Got uneven colored plugs? VW Engine Tips Part 1

Chad Stenson

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Show of hands… How many of you have pulled your plugs doing routine maintenance only to find that the rear cylinders are running super rich when compared to the front? Keep your hands up. Now, how many ofyou are using intake manifold end castings that bring the air/fuel mixture up from the back of the engine and from underneath the engine? One last question. If you let your engine idle for an extended period of time at full rich, does it 'load' up?
That's what I thought. Smile

Disclaimer: The following is not being represented as anything more than my own experiences and some of what I know for certain to work (and likely some examples of what didn't work). ALL of these ideas are flight tested by yours truly. None of this is theory, none of is has any mathematical equations in it or any other scientific proof to support my views and opinions. I don't dig into text books or surf the internet trying to find supporting documents to any of my ideas. I try them in real life situations in a real life airplane. Some work, some don't work, but I'm still alive to share my experiences and hope you are able to better your own power plant in some way through reading these articles. You are entitled to agree or disagree with anything that I say, but unless you've done exactly what I have done and saw different or opposite results from mine, please don't draw any conclusion or condemn me. Your mileage will vary bla bla bla… Ok, on with the show.

Through my endless experimentation with the VW engine in my Sonerai IILS, I learned quite a few things about intake manifold design (along with a whole bunch of other stuff that I won't go into here). One of the things that I spent the most time on was trying to get all 4 of my spark plugs to 'read' the same color when I pull them out to replace or inspect them. This is obviously in a single ignition application, and if you're wondering, I use the Compufire DIS-IX system.

I realized early on that I had poor fuel atomization and even worse fuel distribution with my existing induction system. As VW pilots, we have basically 2 choices for controlling fuel to our engines. Float bowl type carbs like the Zenith, or throttle body type carbs like the Aerocarb, Revflow, or the Ellison if you have deep pockets (no offense to those of you that fly them, I just wish I could afford one!). I guess there's one more option, which is electronic fuel injection, but I don't know anyone personally that's doing it, so for the sake of this discussion lets keep it to the first 2.

Now take a look at your intake manifold. It's likely some kind of 'Y' shaped thing with the carb mounted under the engine. So for the sake of conversation lets say you have 30 some inches of intake manifold tubing from the throat of the carb to either cylinder head (should be more tubing on the left side than the right due to the offset of the engine). Now I'm making some generalizations here, but stay with me. Here's a picture of what I mean...

You can see that the intake manifold comes up from underneath the engine, turns towards the front and then down into the cylinder head ports.

Lastly, look at the inside of your intake manifold end castings. I don't care what brand they are, they all have some kind of port splitter (assuming dual port heads) that separates the front cylinder from the rear. The end castings in the picture above are GPASC castings, but you'll see similar design in the Aerovee manifolds (early or late model) as well as some others.

I went through 3 different intake manifold designs, 2 different carbs as well as modifying my end castings on my Sonerai before I got an induction system that worked really well. It worked well for a couple other people too. I reworked end castings and consulted a fellow Sonerai owner in Iowa as well as a few Sonex guys in Texas that were all having the same problem I was. In the end all of our engines "cleaned up" so to speak when it came time to pull the spark plugs with little if any difference in the 'read' of any of the spark plugs.

There are probably 2 questions in your head right now. You are thinking 'my engine doesn't run bad; I just notice that the plugs are dark'. Well, you're probably right, it doesn't run BAD, but it could run better. The second question is WHY are those plugs dark?

Well the answer to the second question has to do with the length of the intake runners coupled with inefficient atomization of fuel at the carburetor. Most of us use slide type throttle body, or float less carbs. That's the group that I'm focusing on because that's the experience that I have. Anyway, what happens is at low power settings (especially idle or a little faster idle for taxiing) there isn't enough air velocity to keep the fuel in suspension with the air molecules in the intake track over this long distance. So what happens is the fuel falls out of suspension and you basically get a 'stream' of fuel that runs along the bottom of the intake tubing and then falls into the first available cylinder head port. That port happens to be the rear. Now, there's still enough fuel getting to the front cylinders to keep the engine running smoothly, but you're running the rear 2 cylinders quite a bit richer than the front. If you have an EGT probe in all 4 exhaust pipes and they are all located the exact same distance from the port, you'll see higher EGTs on the front 2 cylinder than the rear. Probably not by much, but remember that this is an engine at idle, so your temps should all be pretty darn close. Under a load at full throttle, you can see differences too, but again, they should all be close.

