"Pump Sense"

by Dan Johnson

((VIBRATION))

First, let's come to an understanding. In the pump business, there are no "Good Vibrations". Any rotating equipment, such as pumps, that moves while running is in trouble. In this column we will diagnose some common causes, diagnosis, and cures for vibration in pumps. Note that there are some very sophisticated methods, involving dynamic balancers, and even laser alignment jigs, to diagnose vibration problems. Here, however, we will only look at some more common causes and cures for vibration in sewage pumps that can be dealt with in field without getting overly technical.

All Vibration is Relative

To understand vibration's role in operating equipment we must first get a feeling for what is and is not acceptable vibration.

All running machines vibrate to some degree. The degree of allowable vibration is based on the assumed life span of the machine. We accustom ourselves to accept a level of vibration relative to the machine we are dealing with. Cars vibrate, watches don't! The amount of allowable vibration for any machine is relative to the amount of run time it encounters in its life. The best analogy I can think of is the comparison between a car engine and a pump. A modern car could be expected to run 100,000 miles and last for five years. With an average speed of 50 miles per hour, the actual run life is approximately 2,000hours or 100,000 miles. A pump running continuously for five years, not an unusual requirement, would run 43,800 hours. At that rate, a car would travel 2,190,000 miles. Obviously, the pump must run much smoother than the car to allow for such a long run life.

What is acceptable vibration?

I know pump servicemen that will brag that they can align a pump so that you could stand a nickel on edge on it while running. Perfectionism is OK, but let's not get carried away.

Technically, vibration is measured by an electronic analyzer and is expressed in terms of mills, or inches-per-second if you really want to get technical. One mill is movement of the rotating assembly of the pump .001" (one thousands of an inch) perpendicular its axis. Untechnically, one mill or less will allow that nickel to stand right up, but is nearly unattainable in the field. The most stringent field vibration mill specifications that I have ever encountered are dictated by the U.S. Army Corps of Engineers and called for no more that 2 mils in any direction from the axis for all equipment including reciprocating pumps. This 2 mills spec. is not unusual, but the pumps in this case were vertical non-clogs with 30' of intermediate shafting. We actually had to have factory modifications as well as extremely careful installation to meet this specification. No reciprocating pump would ever meet this spec.

Most vertical and horizontal non-clog pumps, however, have the motor coupled to the power frame and short shafts with a flex coupling. These can be balanced to 2 mils without special modifications.

Note here that pump vibration, in most cases, does not have anything to do with speed. Increasing the speed of a pump

that already vibrates will only make it self-destruct more quickly.

At 2 mills of vibration, you can lay your hand on the pump or motor and just barely feel a humming sensation. At 5 mills you will begin to feel an actual vibration. At 10 mills, you may actually see the motor vibrating. At 15 to 20 mills we call it "Rock 'n Roll".

Vibration Causes

Vibrations can be categorized as either mechanical or hydraulic. Taking this one step further, you can sub-categorize them as either slowly developed or immediately developed.

The following are some of the most frequent causes:

Mechanical-immediate

--Impeller clogged with heavy mass
--Impeller broken
--Impeller loose on shaft
--Pump shaft bent
--Shaft coupling failed
--Rapid pump bearing failure
--Critical speed with VFD driver
--Misalignment in piping connected to the pump.

Mechanical-slow

--Changes in suction source
--Changes in discharge piping
--Shaft coupling beginning to wear
--Bearings beginning to fail

Hydraulic-immediate

--Clog in suction piping
--Clog in discharge piping
--Valve failures
--Entrained air entering suction

Hydraulic-slow

--Tank on suction side filling with heavy solids
--Discharge piping filling with solids
--Partial clog in impeller

Diagnosis

It is imperative that the operator be aware of how pumps are running. It is not necessary that you run around with a vibration analyzer. Noticing when a pump is beginning to vibrate can make all the difference in its ultimate run life.

The following are some tricks that I have learned over the years that can help to quickly narrow down the ultimate source of a vibration problem.

1) Drain the pump volute and turn the pump on. (Caution should be applied so that the pump seal does not run dry.) If the problem persists, you have a mechanical problem. If the pump runs smoothly dry, you have a hydraulic problem.

2) Isolate the motor from the pump then run the motor.

3) Pull the rotating assemble of the pump from the volute and examine the impeller in inner volute.

4) There are stethoscopes made that can be used to listen to different parts of the pump while it is running and allows you to tell where the "loudest" sounds are coming from. A cheap and quick way to do this is to use a screwdriver. Use the cheap kind with a hard plastic handle that is too small for the tool. I like a long thin screwdriver. Hold the handle end tightly to a spot on your upper cheek bone near your ear and place the blade of the tool at the spot on the pump that you want to "listen" to. Move the blade to other spots and note the differences in vibration. This trick also works well to determine if water if flowing through a pipe.

If you get this far and still have not found the problem. You may have a complex situation and, like me, may need professional help.