

## Why Bother Aligning Pumps? **Because it's good for you (and them)**

You had to eat your vegetables so you could grow up to be big and strong. Now help your pumps attain a long, flowing life.

Things are normally done for a reason. Hopefully those reasons are to save you some time, and your company some money. This article is intended to do both.

Now you ask, "What possible benefits do I get from pump alignment?" To answer that, let's instead ask, "What will happen if I *don't* align?" There are several problems caused by not having proper alignment. They include:

- Vibration and subsequent noise.
- Excessive bearing loading, leading to bearing failure in both the pump and motor.
- Damage to the coupler insert.
- Additional power consumption.
- Uneven wear of a mechanical seal, or machining of a shaft sleeve for packed-type pumps.
- Change of clearance between the pump's rotating and stationary internal components.

That's quite a list, and it's just the start.

Can you see how all these will cost you additional time and money?

Now for the good news: Alignment problems are easy to solve. Let's see how.

There are three different alignment measurements we must make. They are parallel, angular, and axial.

Parallel misalignment is when the pump and motor shaft centerlines are not concentric to one another. Angular misalignment is when the shafts are not parallel to one another. The axial dimension is the distance between the coupler flanges.

### METHODS OF ALIGNMENT

There are three basic methods of alignment. They are 1) straight edge with a taper gauge, feeler gauge, or caliper; 2) dial indicator; and 3) laser.

Which method do we use, and when? It all depends on how critical alignment is.

The main factor that determines the critical nature of alignment is shaft speed. (However, don't forget about variable-speed applications; they may not only require more accuracy, but also a special coupler sleeve.) The greater the shaft speed, the more critical alignment becomes. Therefore, less accurate methods can be used at slower shaft speed.

A typical pump in an hvac application requires a four-pole motor (1,750 to 1,800 rpm, depending on slip). Alignment is important, but we can get away with the least accurate method. Therefore, the straight edge and taper gauge (or feeler gauge, or caliper) method would be appropriate (Figure 1).

The nice thing about this method is that it requires no special tools or training, just a keen eye. Hence, it is the least expensive method and relatively quickly done. Simply lay the straight edge across the coupler halves at the top, bottom, right and left to measure parallel misalign-

ment. Note how much we are off.

Caution: When holding the straight edge, hold from one side so you don't "bridge the gap" across the coupler halves.

Next, insert the taper gauge (feeler gauge)

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### How much do I adjust?

It is obvious that to move a motor in the vertical plane (up or down), we must add or remove shims. Equally obvious, to move in the horizontal plane we must move the motor to the right or left.

A pure parallel correction would require placing the same-size shims under all four feet of the motor, or moving all four feet of the motor the same amount right or left.

The next question would be, "How much?" With the straight edge and taper gauge, you would eyeball it. With the dial indicator you would use the swing of the indicator when going from top to bottom, or right to left.

For parallel corrections, you would obtain measurements A and B as in Figure 1 from your dial indicator. Then calculate correction C.

$$C = \frac{A+B}{2}$$

To obtain the angular correction, refer to Figure 2.

$$S = M \times \frac{L}{D}$$

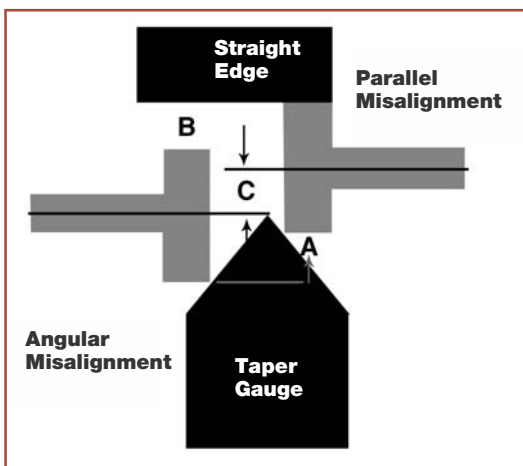
Where:

S = Distance to move motor for alignment (or shim required)

M = Misalignment (in.)

L = Distance between front and rear hold-down bolts (in.)

D = Diameter of coupler (in.)



**Figure 1: Straight edge and taper gauge method**

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between the coupler halves (or use a caliper on the outside of the coupler halves) to measure angular misalignment. Again, take note. We will return to how to correct for the misalignment.

### MORE ACCURACY

A dial indicator would be used when more accuracy is required or desired. This occurs when using a two-pole motor (3,500 to 3,600 rpm).

