BALANCING TIP # 103

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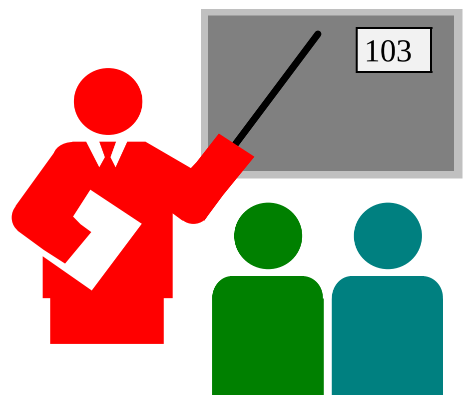
SELECTING THE PROPER BALANCING SPEED IN A BALANCING MACHINE



One of the most often asked question relating to balancing in a balancing machine is, "what RPM should I operate the rotor to balance ? The only question within a question is whether the rotor is considered a rigid or a flexible rotor. This Balancing Tip deals with the more common rigid rotor. Techniques for flexible rotors and whip will be covered in a later Balancing Tip.

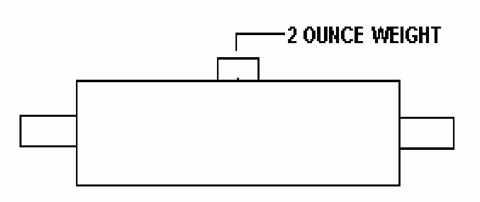
A review of the many balancing specifications in use today reveals many that include a reference to balancing speed. Several recent ones encountered stated, "Balance to G1 of the ISO Standard at 1000 RPM" and another was "balance to 0.2 mils at 3600 RPM". The following Balancing Tip will discuss balancing speed and provide some practical guidelines and recommendations for everyday use. It is intended for the more common rotor that is defined as rigid. Balancing speed relative to flexible rotors will be covered in a later TIP.

A RIGID ROTOR

There are technical definitions for defining a rigid rotor, however from a practical point of view, a rigid rotor can best be defined as one that does not change its shape at its operating speed. There are many rotors that meet this definition, in fact, most motor armatures can be treated as rigid rotors. There are many applications where flexible rotors are widely used, however, and applying the standards for rigid rotors should not just be blindly followed. If there is any doubt, the manufacturer of the rotor should be contacted.

DISCUSSION

Let us assume, by some luck of the draw, were able to secure a perfectly balanced rotor, and for testing purposes, we added a two ounce weight to the rotor. We will operate this rotor at different RPM's and see what happens as we change speed.



(Perfectly balanced rotor with 2 ounce weight added)

One thing we know from the basics of balancing is that the Forces on the bearings supporting the rotor will increase as the square of the speed due to any unbalance in the rotor. The Force formula is;

$$\text{Force (in pounds)} = 1.77 \times (\text{unbalance in oz-in}) \times (\text{RPM}/1000)^2$$

From our example, we added a 2 ounce weight to a perfectly balanced rotor and we will use 10 inches as the radius. As we spin this rotor, the Forces at various speeds would be;

Force at 600 RPM = (1.77) x (2 oz x 10 in.) x (600 RPM / 1000)^2 = 12.74 lbs.
Force at 900 RPM = 28.67 pounds
Force at 1200 RPM = 50.98 pounds
Force at 1800 RPM = 114.69 pounds
Force at 3600 RPM = 458.78 pounds

As we can see from the calculations, the 2 ounce weight added to the perfectly balanced rotor is causing considerably more problems as we increase the speed by increasing the force on the bearings.

What is important to notice in the formula **is the rotor is always unbalanced by the same amount** (2 ounces) **regardless of the speed.**

What we can learn from this example is that the rotor doesn't care at what RPM we balance it in a balancing machine, as long as the equipment used is sensitive enough to see the 2 ounces that the rotor is out of balance. We do not have to see the force at a given speed, only the unbalance at any speed.

This also shows us that the **balancing speed we use is dependent upon the balancing machine, not upon the rotor.** From a practical point of view this also tells us the slower we can balance, the better. Not only is it safer, it will take less time to start and stop the rotor, use less power, etc. Therefore, when specifing the unbalance level to be obtained, the balancing RPM of a rigid rotor is not required as a portion of the balance specification. Advising the operating RPM as well as the weight of the rotor should be specified whenever possible to assist in calculating unbalance tolerances.

As with all rules, there are exceptions. There are rotors which require that a certain speed be achieved to properly position components. A hammermill would be an example. The proper method of handling would be to determine the minimum speed to position the hammers.

Due to the limits of electronics as well as the mechanical nature and type of balancing machines themselves, there are minimum speeds at which they can operate in order to be able to measure the unbalance in the rotor. This minimum RPM is always stated in the manufacturer's specifications. There is also one type of machine that has a change in sensitivity with balancing RPM. Be sure to check this, especially if a low balancing tolerance is required.

SPEED SELECTION

1. Determine the fact that the rotor is a rigid rotor (See practical definition above).
2. Select the lowest speed based upon the balancing machine manufacturer's specification. A Practical Note: When operating the balancing machine at less than 50 % of the machines rated weight capacity, increase the balancing RPM by 50 % over the stated minimum. (Also check specifications to see if sensitivity increases with speed).
3. If there is any question as to validity of the readings, record readings and increase speed by 100 RPM (Readings should remain the same). For example, if the balancing speed selected is 400 RPM, record readings at 400 RPM and increase to 500 RPM to verify that the readings remain constant. This applies to balancing machines that read out in vibration units such as mils, as well as machines reading out in ounces and grams.