

How do you “read” a spark plug?

In our last article we discussed function, tip design, and heat ranges of spark plugs and why that is important when selecting the correct plug. That helps us understand how engine conditions change the appearance of your spark plugs, and how we can use visual cues to improve the tuning of our pulling tractors.

Careful inspection of your spark plugs can help attain proper air-fuel ratio, proper heat range to avoid detonation, and possible engine problems such as oil usage.

Since improper heat range can easily cause detonation and spark plug insulator failure let's take a look at that first. The length of the exposed tip and insulator (inside your combustion chamber) determines how hot the tip gets during engine operation. Since internal gas temperatures of an engine can exceed 4500° F the spark plug tip must dissipate heat in the engine head or block. If tip temperature is higher than about 1400° F it will fail, but if it drops below 900° F it can begin to foul from soot. Race fuel can often accelerate fouling because of the chemicals used to resist detonation.

Inspection of the ground strap is an easy method to determine proper heat range. Do not attempt to inspect a brand new spark plug. It takes a few heat cycles to attain accurate readings. For tractor pulling I suggest checking the plugs after each hook until you have determined correct conditions.



Much like a knife maker who looks for the proper “temper line” to read metal temperature, we can use the same method to read spark plugs. As your plug heats up, a color line begins to form on the ground strap. Even if your spark plug has carbon soot, you can carefully wipe the plug clean and read the color change of the metal.

The beginning of the line (towards the tip) indicates initial ignition timing while the other end indicates max timing. The line should be on or near the curved portion of the ground strap for proper spark plug temperature. The most dangerous condition I have seen is using a plug that is too hot. After a long hard pull the “over heated” spark plug tip can fail or cause detonation. Find a sparkplug that operates at the lowest temperature possible without fouling the plug. This will eliminate the spark plug as a heat source that causes detonation. Running proper timing also reduces exhaust valve temp which is another common source of detonation.

Base ring inspection is used to determine proper jetting. As a spark plug is used, a certain amount of residue collects on the base of the plug and the residue should cover at least 7/8 of the way around the base ring. Too little indicates lean jetting while excessive build up indicates rich conditions. Try to examine a fairly new sparkplug to determine if recent operation was at the correct air-fuel ratio.



The spark plug shown above has an even light color indicating correct jetting. If you are using certain ignitions such as our C5 multiple spark system the color typically appears lighter than a stock type ignition with a single spark. Using an air-fuel meter to verify jetting is highly recommended and saves time.

The spark plug shown below is from my friend’s Moline puller burning LP with our C5 ignition and larger carburetor. We used our AF meter to adjust the new carb for an exhaust reading of 0.88 Lambda (13.6:1 air-fuel ratio for LP fuel).

As you can see the base circle has a nice light color. The red arrows show the initial/final timing is appropriate, as is the heat range. There are no signs of detonation on the insulator even though we run almost 30 degrees of timing.

If your base ring is wet it could indicate oil burning or an ignition failure. Good running engines generally have a base ring that appears dry, with fine soot.



Reading the porcelain of a spark plug can be used to indicate timing problems and WOT (Wide Open Throttle) lean conditions. Usually a brown ring appears at the tip of the porcelain after some hard pulls. It should be a sharp defined ring about 0.020" wide. A wider ring indicates not enough timing. If the ring is smaller, incomplete or nonexistent, that could indicate too much timing. The plug shown above was new and had not formed the ring yet.

The next spark plug shown below is from one of my motorcycles. It was probably changed after extended idling because the ceramic was so dark there was no useful information to gain from reading it. Old fuel can also cause irregular plug color.



Black specs on the insulator indicates detonation, silver specs indicate piston damage from extreme detonation. Use a magnifying glass and bright light to inspect the insulator down at the base (inside the threaded area). Generally a 2 millimeter wide brown or grey color at the base is acceptable.

The spark plug shown below is from my Allis Chalmers WC with magneto ignition and horribly worn out spark plug leads. This engine is obviously suffering from ignition issues and most likely the oil control rings are worn out. It is a wonder how this spark plug could function at all, but this wasn't even the worst of the group!



There are many online articles with excellent photos showing how to read spark plugs. I hope this helps get you started and encourages more research on your part. Learning to read spark plugs can be very helpful and prevent expensive engine failures due to detonation. As we discussed in the previous article, the mechanical design of a spark plug affects the heat range and ability to resist fouling. Do not be afraid to compare with your friends and help each other learn more.