Making Your Rod Drop Measurements Count

Some people believe that rod drop measurements don't work and they're a waste of money and time. Others believe that the rod drop measurements provide outstanding value and precise measurements. What is interesting is that both can be true depending upon how the measurement is made.

For this discussion, we will provide you some definitions so we're clear when we use certain terms. These definitions come from the API 670 subcommittee on reciprocating compressors. These definitions are subject to revision, but they are appropriate for what we want to get across today.

1. **Piston Rod Monitoring:**
   The use of proximity probe(s) to produce the measurements of piston rod drop, piston rod position and piston rod vibration.

2. **Piston Rod Drop:**
   A measurement intended to indicate piston rider band wear in the cylinder, measured using a single non-contacting displacement probe mounted vertically at the measurement plane (typically near the pressure packing case) on horizontal cylinders. It is calculated using the similar triangle principle.

Example from Metrix 5580 Signal Conditioner

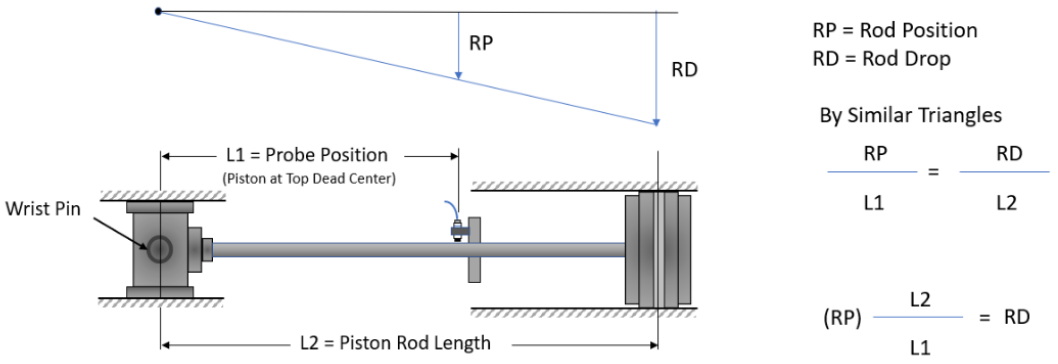

Figure 1 – Rod Drop Calculation

3. **Piston Rod Position:**
   The movement (magnitude and direction) of the piston rod during one crank revolution with respect to the center of the cylinder bore at the measurement plane (typically near

the pressure packing case) using orthogonally mounted (true vertical and true horizontal) non-contacting displacement probes.

4. **Piston Rod Vibration:**
   The peak to peak (max-min) displacement measurement of the piston rod at operating speed within one crank revolution. The measured vibration value(s) are reported directly at the measurement plane (typically near the pressure packing case) from the non-contacting displacement probe(s).

The above defined terms can all be employed when you have a fully outfitted API 618 reciprocating compressor. In most cases, this will not be the case. For instance, in the thousands of reciprocating machines that Metrix monitors, the usual monitoring suite includes velocity transmitters at each end of the crank case, an impact transmitter on the crosshead, and rod drop monitoring at each cylinder.

