August 2016

ASK THE EXPERTS: The Characteristics and Applications of the Ultrasonic Sensor (Part 2 – Engines)

QUESTION: I recently had start-up assistance training on my Windrock analyzer. What are some of the best practices in regards to the ultrasonic sensor?

There are two main ways to utilize an ultrasonic sensor: collecting crank angle based vibration traces and listening to the signal with a set of frequency reducing audible headphones. By implementing these tools, down time can be reduced and the effectiveness of an overhaul maximized. This can be done by optimizing the time spent on a machine to identify known problem areas or replace and adjust only the deficient parts.

Ultrasonic testing of compressor and engine cylinders is an informative preventative maintenance practice. On engines, ultrasonic readings can show problems such as leaking valves and valve opening/closing deficiencies.

Figure 1

The Windrock A6050-04-00 Ultrasonic Sensor (Figure 1) has a few key components that make it operate. Most importantly would be the piezoelectric microphone. This style microphone has a peak working range from 35 KHz – 45 KHz. Next is the rubber tip which blocks out surrounding noise, making it possible to isolate key signals being produced inside the unit and reference it to crank angle. Lastly, there is a gain adjustment knob for the sensitivity of the microphone. This is important in minimizing the floor noise in your ultrasonic traces as well as to avoid clipping on loud events.

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The most important technique to follow when taking ultrasonic readings is to ensure there is an excellent seal between the rubber tip and the surface of the machine. Be sure to keep the probe body away from near-by objects, which can produce false ultrasonic activity in the trace. Also, PAY ATTENTION while collecting data to ensure the best results, and never adjust the gain in the middle of a collection route. The gain setting (Figure 2) on the ultrasonic sensor will be set between 2 and 9 while using the analyzer. However, while using the headphones and battery pack, most often the gain setting is near 2.

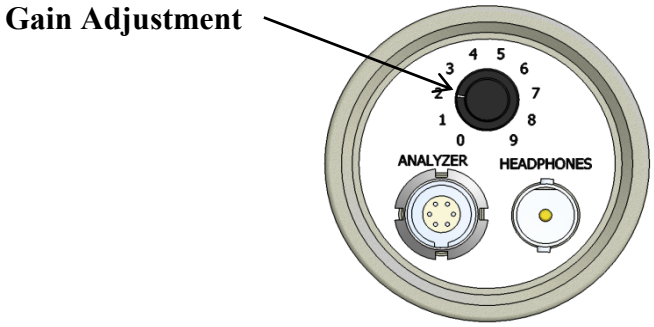

Figure 2

Table 1 describes some of the common engine faults identified with the ultrasonic sensor. Note there are two ways to use the ultrasonic sensor in "Stand Alone" mode. One is using the analyzer in conjunction with "Direct Channel Read" and the other is by using the headphones and battery pack. In "Stand Alone" mode, crank angle based data cannot be seen or stored.

External Leak Identification	**Internal Leakage Identification & Mechanical Condition Indication (Crank angle related)**
Spark plug seat areas	Power valve leakage (exhaust & intake)
Power cylinder head gaskets	Fuel valve leakage
Valve guides	Event timing
Exhaust leaks	Valve recession
Air manifold leaks	Fuel valve flow restriction
Air starter valve seat gaskets	Cylinder liner ring ridge
Fuel valve seat gaskets	
Fuel manifold control vale	

Table 1

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An engine uses the same basic steps as a compressor. Look at the data as it is being collected on the screen to ensure proper gain adjustment as well as confirming a good seal to the machine with the rubber tip. Ultrasonic readings have two uses that can be useful in determining deficiencies. The first are valve events on 4-stroke units and the second are ring deficiencies on 2-stroke units. Figure 3 shows ring deficiencies are detected using the ultrasonic sensor. In this example, all of the blue traces are from a healthy cylinder while the red traces are from a problem cylinder. This conclusion must be confirmed with other information such as a Pre-Combustion Chamber (PCC) check valve closing early and a pressure trace. This gives both the analyst and the engine owner the confidence to move forward and perform a timely repair.

