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Proper application of state-of-the-art tools and techniques in this area can help save time, money and, most importantly, equipment.



Misalignment and unbalance are two major causes of vibration in rotating equipment, vibration that means increased maintenance and reduced machine life. With proper alignment and balancing programs, reductions in maintenance and operating costs can easily reach into six figures per year.

When shafts are misaligned, forces are generated that can produce stresses on the rotating and stationary components. Even when couplings do not fail from the stresses produced by gross misalignment, bearings and seals will most certainly fail under these conditions. In extreme cases of misalignment, even the shafts may fracture and break.

Shaft alignment

Shaft alignment is the positioning of the rotational centers of two or more shafts so that they are collinear when the machines are running under normal operating conditions. Proper alignment is not dictated by the total indicator reading (TIR) of the coupling hubs or the shafts, but rather

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by the proper centers of rotation of the shaft supporting members (the machine bearings).

There are two components of alignment: offset and angular (see Fig. 1 and Fig. 2).

Offset alignment, or parallel alignment is the distance between the shaft centers of rotation measured at the plane of power transmission. It is typically measured at the coupling center. The units of measurement for offset alignment are mils (1 mil = 0.001 in.).

Angular alignment is the difference in the slope of one shaft compared to the slope of the mating shaft. The units of measurement are comparable to the measurement of slope; that is, rise/run. The units for angular alignment are mils/in.

There are also two planes of potential misalignment: horizontal and vertical. Each plane has both offset and angular components. Thus, there are four alignment parameters: horizontal angularity (HA), horizontal offset (HO), vertical angularity (VA), and vertical offset (VO).

Alignment methods

Of the many methods available to measure shaft alignment, the two most popular are dial indicator alignment and laser alignment.

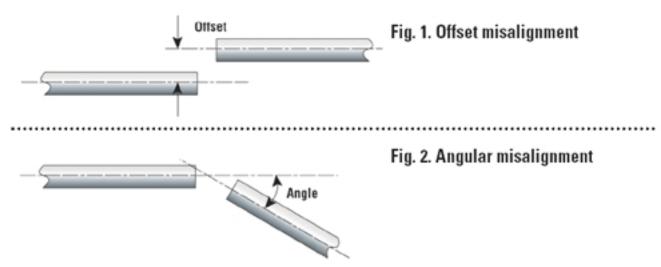
The two most popular methods of dial indicator alignment are the rim and face method and the reverse indicator method. The rim and face method takes an offset reading with a radial indicator and measures the angularity with an axial indicator. The reverse indicator method measures offset at two different locations along the axis of the shafts, thereby allowing the angularity to be calculated.

If used correctly, dial indicators can be an effective means of shaft alignment. However, the process of taking readings, calculating results, making corrections, and repeating the process can be very time consuming.

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Laser alignment offers the potential for much greater accuracy than dial indicators, as well as considerable time savings. Several laser systems are available. Some use a single laser and detector configuration, others use a reflected beam approach, and still others use a dual laser configuration that works along the same principle as the reverse dial indicator method. A good laser alignment system will have an accuracy of at least 0.0001 in.

A major advantage of laser systems is that foot corrections and alignment data at the couple are provided almost instantaneously. They also will accommodate much longer spans than dial indicators. The major disadvantage is cost, with systems running anywhere from a few thousand dollars to more than \$20,000. But these upfront costs are typically easy to justify through reduced maintenance costs, extended equipment life, and shorter downtime.



Balancing

Out-of-balance machine components are a principal cause of machinery vibration. The condition often is caused by less-than-perfect manufacturing, and it is routine for rotating equipment, reciprocating machines and vehicles. Mass balancing may be necessary if an operation or product requires quiet operation, high speeds, long bearing life, operator comfort, controls free of malfunctioning or a quality feel.

There are three types of balancing machines: static balancing stands, hard bearing machines, and soft bearing machines. Static balancing stands do not require spinning up and can correct for static or single-plane unbalance only. They feature low cost and safe operation.

Hard bearing balancing machines have stiff work supports. They have low sensitivity and

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sophisticated electronics. They require a massive, stiff foundation where they are permanently set and calibrated in place. Background vibration can affect balancing results. They are used mostly in manufacturing production operations where fast cycle time is required.

Soft bearing balancing machines have fl exible work supports. Their sensitivity is high and electronics simple. They can be placed anywhere and moved without recalibration. Their fl exible work supports provide isolation from ambient vibrations. A belt-driven soft bearing balancing machine can always achieve fi ner balance results than a hard bearing machine.

The two main types of fi eld balancing instruments are tunable fi lters and digital analyzers.

Tunable fi Iter instruments are easy to use, affordable, and capable of measuring to fi ne levels. They use a strobe light for phase measurement that requires visual access to the rotor in subdued light.

Digital analyzers are more complicated, prone to operator setup errors—and usually more expensive

. They generally use a photoelectric sensor for phase measurement that is safer because the operator can stand back and close the door.

Tunable fi Iter instruments only take measurements; the balance calculations must be done separately. Digital analyzers combine measurement and calculation.

With either type of instrument, the knowledge and experience of the instrument operator is the most important factor in achieving good results. It is vitally important for these individuals to be able to recognize a non-balance problem and abandon the balance job in favor of some other solution.

Importance of training

Experts agree that thorough training is paramount to achieving the best results in alignment and balancing. Remember that even the most sophisticated instruments are no substitute for a highly trained and experienced specialist. Besides the initial training necessary when equipment

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is purchased, technicians should receive additional training to better apply their knowledge as their experience grows.

Supervisors and managers also should be involved in training so they develop a better understanding of the problems faced in the field and the time required to do the job right. The list on the following page refl ects some of the leading suppliers in this marketplace. **MT**

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