



While vertical line-shaft pumps usually make up a relatively small percentage of a plant's total pump population, they often consume more than their share of maintenance dollars. For many vertical pumps, bearing (bushing) wear and shaft journal wear drive the maintenance cycle. In this issue we will discuss some of the more common mechanical causes of premature failure and steps that might be taken to lengthen repair cycles.

*Best wishes to everyone for a happy and safe holiday season from all of us here at Lawrence Pumps!*

*Dale B. Andrews*

Dale B. Andrews – Editor

Installing a new or refurbished vertical line-shaft pump normally results in a smooth, quiet, trouble free start-up. This is true even if the pump has been poorly maintained or incorrectly installed. Equipped with new bushings to support the shaft, everything appears to be in order. However, poor installation, and sometimes inadequate maintenance, accelerate the rate of bushing wear until the shaft is no longer adequately supported to keep its lateral critical speed out of the operating speed range. Severe vibration then results, often with little warning, and the pump is back in the shop after a few months instead of a few years.

The primary mechanical contributors to this scenario are:

- Plumbness of the pump
- Nozzle loads
- Column alignment
- Shaft straightness
- Lubrication of support bushings

**Starting at the beginning - Plumbness of the pump.**

Line-shaft pump bushing clearances are typically in the range of .010 inches to .030 inches diametral. The pumps are sufficiently flexible to permit the support columns and shafting to bend. When installed out of plumb, this flexibility results in bending along the support columns as gravity attempts to move the lower mass of the pump back to true vertical causing the pump to bend along the length of the support column. Once the misalignment



exceeds the internal bushing clearance, the load on the bushings increases, and accelerated wear begins. Most vertical pump manufacturers specify that the pump mounting plate be leveled to within 0.002 – 0.003 inches/foot for this reason. A pump with a 10 foot setting that is out of level by 0.020 inches/foot at the mounting plate will have a 0.200 misalignment at the lowermost bowl. Pumps for general sump installations should be shimmed to correct an out of level condition. Likewise, tank nozzles intended for mounting pumps must be leveled to the same tolerances to provide for a good pump installation.

## Nozzle Loads



Excessive nozzle loads will have an effect similar to that described above under “plumbness of the pump”. As force is applied to the nozzle, the pump will distort until an equal opposing force is generated. The distortion will be at the expense of shaft and bushing alignment and accelerated wear will occur. A discharge flange that has to be pulled into place with wrenches, or worse, may appear expensive to fix, but the cost is probably insignificant to the cost of pump repairs. Allowable nozzle load data is usually included with the pump documentation or can be obtained directly from the pump manufacturer.

## Column Alignment

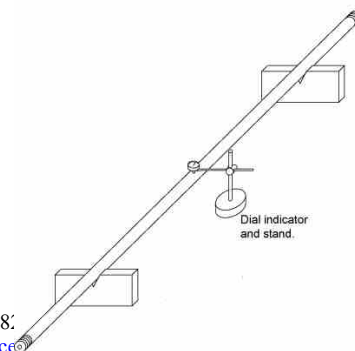


Most large industrial vertical pumps use flanged columns to support the shaft and the weight of the pump bowls. The flanges have register fits between mating surfaces that maintain the concentricity and squareness of the bushings relative to one another. Typical clearances in the register fits are .002 to .004 inches depending on the diameter of the columns. Each time the pump is disassembled and reassembled the register fit clearances open slightly. This maintenance related wear, combined with metal loss due to corrosion, may result in a tolerance stack up between all of the register fits that exceeds the total bushing clearance.

Another common problem occurs in the maintenance shop when welding up and remachining column fits to restore the register clearances. It is not enough for the register fits to be concentric. They must also be square or misalignment will occur when the pump is assembled. It is a common mistake to assume that a setup is square when one end of the support column is flush against the lathe chuck. This is not necessarily true. Most columns are sufficiently long to permit significant deflection between the lathe headstock and the tailstock or steady rests. This results in an out of square condition when the support column is turned end for end in the lathe to machine the second flange face. A better system is to use internal adjustable spiders and machine the support column between centers. This allows both flanges to be machined square and concentric in a single set-up.

## Shaft Straightness

Shafts should be well supported on v-blocks and rotated under a dial indicator at different points along the shaft’s longitudinal axis. Shaft runout at any location should not exceed 0.003” and preferably should be less than 0.002”. Shaft straightening should be done mechanically without applying heat. When heat is used, straightening is often temporary and the shaft will relieve itself back to its distorted state. Mechanical straightening is more art than science. Unless the machinist is experienced, labor cost can quickly exceed the cost of a new shaft.



## **Support Bushing Lubrication**

Most vertical pumps never achieve the type of hydrodynamic boundary achieved in turbo-machinery journal bearings. The clearances are too large, the lubricant does not have sufficient viscosity, and the pumps operate too slowly to generate the lift necessary to move the shaft away from contact with the bushing surface. The lubricant in most applications is water, or the fluid being pumped, which, at best, removes heat and provides some boundary lubrication. Keeping the keep solids out of the bearings is most important. The bearings need a separate clean flush when pumping dirty fluids. If this is not possible, or if the flush has an environmental cost associated with it, another style of pump should be seriously considered. With no real fluid film to remove particulates, any solids getting into the bearings will work to wear the shaft journals and bushings. Hard facing the shaft journals and grinding them to a 32 rms or better finish will prolong shaft life.

Vertical line-shaft pumps for industrial applications where solids are present are slowly becoming obsolete as more modern designs with lower life cycle costs replace them. However, for many installations justifying the capital expense to replace existing equipment is difficult. Many vertical line-shaft pumps, with proper installation and alignment will operate with an overall reduction in maintenance costs associated with an increased mean time between repair (MTBR).