PUMP SENSE
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Pump Priming
Why do I have to fill some pumps with water in order to get them to pump?

This is a common question when I give instructions for operating pumps. Usually I give a very simple answer to save time, and the attention of my audience. Here I would like to go into more detail because sometimes knowing the physics of a process can give us a working knowledge that can help with various situations, including troubleshooting pump problems.

First of all, we are dealing generally with centrifugal pumps when we talk about pump priming. Positive displacement pumps, for the most part, will pull water or air into their suction side with nearly equal efficiency. In other words, positive displacement pumps are truly self priming.

Centrifugal pumps, on the other hand, cannot produce a reduced pressure on their suction side without the presence of water inside the volute and so they have to be primed. Priming is the act of replacing the air inside the pump volute with water. Priming can be accomplished manually by the operator opening a valve, pouring with a bucket or automatically by using priming assist equipment.

Technically, a centrifugal pump must have water up to the horizontal center line of the impeller in order to go dynamic when turned on. This is called the datum line. A line just above the center line is the datum + line and is the practical priming level. The datum line relies on all tolerances to be perfect inside the pump. The datum + line can allow for some inefficiency. Figure 1 shows this on a standard centrifugal pump configuration. When the impeller starts to turn, water is moved around and outward inside the volute. This creates higher pressure on the outside of the impeller veins that at the center or eye of the impeller. The pressure difference causes water to be drawn into the pump suction where the pressure is lowest. This works fine as long as the pump is below the inlet water level and is called flooded suction.

If the inlet water is below the pump, called a suction lift, the pump must be able to not only pull water into the suction, but release the air that is being moved up the suction line into the pump. The most common way to do this is to locate the impeller and volute inside a case called the priming case. When the priming case is filled with water up to the datum of the pump, there is sufficient volume of water available to the pump to keep it dynamic so that the suction side will maintain the lower pressure necessary to pull water or air into the inlet. When air enters the inlet it is separated from the water in the priming case and is vented out the pump discharge. This type of pump is commonly called a Self-Priming pump. More accurately, it should be called a Re-Priming pump because the pump must be manually primed before is it run. Figure 2 illustrates a typical self-priming pump.

Beyond the standard self-priming pump there are modifications for specific priming problems available in the industry today. Priming assist equipment is becoming more and more prevalent due to the demand for what are called dry-prime pumps. These are pumps with the ability to automatically prime without adding water to the volute and usually employ a compressed air and venturi system. In other cases, a high volume of air entering the pump along with water, such as multiple suction points or dewatering systems, require a high volume vacuum pump. Priming assist equipment even gives us the flexibility of using high volume or high head pumps in dry priming applications.

To summarize, a pump must have at least one half of its volute casing filled with water in order to be dynamic when running. Suction lifts require specialized equipment to maintain enough water inside the pump to keep it dynamic. In general, getting the air out is the key to priming success.