To use a dial indicator, mount it on the coupler halves as shown in Figure 2. Mark the other side with a marker or chalk. Rotate the halves together, always matching the chalk mark. The swing of the gauge will give us twice the misalignment. Again, check top, bottom, right, and left. Check for both parallel and angular misalignment. You may find it easier to “rough in” using the taper gauge method before using the dial indicator.

Where even greater accuracy is required, we may opt for using a laser. Generally the laser is mounted on one shaft with a receiver or mirror prism mounted on the other. As the shaft is rotated 360 degrees, the laser accurately measures the deflection, just as the dial indicator did previously.

Usually this information is fed into a processor along with distances between the bolt hold-downs. A computer then performs calculations and determines where and how many shims to add, and which way and how much to move the motor.

The major disadvantage of this method is cost. However, depending on your need for accuracy and the number of centrifugal devices you align, this may be the best option for you.

If you find alignment very difficult or impossible, maybe it is physically impossible to align the pump to the driver. But how could this be?

Perhaps the motor has a “soft foot” that changes the alignment depending on the

order in which the hold-down bolts are tightened.

To check, tighten all four bolts, look for gaps under the motor feet, and see how it changes alignment.

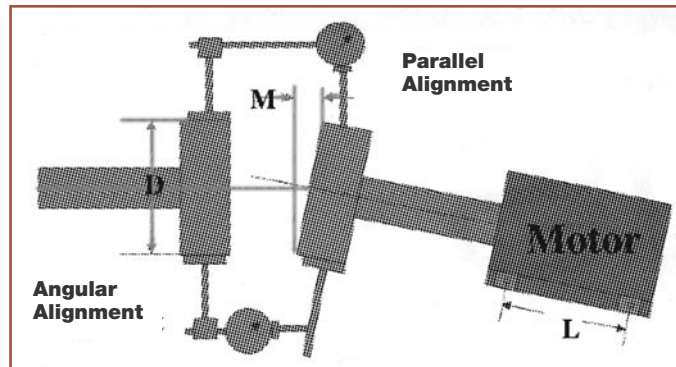


Figure 2: Dial indicator method

Also, the bores through the coupler flanges may not be concentric or they may go through the coupler at a skewed angle. The shafts may be bent. Stress placed by the piping on the pump may have caused the pump to warp over time.

A support foot may pull the pump out of alignment if cap screws are tightened in the wrong order. The saddle may be sagging.

You ask, “Didn’t it go out the factory door OK?” Most manufacturers align the pump and motor before they are shipped. However, shipping can be rough on the pump. The odds are it is no longer in alignment when it arrives on the jobsite.

As you can see, misalignment may occur due to manufacturer errors, during shipping, at installation, and over a long period of time.

### RECHECK, PLEASE

So when do you recheck or how often? Hopefully, before problems occur. But remember, once equipment has been damaged by misalignment, properly aligning it will not undo the damage that has occurred. Damaged equipment must be replaced.

If problems occur more often than normal, check alignment often. It is an easy, cost-effective part of your preventive maintenance program. There is a definite relationship between the amount of mis-

alignment and time between failures.

Before aligning, the pump and motor base should be level on a pad and properly grouted. The pipe should be targeted so as not to place strain on the pump.

When aligning, you will move the motor. The pump cannot be moved. It is held in place by the piping.

To correct for angular and parallel misalignment in the vertical plane, add or remove shims. To correct for angular and parallel misalignment in the horizontal plane, move the motor sideways. (See “How much do I adjust” on page 7.)

How close do you have to get? Check with the coupler manufacturer. Remember, the

primary function of the coupler is to transmit energy from the driver to the “driven.” The secondary function is to take up minor misalignment. Exactly how much is determined by the manufacturer.

Every time you change alignment with a shim, retighten bolts and recheck alignment. Use thicker, fewer shims vs. many thin ones to avoid sponginess. Once you align in one direction, check to see if it has affected alignment in the other.

Separate coupler halves to manufacturer specifications to allow for shaft growth and for the motor to find its electrical center. Recheck alignment after reaching operating temperature.

What order do we use to align? A four-step procedure is recommended. Take care of corrections requiring shims first, then angular before parallel. Hence, angular in the vertical plane, parallel in the vertical, angular in the horizontal plane, and finally parallel in the horizontal.

Just remember, be patient. It takes time to master this skill.

**This article was written by Bell & Gossett engineers, and was originally published in the Air Conditioning, Heating & Refrigeration NEWS Magazine. Reprinted with permission.**