Rod Position Trend Vertical and Horizontal Probes

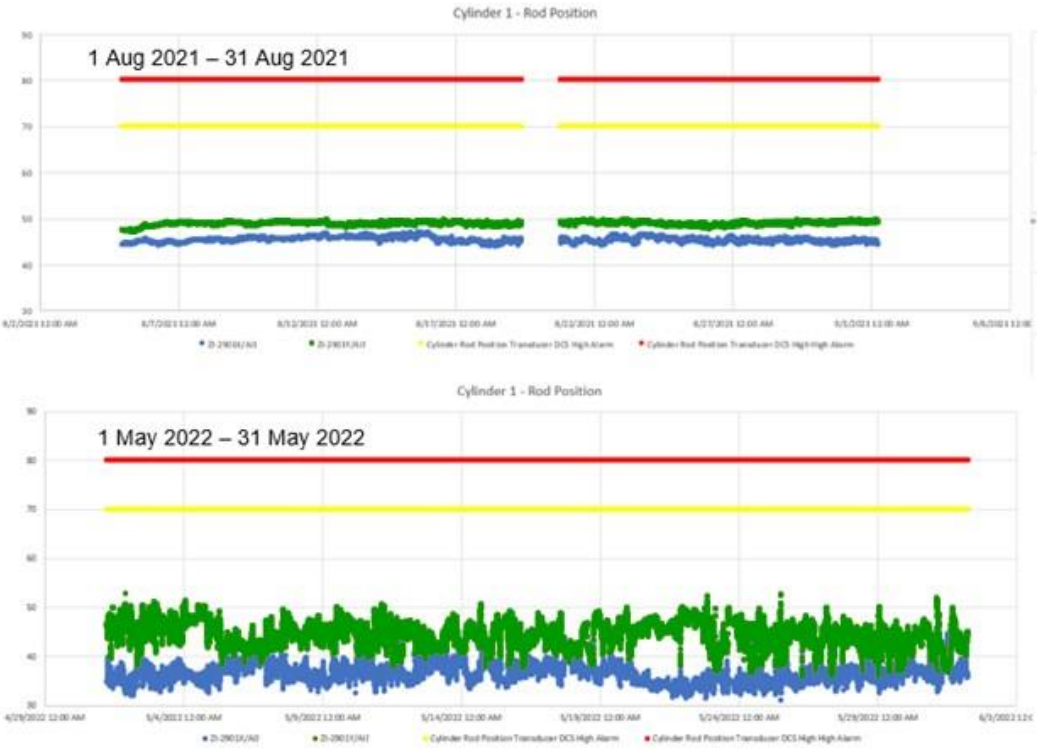

Figure 2 – Rod Position Trend

This whitepaper will discuss the rod drop measurement, which has its root at the vertical rod position measurement in the machine. What we infer from the similar triangle methodology is that the vertical rod position measurement corelates with the actual rod drop and rider band wear within the cylinder. The correlation has to do with the ratio of the piston rod length (L2) to

the probe position length (L1). The logic being, if the piston rod position moves downward relative to the probe, then the piston must move downward, and for this to happen, the rider bands have to be wearing. It should be noted that the rider bands are sacrificial parts within the reciprocating compressor, they are intended to wear. The rider bands support the piston, allowing the piston rings to remain centered, this allows the piston within the cylinder to do its job and compress the gas. As the rider bands wear with time, there comes a point when the rider band has to be changed out or risk the piston coming into contact with the cylinder, which is a major fault and needs to be avoided.

As mentioned above, the focus of this whitepaper will be rod drop measurement or the vertical rod position measurement. In the above figure (Figure 2), there are two rod position measurements, Y being the vertical position and X being the horizontal measurement. You can see that in August 2021 there wasn't a lot of activity for either measurement. You can see by May 2022, there is a lot more activity on both measurements. This activity that you see in May is typical of most reciprocating compressors. The data looks chaotic and non-periodic. If collecting instantaneous data at one revolution of the crankshaft, this is fine in a monitoring system when you have a phase trigger and a monitoring system processing the data. In the Metrix case, due to the minimal transducer suite for most reciprocating compressors, we must use a different methodology.

When you're looking at rod position data at the different way, it is often very helpful to use a seven-day running average to compute the rod position location. For example, during the month of May in the above figure, the data looks very chaotic, which is the usual case. Please see the case history below.

By looking at the seven-day running average data, you get a true picture of what's happening. Vibration and position data is typically normally distributed, meaning that, if you plotted the frequency at which certain values appear under steady state (constant speed and load) conditions, you will find that the frequency distribution is a bell-shaped curve. For example, in the data below, you can see the bell-shaped curve for the case history.

