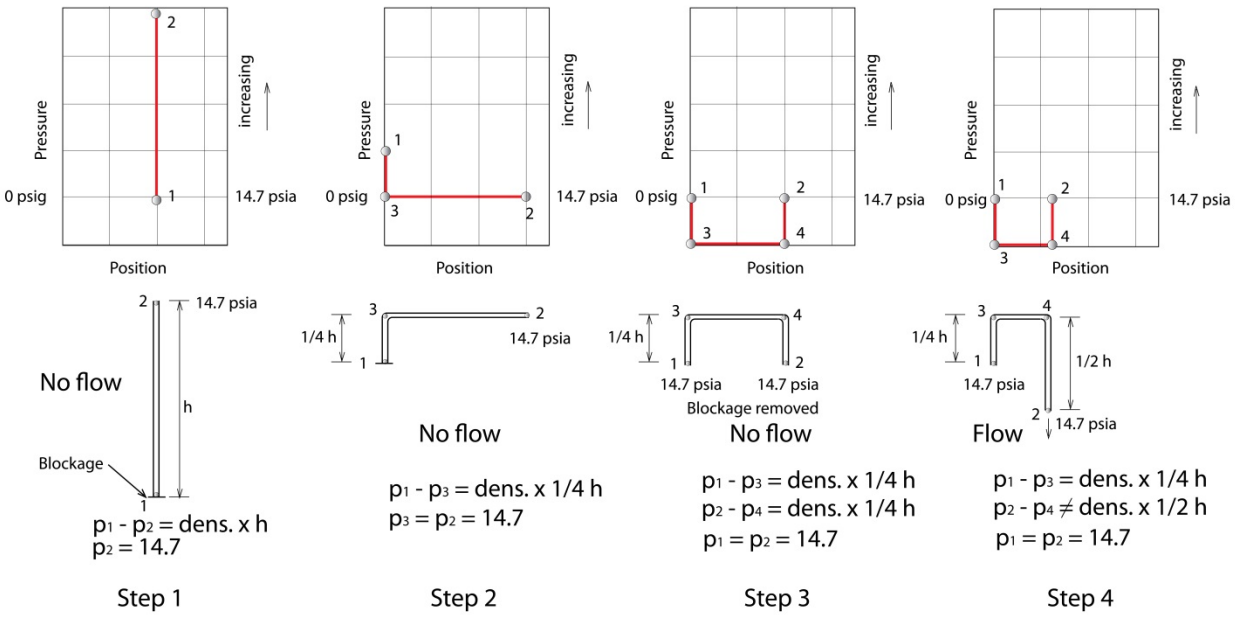

Figure 4. Making a siphon step by step.

In step 2 we bend the tube creating point 3. The pressure at point 1 will be higher than point 3 since point 1 is higher up.

In step 3 we bend the tube further and we remove the blockage at point 1. The pressure at point 1 immediately becomes the same as the atmospheric pressure and point 2 is also at atmospheric pressure. There is no flow because everything is in equilibrium, the pressure at point 4 is sufficiently low to suspend the column between points 2 and 4, and the same for the pressure between points 1 and 3.

In step 4 we lower point 2 and flow begins. The pressure at point 3 remains the same and since point 4 is at the same elevation it will have the same pressure assuming no friction. The pressure at point 4 would have to be much lower to suspend the column between 2 and 4 and that is why the column falls and why there is flow. The pressure wants to become lower at point 4but it cannot, therefore it pulls the liquid up from point 1.

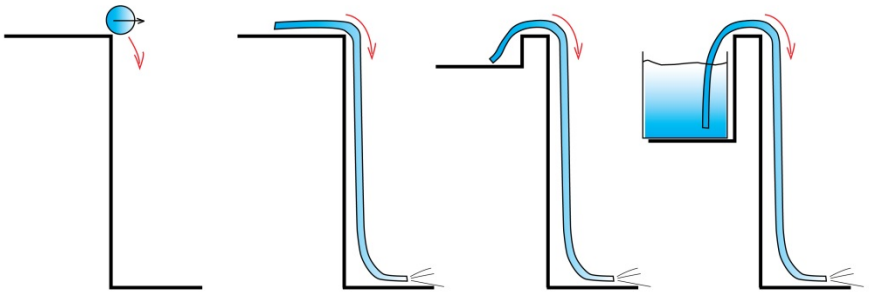

Figure 5. The liquid in a siphon just falls

To sum up, the reason why a siphon works is that the pressure at the high point is not low enough with respect to atmospheric pressure to keep the tall vertical column of liquid suspended. And the reason why liquid moves up in the short vertical column is that it is connected via pressure (like pearls on a string) to the downward moving liquid column. The liquid literally falls out of the reservoir.