A little sidebar…

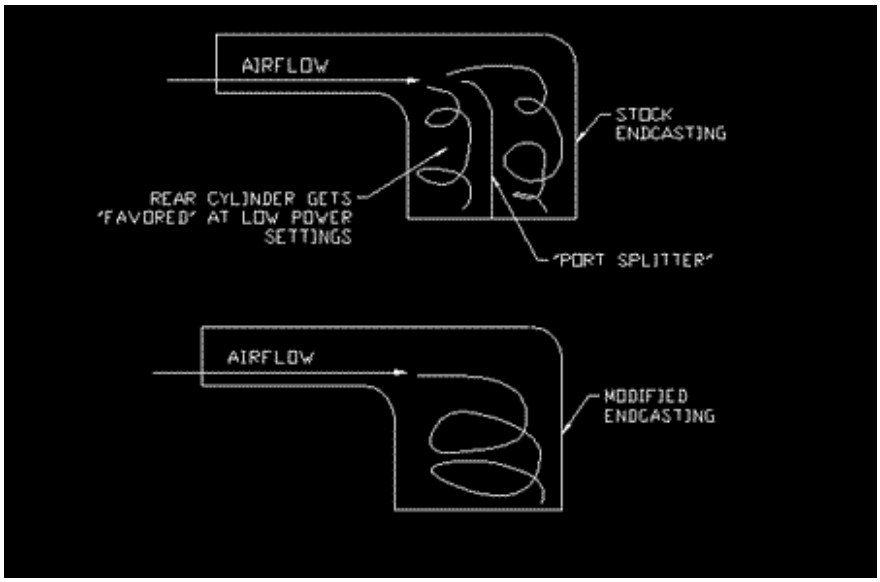
If you've ever looked under the hood of a stock VW Beetle you'd see the carb mounted in the center of the engine (above the engine obviously) with the intake end castings basically splitting the incoming air closer to the centerline of the cylinder head ports. Couple this with full time 'carb heat' in the form of the heat risers, and you get a very simple but very effective intake manifold with at FLOAT type carb mounted to it.

Ok back to our airplanes. We don't mount the carb on top of the engine in most cases. The reasons vary, but fire hazard is the main reason for me to keep the carb under the engine. Fuel dripping on a hot engine or getting on the exhaust somehow is a recipe for disaster. Many VW Beetles burned to the ground due to engine fires. So since we mount the carb on the bottom, we require these long, inefficient intake runners.

So what can we do about it? Convert to port fuel injection! Just kidding. What I found to be the simplest solution was to modify the end castings. I used GPASC end castings on my engine, mainly because they are basically all that's available to the general public. What I did was turn the end casting into a single plenum manifold. In order to do this you take a die grinder and carefully reshape the inside of the end casting to look kind of like a peanut. Like this….

Now the splitter runs back into the end casting quite a bit, so you'll need a steady hand and a long aluminum bit. I used a Makita electric die grinder with a purpose made aluminum burr, but an air operated die grinder would work too. I guess a Dremel tool would work too, but I think it would take forever. The aluminum burr is key. I don't have it handy to take a picture, but it's a real aggressive looking thing.

Ok, now you're asking yourself how does this modification help with the 'streaming fuel' affect at low throttle settings. The answer is absolutely nothing. What is DOES do though is eliminates the barrier that keeps that stream of fuel from feeding the front cylinder once it drops down into the rear cylinder port. You may have to read that a few times to follow me, but here's a picture that may help you visualize what I'm saying…



The above pictures is a really quick, simple (and kind of ugly) and somewhat exaggerated picture of what happens in the 2 different designs. You can see how the stock setup favors the rear cylinder. When we get rid of the port splitter, we create one big open plenum for the air/fuel to tumble around in. One of the benefits of this design is that we always have some reversion in the intake track either from the opposite side of the engine or from the valve overlap on the same side. This reversion is actually a disruption in that intake manifold plenum and tends to 'stir' whatever is in there. In our case, we NEED to stir that fuel and air mix to better prepare it to be drawn into the next intake port and then into the combustion chamber to be ignited and so on.

After this mod was done, my exhaust temps were within 15 degrees of each other, which on an analog Westach type instrument is hard to even see. I can't say I picked up a great deal of performance in the air but it was probably worth 25-50rpm increase at wide open throttle in the air. Not much, but every little bit helps. The true result was no more mismatched spark plugs and an engine that would idle all day long.

Why is the idle of any concern to me? Well here's what happens with the stock end castings. Since you're 'robbing' the front 2 cylinders of fuel at low RPM, you end up compensating by richening up the jet needle on the carb. Then you find that the engine is a little 'fat' in the air and doesn't really like to run at full rich or maybe an engine that runs better only after you lean the mixture slightly.

As a wrap up to this Part 1 article it is important to note that using the stock parts as supplied from any manufacturer is completely acceptable. You will get good results using any manufacturer assuming you follow their instructions. Most companies will shoot for 'good enough' in a wide variety of installations. Good enough truly is 'good enough' but I look for 'as good as I can make it' so I putz with stuff. I invite you to experiment in whatever way you most feel comfortable with but please bear in mind that I'm not saying any of these parts are of poor quality or design in their original form.

Blue Skies.

Chad Stenson
Vee-Power Systems LLC

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