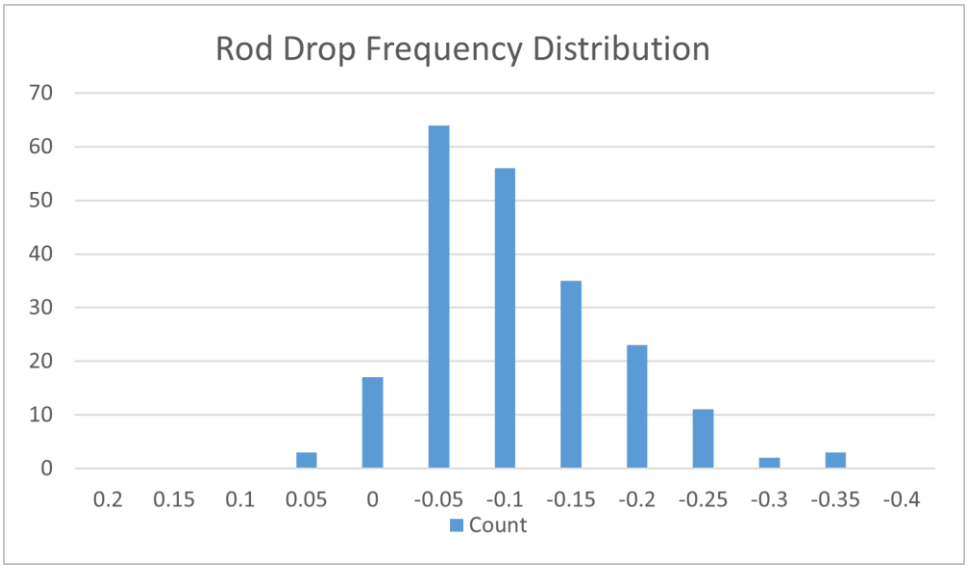

Figure 3 – Normal Distribution for Rod Position Data

Because the data is normally distributed (bell-shaped), the average and the standard deviation from the average now have meaning (Note: If the data was skewed to the left or the right, we could not use the average, we would have to use the median as a measure of central tendency). Due to the fact that the data is bell-shaped, we can use the average for trending purposes. In a rod drop application, because the rider bands wear over time and usually don't suddenly fail, the 7-day running average is more effective at showing the actual wear on the rider bands than any instantaneous value. An instantaneous rod drop measurement is made at the same point in the piston stroke, this is done using a phase trigger measurement. The phase trigger allows the vibration monitoring system to take the rod drop data at the same time, or crank angle, in the stroke, preferably when the piston rod is under tension in order to obtain a repeatable rod drop value. Even with an instantaneous rod drop measurement made with a phase trigger, the measurement can be enhanced with a 7-day running average.

The below case history shows the value of the rod drop measurement.

Case History

A well-known OEM did not believe the accuracy of our rod position measurement from our MX2034 position transmitter watching rod position within their reciprocating compressor. In fact, they said that they should remove it because it did not work. They looked at the chaotic readings and said, "What value can this possibly provide?" Metrix asked them for the data over a six-week period of time. We took the data and performed a seven-day running average and this significantly smoothed out the data and indicated that they had 2.0 mils (50 µm = 0.05 mm) of wear. The OEM doubted the measurement, so they opted to stop the machine and physically

measure the rider band wear. After the OEM stopped the machine and measured the rider band wear, they found that the value that the Metrix system provided, using the 7-day running average, was in line with their measurements. The OEM apologized to Metrix and asked if we could provide them reciprocating machine monitoring training, especially regarding rod drop monitoring.

