Pump Alignment - Facts and Myths

Proper alignment of a base mounted pump / motor assembly after installation is paramount to equipment longevity and trouble free operation. Although most manufacturers factory align their pumps prior to shipment in accordance with the Hydraulic Institute Standards, there are several factors before, during and after installation that can adversely affect alignment. This article will discuss proper pump installation, alignment techniques, the facts and myths of flexible couplings as well as the consequences of operating misaligned equipment.

It is important to understand the consequences of inadequate alignment. Misalignment creates dynamic stresses on bearings and couplings that can result in shaft distortion and abnormal wear in seals leading to premature deterioration and failure of all or some of the components. The time to failure can be very short (a few minutes for an elastomeric coupling to unravel due to gross misalignment) to several years until fatigue damage fails a bearing at 50% of its expected 20-year life. Misalignment usually creates some abnormal noise and vibration which should be detectable immediately at start-up.

Installation

First and foremost is the importance of a smooth level mounting surface to properly support the pump baseplate at all points. Housekeeping pads or inertia bases made of reinforced concrete prove to be the best foundation for mounting and are typically about 2.5 times the shipping weight of the pump assembly. If the pump assembly is to be mounted on structural steel framework, care should be taken to avoid baseplate distortion as this will adversely affect alignment.

Once the pump has been placed on the foundation, the flexible coupling should be disconnected until all piping is completed, the pump and motor shafts have been aligned coaxially and the pump base grouted. Insert metal leveling wedges (figure 2) on either side of the foundation bolts under the baseplate leaving adequate space for grouting. Carefully level the unit by adjusting the metal wedges until the shafts of the pump and driver are leveled. Check the coupling faces and suction and discharge flanges of the pump for vertical plumb, making necessary adjustments with the metal wedges. Once the baseplate is completely level, the foundation bolts should be tightened evenly and firmly. Thoroughly grout the baseplate with a good mixture of non-shrinking grout. After the grout has hardened (usually after 48 hours), tighten the anchor bolts and remove any grout forms.

Piping

Never connect a pump to the piping or draw piping into place using force at the pump flange as this can have an adverse effect on pump alignment and / or cause damage to the pump housing. Always start piping from the pump and ensure proper alignment of the piping to the pump connection. Piping must be properly supported independently of the pump as the pump is not intended to carry the load of the pipe. Additional load imposed by the piping can cause pump misalignment and / or damage to the pump. Do not connect piping to the pump until grout has thoroughly hardened and pump and motor anchor bolts have been tightened.

Alignment

After the pump / motor assembly has been set level on the foundation, the grout has thoroughly hardened, the foundation bolts tightened and the piping connected, an accurate alignment of the motor to the pump must be made. All alignment at this point should be made by moving or shimming the motor as the pump should be in its final position. It is important to note that even though flexible couplings allow some parallel and angular misalignment, the couplings are intended to compensate for temperature changes, shaft end (axial) movement and to transfer energy (torque) from the motor to the pump shaft. They are not intended to compensate for pump / motor misalignment (figure 3). Faulty alignment, again, will result in noisy pump operation, reduced bearing life, excessive coupling wear and wasted power.

To check for misalignment, one must take a series of radial and axial measurements (figure 4) to determine the location of the pump shaft with respect to its driver (motor). If misalignment exists, calculations are made to determine how far the driver must be moved to align the centerline of the pump to the centerline of the driver. These calculations must consider any thermal expansion that takes place when operating temperatures are above ambient (information available from manufacturer). The motor must be shimmed to obtain alignment with the pump as the pump is now in a fixed position as connected to the piping. It is a good practice to re-check alignment after a week or two of operation as some settling may occur.

There are presently no ISO or ANSI standards for alignment but there are guidelines and / or specifications within industry and government. A good specification should define the final desired results at the pump / driver interface, but not dictate what method or instrument to use for measurement.

Instrumentation

There are three common types of instruments used for measurement during pump alignment, each with different procedures to achieve success.

- Straight edges, inside calipers / feeler gages
- Dial indicators
- Lasers

Straight edges and feeler gages are the least sophisticated or the alignment instruments but are still used today to achieve proper alignment. A straight edge is placed across the coupling or shaft and must rest evenly on the top, bottom and side surfaces. Inside calipers or feeler gauges are then used to check the distance between coupling halves or shafts at the points where the straight edge was used. These distances must be equal.

Dial indicators are the most useful of the instruments as they are the most universal and can be used in various techniques. Dial indicators can be used in the reverse indicator method (figure 5) and in the face and rim method (figure 6) along with several variations. Dial indicators are used to measure shaft run-outs as well as baseplate deflection caused by uneven foundations (referred to as “soft foot”). Dial indicators can be used to measure other types of distortion and geometric features by re-fixturing the indicators. They are extremely accurate and flexible in their use, and as such, have advantages over lasers.

Lasers (figure 7) are the most restrictive in their use as they can only be used in instances where the clamps and heads will fit. Given the fact that the sending and receiving units are clamped to the drive and driven shafts with the coupling in tact, they have difficulty on smaller equipment as there is sometimes inadequate clearance to mount the clamps to the shafts and rotate the heads. Lasers do, however, automate the measurement and calculation function in alignment, thus simplifying the process and saving time. Lasers achieve equivalent results to dial indicators, but no better, at several times the cost.

**How to Recognize Misalignment**

Vibration analysis can be used to diagnose misalignment along with other mechanical defects. Low vibration is evidence of good alignment, but high vibration can indicate poor alignment or other mechanical defects like bad bearings, distorted shaft, etc. Other indicators are a repair history of coupling, bearing and seal failures, binding when turning by hand, fluid leakage, shredded elastomeric coupling material, loose bolts, cracks, abnormal noise and excessive heat at the coupling.

**Overwhelmed?**

If all of this sounds overwhelming, consider the use of Armstrong Pump’s Series 4300 Vertical Inline Split Coupled Pump. Armstrong’s vertical split coupled design employs a machined fit coupling that ensures perfect alignment without foundation leveling, base grouting, shaft measurement and shimming. If you are interested in more details, contact your local Michigan Air Products sales representative or visit [www.armstrong.com](http://www.armstrong.com).