A Quick Guide to Basic Centrifugal Pump Trouble Shooting

A centrifugal water pump, designed to flow 100 gallons per minute and produce 100 feet of head, is not working as expected when installed. In the manufacturer's test facility, the pump achieves the desired performance, but on site, it is only producing 80 gallons per minute.

Through review of the pump manufacturer's installation instructions, the installation adheres to the best practices.

When all the right steps of installation are followed, here are the next steps that can be taken to help troubleshoot this pump.

Pump Curve

The first step toward troubleshooting the centrifugal pump is to look at the Pump Curve (Figure 1). This curve is published by the manufacturer to plot the pump's ability to produce flow against a range of pressure. Flow rate is typically shown on the horizontal axis as Q and in units of Gallons per Minute (gpm). Head (H) is shown on the vertical axis in units of feet (ft).

The centrifugal pump is a simple machine and will always have a predictable, fixed output. However. there are factors that influence performance including impeller diameter, RPM, and mechanical wear. With these exceptions in mind, the characteristics of the performance curve on a particular pump are not going to change.

Now that the Pump Curve is available, the point on the far-left axis, known as the shutoff head, needs to be identified. Shutoff head is the head recorded when the pump is flowing zero gallons per minute.

Once the listed shutoff head is identified, record the same readings onsite with the actual pump. To obtain that reading, close the discharge valve and take a gauge reading.

If the onsite head measurements match exactly what is shown on the Pump Curve, this demonstrates that the pump is performing as expected at a critical point on the performance curve. if the shutoff head does not match it is necessary to contact the pump manufacturer.

Figure 1: Typical Pump Curve

System Curve

The next step in the process is knowing what the System Curve looks like.

The system head curve is derived from static head, pressure head and friction head (losses). A System Curve is dynamic and will change based on water level, pipe age, pipe size, throttled valves and many other factors.

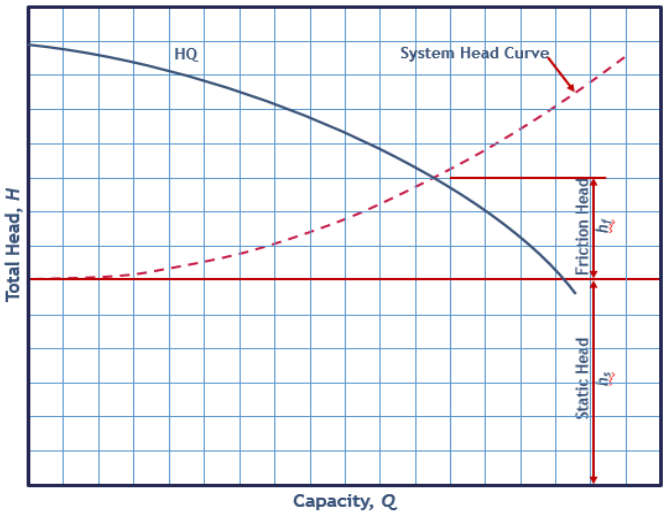

Figure 2: Typical System Curve

A centrifugal pump (simple machine) will only operate at the point where the Pump Curve and the System Curve intersect. This point is called the duty point (shown in Figure 2).

As mentioned previously, a System Curve is dynamic. For examples of how a pumps output can vary based on changing system characteristics see Figure 3

Figure 3 is an indication of the range in performance seen when a valve is partially closed vs fully open. Our friction head curve changes shape and intersects with our Pump Curve in two different places. This will explain a change in flow rate very easily. It is possible a valve is partially closed or there is a possible blockage in the discharge piping.

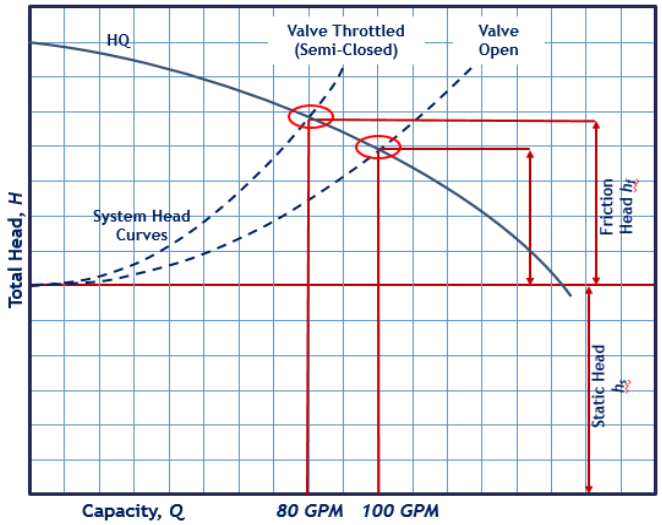

Figure 3: Friction Head Curve

Another example of how a system can impact pump performance is a change in static head.
Figure 4 illustrates a pump system with flooded suction and open discharge and how changes in the water level (suction static head) will impact where the pump curve and system curve intersect

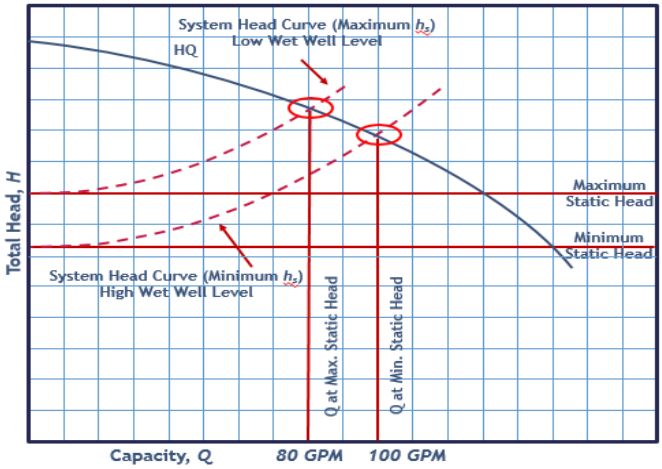

Figure 4: System with Varying Static Head

Conclusion

It may seem as though the pump flow rate is less than expected, but this can be reconciled with a better understanding of the relationship between the Pump Curve and the System Curve. It is possible that the characteristics of the system curve will not allow the pump to perform at 100 gpm @ 100' in this particular application. The pump can perform to this condition, but aspects of the system design are driving the pump to operate at a flow rate on the curve that is less than expected. In many cases, the System head Curve is not available to the person selecting the pump. It may also be the case that the System head Curve is not accurate or up to date. The System head Curve can often be a theoretical value with many safety factors built in and does not represent actual conditions seen onsite.

A Pump Curve, System Curve and pressure gauges will help determine why a pump is not performing as expected It is essential to understand that the pump is a simple machine and at a constant speed it will only operate where the system allows it to operate. The relationship between the pump curve and the system curve is critical in initial pump selection and when troubleshooting pump performance.