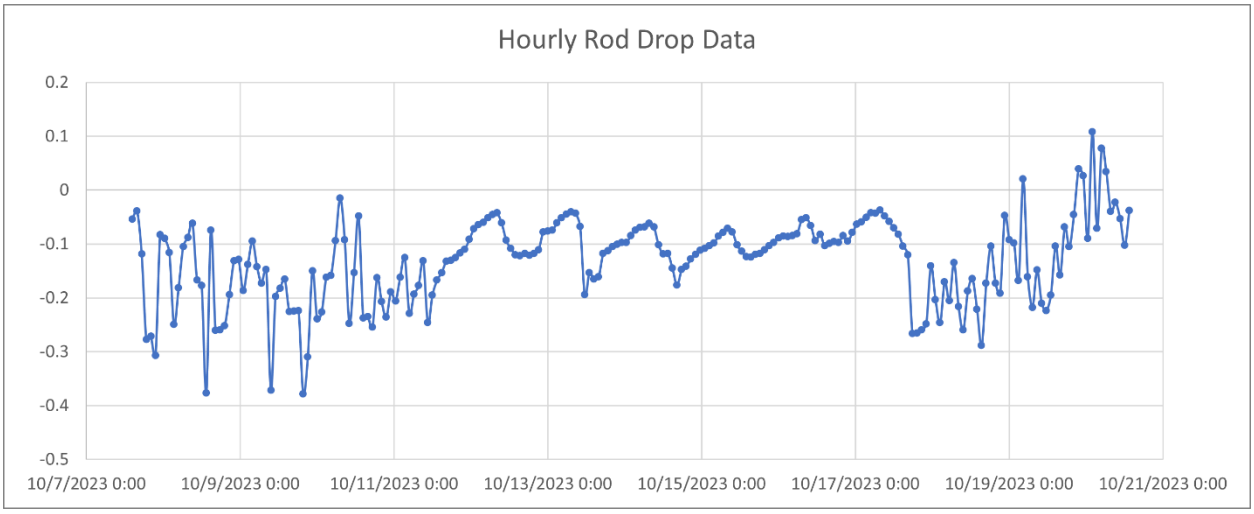

Figure 4 – Trend Plot Showing Hourly Rod Drop Data

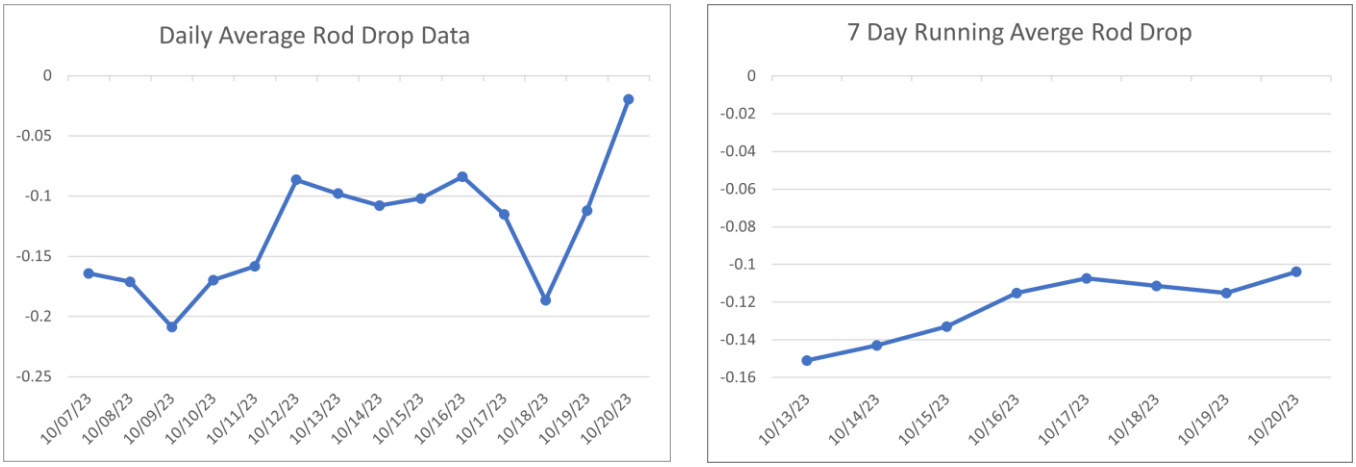

Figure 5 – Trend Plots Showing a Daily Average and a 7-Day Running Average of Rod Drop Values

Summary

The Rod Drop, Rod Position, and Instantaneous Rod Drop measurements are tools to measure rider band wear. The variation of these measurements over time makes the rider band wear sometimes difficult to assess. In other words, we want the rider band wear that is measured to be equal to, or close to, the actual rider band wear. The variation of the Rod Drop, Rod Position, and Instantaneous Rod Drop measurements sometimes make coming to a conclusion difficult. The methodology discussed in this paper has proven to be an effective way to monitor the actual rider band wear found in reciprocating machines. Customers have demonstrated that the amount of rider band wear observed by using a 7-Day running average is directly related to the actual amount of rider band wear measured with a gauge.

For more information, please reach out to Metrix by filling out the **Contact Us** form or look up one of our many **distributors** found around the world. You can also call us at **281.940.1802** - we still answer the phone.