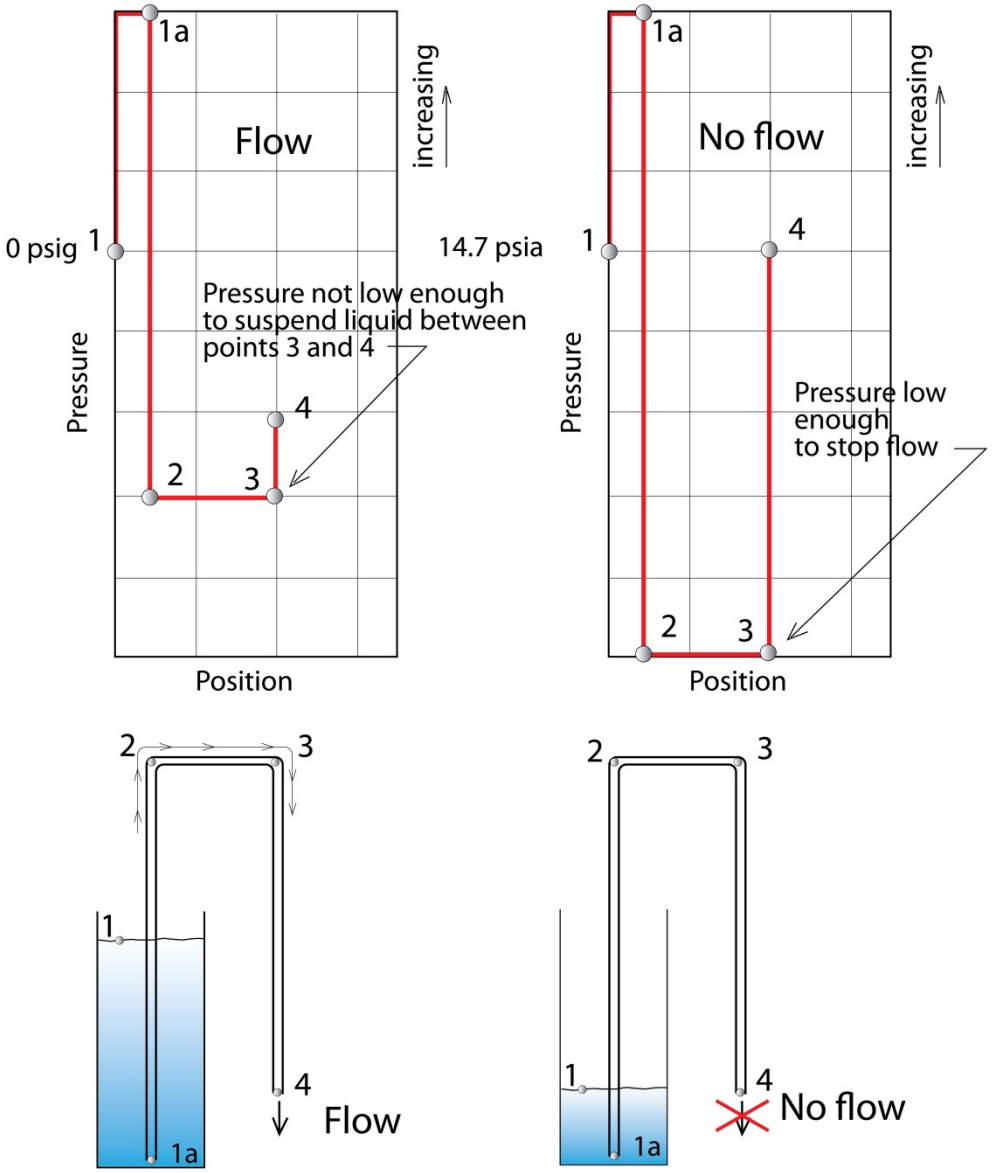

Figure 6. Low pressure at the high end makes the siphon work.