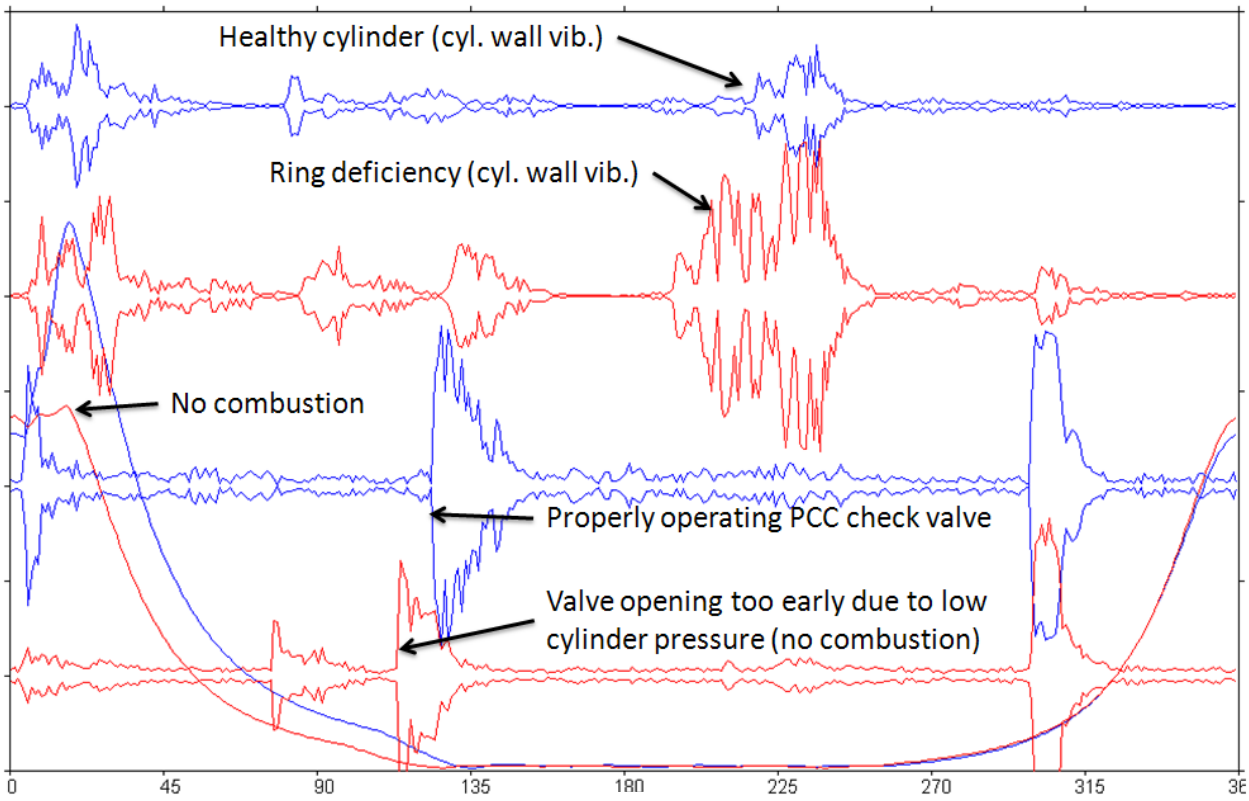

Figure 3

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Using diesel engines as an example, Figure 4 illustrates that the fuel valve timing can vary and should always be checked for proper timing. Improper timing causes bad combustion characteristics as well as undesirable emissions due to excess or unburned hydrocarbons and inefficiencies. It is possible to compare all of the engines valves (up to ten) while they are overlaid onto each other. This makes it easier to see how each individual valve is performing. This technique is also useful to trend how a single cylinder's valve is performing over time.

