How to Gauge the Performance of Centrifugal Pumps

To use centrifugal pumps most efficiently, you must measure their performance, usually with gauges, the "eyes" inside a pump and within the system in which the pump is working. A pump service professional describes how gauges are employed to measuring pressure and vacuum.

Spot any trouble before troubleshooting

To use centrifugal pumps most efficiently, you must measure their performance. This can be done with gauges. They serve as "eyes" inside a pump and within the system in which the pump is working. Gauges measure pressure and vacuum, while providing answers to three questions that must be accurately answered and interpreted to solve performance problems:

1. What is the discharge gauge reading?
2. What is the suction gauge reading?
3. What is the speed?

Gauging the differences

There are many different types of gauges manufactured today, including diaphragm, bellows, spiral bourdon tube, diaphragm capsule, helical bourdon tube and C-type bourdon tube. Basically, however, any good quality gauge will do an acceptable job of measuring pressure and vacuum for you. Whenever possible, use gauges that are liquid filled because the needle tends to dampen out needle vibrations.

Most gauges use the C-type bourdon tube, a hollow tube shaped like a “C.” When pressure or vacuum—above or below the ambient atmospheric pressure—is applied inside the tube, the tube moves. This movement is connected through levers and gears to a hand or pointer. The pointer rotates around a face that has graduations on it (Figure 2).

If the liquid you are dealing with has the same weight or specific gravity as water, use a gauge that reads in feet of water. However, if the liquid has specific gravities above or below water, use gauges that read in pounds per square inch (PSI) and inches of Mercury (Hg); then use the corresponding formula in Figure 1 to convert your readings into feet of water.
Taking proper gauge readings
Some centrifugal pumps have taps in the casing for both suction and discharge gauges. These ports, however, may be subject to clogging and natural casing turbulence. The preferred location for your gauge taps is in the piping, which is located immediately before and after the pump. If a discharge check valve is used, be sure the gauge is between the pump and the check valve.

Install a compound gauge, which reads both vacuum and pressure, in the suction line as close to the pump as possible. Also, place the pressure gauge in the discharge pipe as close as possible to the pump. With the pump working, record the dynamic (in motion) gauge readings.

If your centrifugal pump cycles on and off, record the gauge readings just before the pump shuts off. With the pump shut off, and the discharge check valve open, record the static discharge head. By holding the check valve, you will be exposing the gauge to the static column of water in the discharge piping. This will work only if you have a suction check valve or foot valve. After the pump has cycled again and is off, record the static suction lift on the vacuum gauge.

Obtain an accurate “tached” speed of the pump shaft. Don’t trust that a 1750 RPM motor will run at 1750. The speed could vary as much as 50 RPM.

A Pump Troubleshooting Data Sheet (Figure 3) is provided along with this article to help you collect the proper information to begin to resolve any pumping problems. Described below is the significance of the electrical data to be gathered.

Figure 3 : Centrifugal Pump Trouble Shooting Data Sheet
Sample
Significance of electrical data
Horsepower—When reporting a problem on a centrifugal pump, the customer needs to tell the repair technician the exact electric motor nameplate data in terms of horsepower. If the horsepower is less than what the pump actually requires, this could create a significant problem in the electric motor, and a performance problem with the pump itself.

Speed—The speed is vital to know because the motor would have been specified for a pump at a particular speed.

Voltage rating/enclosure—The voltage ratings on the nameplate, as well as the enclosure style, are all important to know as well. For instance, an open-drip-proof motor (ODP) has a different service factor than an explosion-proof motor.

Service factor/full load amps—Another important piece of information for the service technician is the service factor, as expressed in full load amps. The technician will want to compare his amperage
Measured values
Voltage to motor: Voltage is extremely important because of the possibility that the voltage may go over the rated voltage on the nameplate. For instance, if an electric motor reads 460 volts, but is actually receiving 470 volts via the electrical power source, the amperage readings would be expected to go up. Conversely, if the electrical motor is receiving 450 volts instead of 460, you would expect the amperage readings to go down.

Drive data
Whether the unit is close-coupled, flexible-coupled or v-belt driven may be important to the service technician, depending on the particular problem.

What gauges will tell you
Gauge readings will tell you many things to help you find the real source of the problem, including where your system is allowing the pump to perform on its curve (Figure 4). Here are some other tips as well:

- When gauge readings are high, the total dynamic head is too high.
- When gauge readings are low, the total dynamic head is too low.
- When the vacuum gauge reads very high, you may have a plugged suction line.
- The discharge gauge will show pressure before the pump comes to prime if you need an air release valve on self-priming pumps.
- With a MAX VAC test, you will learn if the pump is pulling the proper vacuum on self-priming pumps.
- When the gauge readings are low and vibrating, vortexing or entrained air is likely.

Figure 4: Centrifugal Pump Trouble Shooting Diagramm
Measuring performance
The performance of centrifugal pumps can be seen by comparing the total dynamic head (TDH) to the flow at a given speed (Figure 5). TDH is the total resistance to flow that exists while the liquid is in motion. By using a gauge, both TDH and the speed of the flow can be measured. We can then find the flow rate at which the pump should be producing.

TDH equals the dynamic suction gauge reading plus the dynamic discharge gauge reading. (If your suction reading is positive, then you must subtract this number from your discharge to get TDH.)

Whatever gauge you use, it must be reliable and accurate. Bad gauge readings are worse than none at all because they will provide you with inaccurate and misleading information.

Figure 5: Performance Chart for Centrifugal Pumps
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