Reverse Rim Dial vs. Dual Face Indicators

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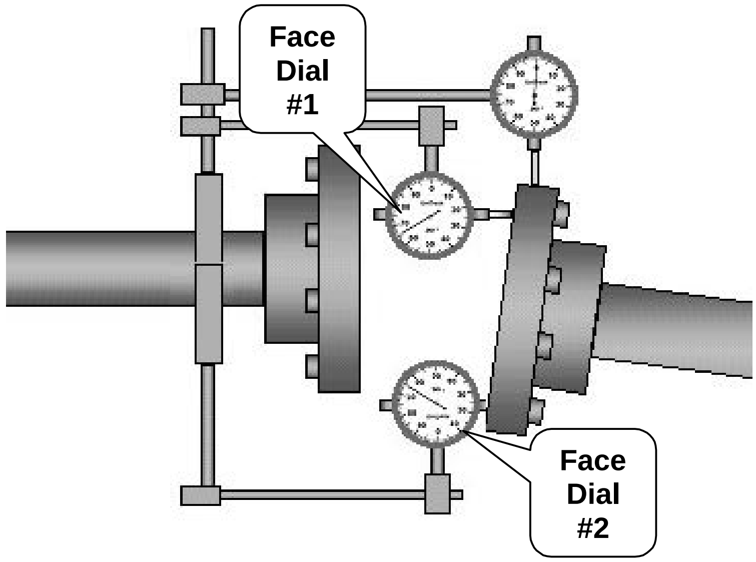
One of the primary challenges of all methods used for shaft alignment on rotating machinery is obtaining valid measurement data. There are many factors that effect measurement accuracy, largely depending on the hardware setup and method used. All measurement options, including laser alignment systems, include sources of error. To a large degree, the most significant challenge of any shaft alignment process is the validity of measurement data.

The two most common dial indicator alignment methods are the rim-face and reverse rim dial methods. For both of these methods, it is recommended that for each set of measurement data, two steps be performed:

- Obtain two consecutive sets of data and check data for repeatability.
- For each set of data, ensure the data is mathematically valid. If a set of data obtained on the face or the rim is valid, the sum of the top (12:00) and bottom (6:00) readings will equal the sum of the side (9:00) and side (3:00) readings.

When these steps are performed, it is often found that the data is either not repeatable and/or not valid. When using the rim-face method, one common source of error specifically related to the validity and repeatability of the face readings is error due to shaft end-play (axial movement.) Axial movement of either shaft will adversely impact the accuracy of the face readings.

Assuming that the source of end-play cannot be eliminated and that the rim-face method is to be used, the only accurate way to determine the amount of error and correct for it is to set up two face dials 180 degrees apart and obtain two sets of face data per measurement. Any difference in the numerical values, other than the mathematical signs, which will obviously be reversed, is due to axial movement. The error can be determined and mathematically subtracted from measurements by using a dial setup such as that shown below.



Consider the following scenarios:

1. Given: Indicator circle diameter = 4 inches
   Shaft Angularity = 0.002”/”
   End-play = 0.000”
   Face Dial # 1 is set to zero at 12:00
   Face Dial # 2 is set to zero at 6:00
   Both shafts are rotated 180 degrees

   Since there is no end-play, the numerical values of Face Dials #1 and #2 will be equal, but the sign will be reversed. That is, at the 12:00 position, Face Dial #2 will read “- 0.008” and at the 6:00 position, Face Dial #1 will read “+0.008”

2. Given: Indicator circle diameter = 4 inches
   Shaft Angularity = 0.002”/”
   Right shaft moves to the right 0.003” due to end-play.
   Face Dial # 1 is set to zero at 12:00
   Face Dial # 2 is set to zero at 6:00
   Both shafts are rotated 180 degrees

   Since there is end-play of the right hand shaft to the right, the numerical values of both dial indicators will be less positive than they should. Whereas at the 12:00 position, Face Dial #2 should read “- 0.008”, it will actually read “-0.011”. Whereas at the 6:00 position, Face Dial #1 should read “+0.008”, it will actually read +0.005

When the numerical values of two face dial indicator readings obtained in the manner described above are unequal, such as those in scenario #2 above, the next step is to determine what the corrected values would be without error due to endplay. There are two options for making this determination. We will use the values in scenario # 2 to describe both options. That is, Face Dial #1 reads +0.005 at 6:00 and Face Dial #2 reads –0.011 at 12:00

Option 1:

This option allows you to determine the amount of error in face readings due to axial movement and the direction of the movement. Then, you mathematically correct the readings for the error due to axial movement.

1. Add the values from the two face dial readings.
2. Divide this sum by two to determine the amount and direction of axial movement.
   - If the value is negative, the direction of movement is away from the dial gauge.
   - If the value is positive, the direction of movement is towards the dial gauge.
3. Subtract the amount of axial movement from the original face readings to determine the corrected face readings.

Example 1:

1. +0.005 + -0.011 = -0.006
2. –0.006/2 = -0.003
   - Since the value is negative the thrust is away from the dial gauge.
3. Corrected Face Readings:
   - Face Dial #1: +0.005 - -0.003 = +0.008
   - Face Dial #2:   -0.011 - -0.003 = -0.008

Option 2:

This option allows you to correct the absolute values of the face readings, then assign the correct sign to those values based on comparison.

1. Subtract the smaller face reading from the larger face reading.
2. Divide this difference by two to determine the corrected absolute value of both face readings.
3. Assign one face value a positive value and one a negative value based on their comparative value.
   - The more positive value is assigned a positive sign.
   - The less positive value is assigned a negative sign.

Example 2:

1. +0.005 - -0.011 = +0.016
2. +0.016/2 = 0.008
3. Since the Face Dial #1 value of +0.005 is more positive than the Face Dial #2 value of –0.011, Face Dial # 1 value = +0.008 and Face Dial #2 value = -0.008.

Note that using either of these options, we arrive at the same values obtained in Scenario #1 above where there was no error due to shaft axial movement. However, a few precautions should be observed.

- This process assumes that the shafts thrust equally and in one direction as they are rotated. On many machines with plane bearings the thrust is not equal and in one direction. For example, if while turning the shafts, one shaft thrusts positive as you rotate the gauge and then negative as you continue to rotate, error will be introduced that is not compensated for in the process described above.
- The options above involve mathematical processes using signed numbers. Such processes are frequently a source of human error.
- The processes described herein require that two face dials be mounted. Space restrictions, lack of alignment fixtures, etc. often prohibit use of this method.

A much more common approach for obtaining accurate measurements on a wide variety of machines where shaft end-play introduces measurement error is to employ either the reverse rim dial alignment method or a method based on its principles, i.e., laser alignment systems.

Essentially, the fundamental principle of the reverse rim dial method and laser systems is to determine shaft position based on two different offset measurements (rim readings) taken at two different points along the length of the shafts. Since no face readings are obtained with this method, measurement inaccuracies due to shaft endplay are essentially eliminated. There are literally countless different indicator setups and shaft alignment methods that utilize this principle, primarily based on the issue discussed herein regarding the increased probability of measurement accuracy.