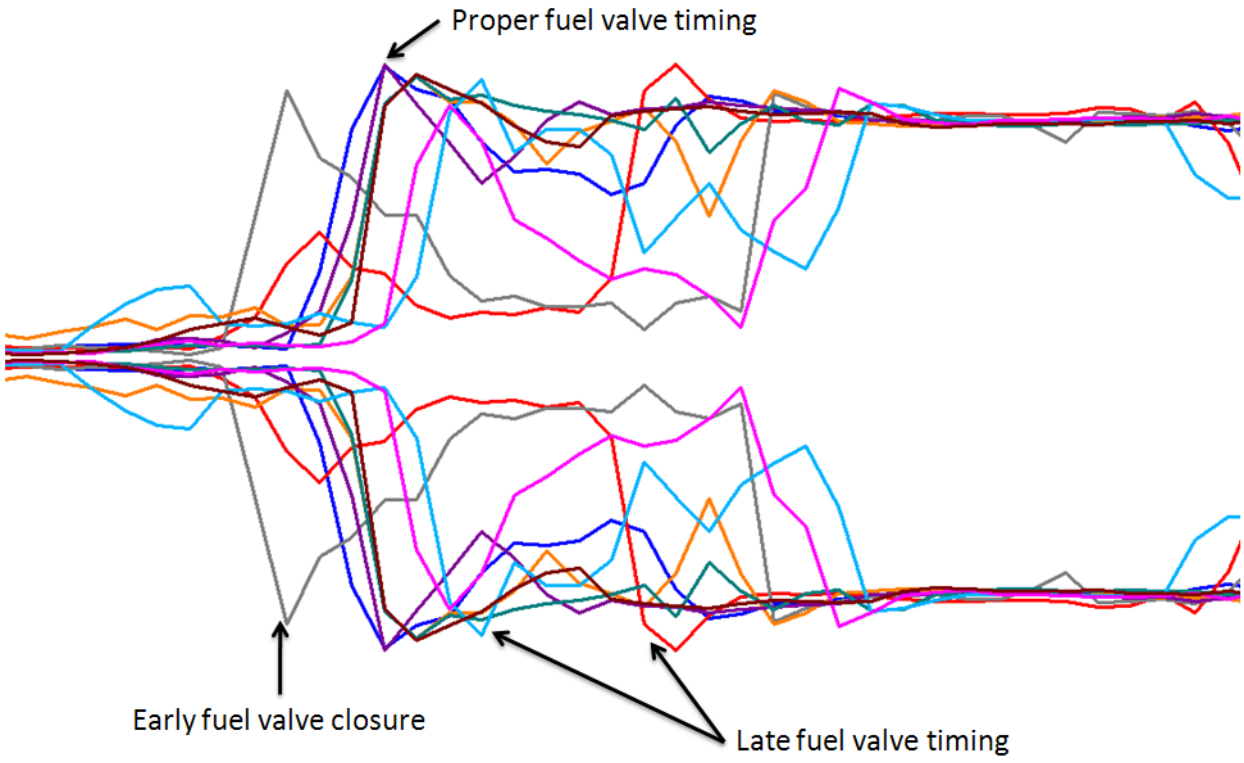

Figure 4

There are many things that can be detected or seen using an ultrasonic sensor on a 4-stroke engine. One is valve event timing. As soon as the valve lash is out of specification, it is detectable with the ultrasonic trace. Using this tool is an effective method to detect which valves need adjustment at a scheduled PM. Making adjustments on valves out of spec minimizes downtime as well as time spent working on the unit, which translates to saving money. Furthermore, ultrasonic sensors also have the capability to detect combustion issues. When the exhaust valve opens, a blow down event is captured in the ultrasonic trace if combustion took place. If no combustion occurs, a flat line is in this place and the cylinder exhaust temperature is low. Low exhaust temperatures in conjunction with this information ensure confidence that there is in fact a dead cylinder. Figure 5 displays some examples of what to expect to see on the analyzer screen.

