Rod Position & Rod Drop

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Rod Position & Rod Drop: What’s the Difference?


A frequently asked question with regards to reciprocating compressor monitoring is the difference between Rod Position (Dual and Single) and Rod Drop. They aren’t just different terms for the same thing - the difference between the two is significant and the resultant readings are not to be confused.

Rod Drop:

When configured for Rod Drop the 3500/72M indicates the vertical “drop” of the piston in the cylinder by applying assumptions about the behavior of the piston rod assembly and extrapolating the measured value of the piston rod displacement at the face of the packing case out to the piston using similar triangles. The 3500/72M Rod Position monitor can be configured to provide an average or an instantaneous value for each crankshaft revolution. The monitor values indicate the amount the piston has dropped, with respect to a reference point. Usually this reference point is the location of the piston inside the cylinder when the machine is at rest and the rider bands are in
the new condition. When configured for rod drop, the 3500/72M monitor triggers an alarm when the indicated vertical position of the piston exceeds a predetermined setpoint corresponding to significant rider band wear. Wear is estimated in the vertical dimension only.

Several assumptions are made when using Rod Drop measurements[1]:

- The changes in the rod measurement at the pressure packing case are directly proportion to the change in rider band wear (assumes the similar triangles relationship is valid).
- Gravity is the predominant vertical force acting on the piston and rod assembly (the piston and crosshead are always in the bottom of the cylinder and on the bottom rail, respectively).
- Rod flex is negligible compared to the amount of rider band wear being measured.
- Operating temperature of the piston is relatively constant.

The reference point for when to start the “drop” displacement measurement must be established once the machine is running. The recommended practice is to “Hot Zero” the measurement after the machine, with brand new rider bands installed, has been at full load operating conditions for a set amount of time, typically 2-4 hours. This should be enough time to ensure the piston and cylinder assembly have reached thermal equilibrium due to operating temperatures in the chamber. This “Zero” reference value needs to be maintained for reliable trend information, even after maintenance work might be accomplished on the pressure packing before the rider bands are replaced. If the Hot Zero procedure is performed with some assumed rider band wear then the rod drop have a high degree of uncertainty. This practice is not recommended.

**Rod Position (Magnitude):**

When configured for Rod Position Pair, the 3500/72M provides an indication of the vertical and horizontal position of the piston rod at the mounting location of the probes, using orthogonal probes. When configured for Rod Position Single the 3500/72M measures just the vertical position of the piston rod at the probe mounting location. The sampled values measure the displacement of the piston rod from the geometric center of the cylinder bore (zero reference). The variable labeled “Position Magnitude”[2] provides a continuous online indication of the maximum distance between the piston rod centerline and the zero reference over each revolution. “Position Angle” provides an indication of the direction of rod movement, and “Crank Angle” provides the crank angle at which the maximum movement occurs.
The cylinder bore geometric center is calculated by the monitor based on piston material, expected operating temperatures and measured bottom and top ‘piston to cylinder wall’ clearances. The calculated center will be reliably and consistently calculated, whether new rider band or worn rider bands are present when the piston clearance measurements are made.

The Rod Position measurements can indicate rider band wear, crosshead clearance issues, packing seal integrity issues, and cylinder over-lubrication issues.

**Rod Position (Pk-Pk Displacement):**

Additionally, when configured for either Rod Position Dual or Rod Position Single, the 3500/72M provides an overall vibration of the piston rod is measured as the *Pk-Pk Displacement* variable. It provides a view of how much the piston rod is moving/flexing, independent of where the piston is within the cylinder.

**Example:**
In this example[3], the three plots (orange, blue, red) illustrate three stages of a machine’s condition. The yellow and red dashed arcs represent estimated alarm levels (alert and danger, respectively) from the bore clearance extrapolated back to the measurement plane. If the piston rod shifts more than 60 mils from the geometric center in any direction, then an alert condition would be raised. Operations could then take early action to possibly prevent actual piston to cylinder liner contact if the situation was allowed to continue to deteriorate.

The orange trace shows the piston rod motion in reference/baseline conditions with new rider bands. The low amplitude and proximity of the piston rod centerline relative to the geometric centerline indicates that the throw is running smoothly with low Pk-Pk Displacement and Position Magnitude values.

The blue trace shows the rod position at a later time as the condition progresses. The Pk-Pk Displacement has increased slightly; however, the Position Magnitude is much larger and more significant.

And finally, when the machine is in an alarm condition (red sample), the pk-pk is much larger along with the rod position clearly indicating an alert condition. In this state there is greater potential for contact with the cylinder wall; however, it should be noted, that the equivalent vertical displacement reading is still indicating much less than the alarm value. This example shows the benefit of the horizontal transducer for a fully 2 dimensional measurement.
Summary:

A downloadable PDF can be found here: Rod Position Rod Drop - What's the Difference


[2] This is typically the variable trended as a scalar value in the DCS.

[3] Utilizing two (2) orthogonal proximity probes in dual-probe rod position configuration

[4] Rod Drop is an extrapolated value based on similar triangles and this column includes the readings that would have been provided by the “Average Piston Position” measurement, had the 3500/72M been configured for Rod Drop. These values assume that a hot zero had been performed after new rider bands had been installed.