If you're like me you don't get to use a siphon very often and there is no much use for them in industry, or is there?

A siphon looks a lot like a pumping system in reverse. In other words after all the liquid has gotten out of your tank using a siphon how do you get it back in there?

A pumping system looks like a siphon in reverse because you pump up over the tank and into it creating that high portion where you will have low pressure. After all the liquid doesn't know it's going upwards or downwards.

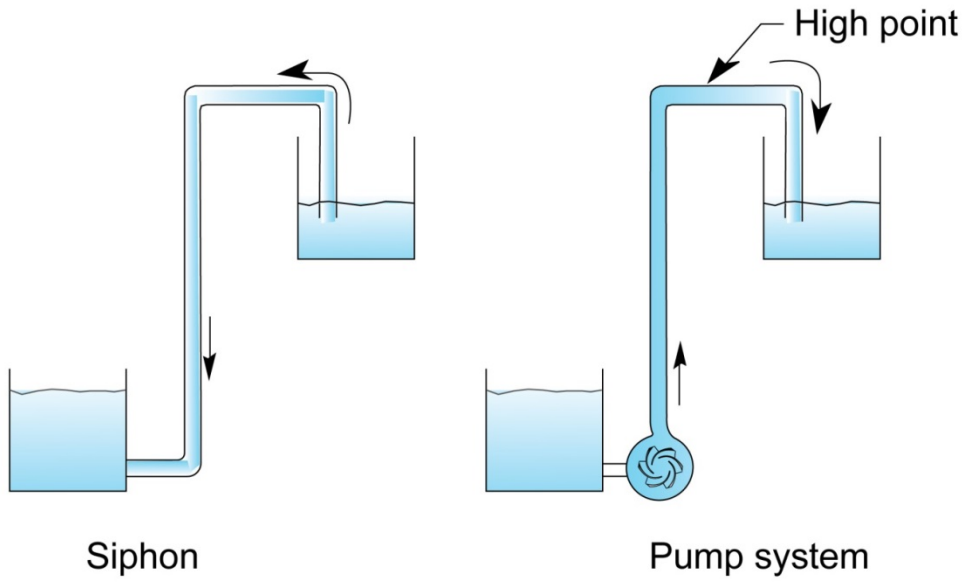

Figure 7. A pump system can be a siphon in reverse

Some potential problems are:

1. The high point is at low pressure so that if any leaks are present in the piping air will enter the system possibly causing problems downstream.

2. If you are thinking of branching off at the high point to divert liquid to another area then this won't work since low pressure at this point will cause air to come in instead of liquid coming out.

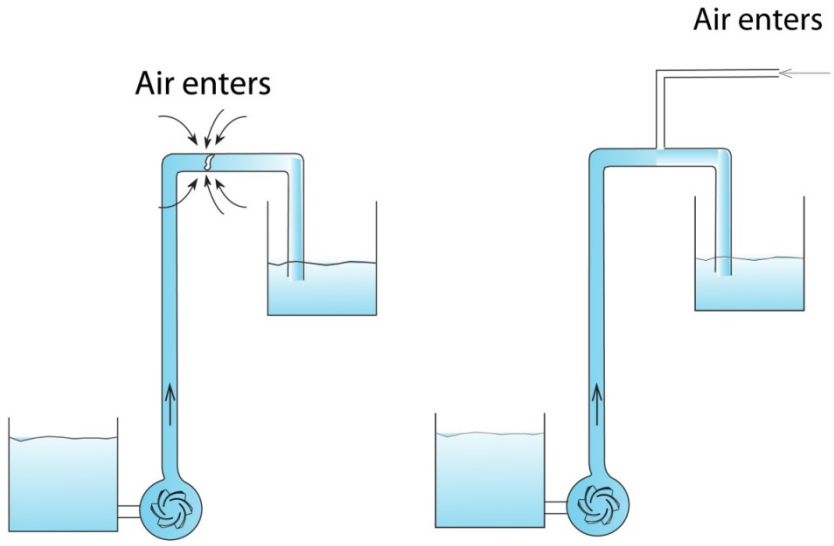

Figure 7. The problems associated with low pressure in the piping (reverse siphon).