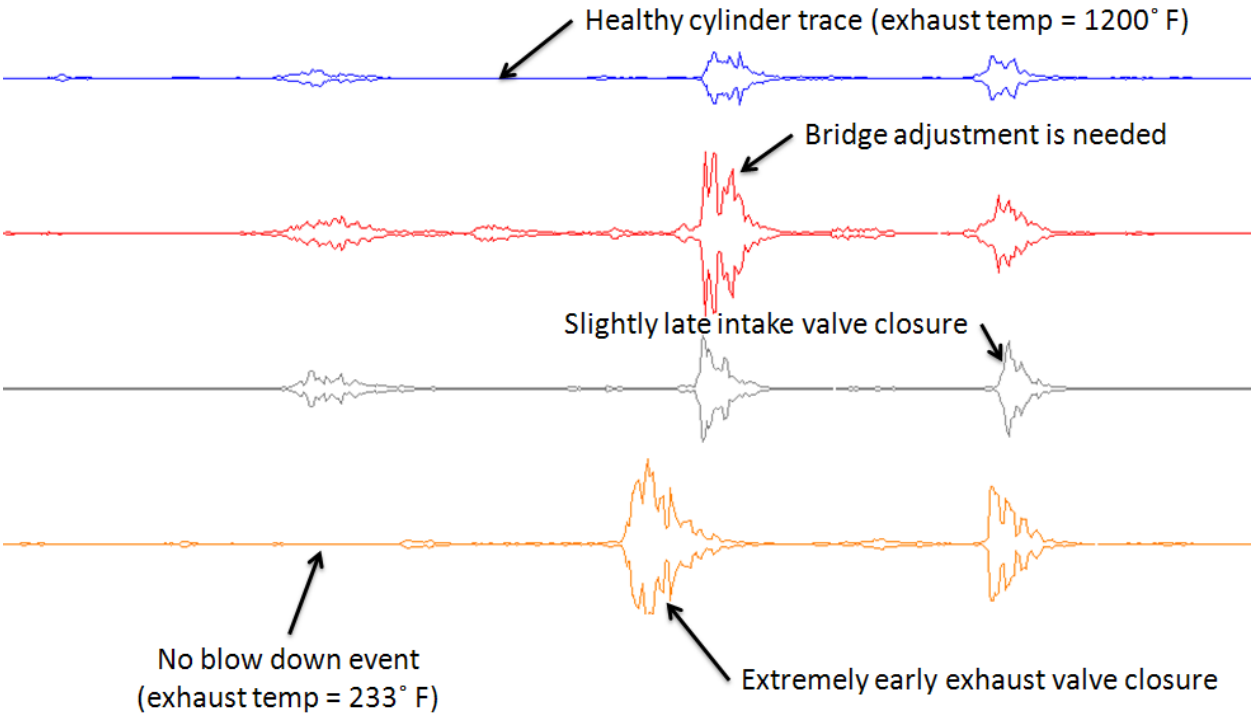

Figure 5

A frequency reducing headset (Figure 6) allows finding the source of external air and gas leaks without the need of the analyzer. Along with this is freedom in an engine room to perform checks in suspected problem areas without having to create new sensor points or databases. The headphones are connected to a frequency reducing filter that the signal passes through making it audible to human ears.

Figure 6

There are many applications for ultrasonic sensors and when used properly, it minimizes downtime and saves both time and money. When compared to an accelerometer, the ultrasonic sensor picks up high frequency air leaks that are outside of the accelerometer's frequency range. While it detects broken or missing rings in 2-stroke engines it is also useful in determining if valve lash or bridge adjustments are needed in 4-stroke engines. While using the headset, detection of packing, flange, and leaks to atmosphere are possible while singling out the origin of the noise. This means that it is also possible to quickly spot check points near a suspected problem source.

In the June 2016 newsletter, we covered part 1 of this topic. It discussed the application of utilizing an ultrasonic sensor on compressors.

If you have additional questions about the ultrasonic sensor or would like more information about other topics, please email **sales@windrock.com**.

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