Linder Technical Services

Networking Newsletter

November 2006

Tech Tip: GM Fuel Sending Unit "Flipping"

Operation of a typical in-tank fuel level sending unit is based on variable resistance. As the float moves up or down according to fuel level, the resistance in the sending unit varies. This varying resistance is processed by the engine control module (ECM) and the resulting information is sent to the instrument panel cluster (IPC) for display on the fuel gauge.

In the past, the sending unit was set up so that high resistance indicated high fuel level, and low resistance indicated low fuel level. Sulfur contaminants found in some of today's gasolines can form deposits on the sending unit, resulting in higher-than-intended resistance (*TechLink, Jan. 2006).* The high resistance from the deposits could be misinterpreted as a high fuel level, when in fact the fuel level is low. The driver may run out of fuel, even though the fuel gauge is not indicating low or empty.

To offset this effect, engineering has begun "flipping" fuel senders, reversing the circuitry. This means that high resistance now indicates low fuel level and low resistance indicates high fuel level. So, if deposit build-up adds to sender resistance, the gauge will err in the direction of indicating less fuel than is actually in the tank.

The "flipping" process began in the 2004 model year continued through model years 2005-06. The remaining vehicles will have their fuel level sending units "flipped" for the 2007 model year:
- Cadillac CTS
- Cadillac SRX
- Cadillac STS
- Cadillac XLR
- Chevrolet Corvette
- Chevrolet Impala, Monte Carlo
- Chevrolet Malibu, Maxx
- Pontiac Grand Prix
- Buick LaCrosse (Allure)

TIP: When diagnosing fuel sender operation, it's critical to refer to the appropriate model year information to be sure which resistance specifications apply.

Note: The TechLink article that is referred to is available to the aftermarket through Identifix OR by going to our website, clicking on "automotive links" and clicking on the link for GM's Tech Link: http://216.182.211.32/techlink/

Air Density Ratio

In our last Bonneville report I mentioned that we felt we had lost 20% of the engine's horsepower on the Salt Flats. I also mentioned that I felt that the engine could not have ever ran any better and the gear ratio and tire height was perfect! Ed Starr (owner of Mag Tech in Indianapolis) had made the statement standing in his sprint car trailer that we had lost the horsepower due to altitude and air density! I had driven the vehicle above the record speed in Indianapolis with room to spare, but NOT 20% extra, and I knew that Ed was serious in his calculations. My only problem was "how did he know" that exact number? He didn't say 10 or 15%, he said you have lost 20% based on the ADR (air density ratio) of the salt flats and the changing weather conditions during the day will make it even worse as the day goes on.! Now I gotta know what in the world has happened to our record breaking-setup from Indianapolis? After many evenings of googling the subject I think I now know enough to be dangerous. After condensing many pages of data from the net here are the highlights:

Density Altitude is only a function of the local atmospheric weather conditions. It cares nothing about what type of racing you are doing, or what kind of fuel you are burning. Density Altitude only describes the ambient air density in the units of feet (of altitude). Simply stated, Density Altitude is the elevation having the same air density as the local, measured atmospheric weather conditions.

For example; if the temperature is 60 deg F, and the "absolute" barometric pressure is 29.92 in Hg, and the relative humidity is 0% - the Density Altitude is 0 ft. Consider another example with a temperature of 42.2 deg F, a barometer of 24.9 in Hg, and 0% relative humidity - this has a Density Altitude of 5000 ft.

However, when you add in the effects of water vapor, things start to get a little more complicated! Water vapor takes up space that would otherwise be occupied by dry air (which normally contains almost 21% oxygen). Generally, motorsports is concerned with air-breathing, oxygen burning engines . . . so the amount of oxygen that is in the air is a key feature. Water vapor takes up space otherwise occupied by oxygen molecules. How much? The space occupied by the water vapor is proportional to the water vapor pressure .

However, there really is nothing mathematically incorrect about the definition of Density Altitude . . . it's all about what you're going to use it for. To help illustrate this point, please consider a common tool in our racer toolbox - a standard 6 inch caliper. A 6 inch caliper is a pretty complicated device, having several components, all put together in a way that allows very accurate measurements of length - actually to the nearest thousandths of an inch. Calipers are manufactured by several different companies, and all will give basically the same answer when used properly. However, a caliper is not the proper tool for measuring the weight of the pistons in your engine

The same idea or concept is true for Density Altitude. It is an excellent tool for determining the elevation having the same air (or oxygen) density as the local, measured weather conditions . . . but it won't give you the correct answer for predicting the performance of your race car

Why not? First, we must go back and examine the history of term "Density Altitude". Density Altitude was originally invented decades ago for use in aircraft flight manuals. Pilots are critically concerned that they will be able to safely liftoff the ground during the takeoff roll within a given runway length. The lift generated by the wings (at a critical speed) must be greater than the aircraft weight in order to actually get off the ground. Lift is directly proportional to the local air density .

Air Density Ratio

Motorsports initially used Density Altitude for jetting Holley carbs, and for this purpose, it does a really good job. Air (or oxygen) and fuel must be mixed in the proper ratio for best engine performance.

The "Problem" with Density Altitude started with the advent of bracket and super class drag racing where the need to accurately predict ET under varying weather conditions became critical to winning races. The erroneous assumption of physics used by many at the time was that drag racing ET is proportional or otherwise clearly related to Density Altitude.

The way that an engine's power varies with changing weather conditions is thoroughly documented in the Society of Automotive Engineers (SAE) standards. These are the same procedures used for correcting observed engine dyno data to the standard day conditions of sea level, 60 deg F and dry air.

OK, in Bubba terms what does all this mean in relationship to our seven runs on the salt at Bonneville.

- Using the ADR we found that the altitude changes from 5200 feet to 7200 feet over a days time. This is caused by a change in temperature, humidity and barometric pressure.
- The engine in our truck won't ever run any better without a major volumetric efficiency change, ie: Bigger valves, more camshaft lift, increased compression ratio, increased air flow through the engine, etc. All hard fixes not adjustments.
- Our jet changes (fuel trim) just kept us at the same performance all day.

So what's the fix for next year? I feel like it's pretty simple (remember I thought that this year) and we had it with us this year but the rain canceled the change. A much better engine, larger camshaft lift and duration, increased compression ratio, and larger valves and ports. We simply need 25-30 % more horsepower than we had this year and we should be on the money.

So how do we measure up at this point? First, we just machined the engine plates for the dyno tests. We now know what the ADR is in the morning, afternoon and evening on the salt and we have a gauge of what it takes to run 97 mph. By dyno-ing the engine we ran this year we can see right away the changes with the two extra engines we have.

We also have a new hilborn direct injection system to test with as well. This should make our daily air fuel changes a little easier on the salt. We also know that to run two classes (Production and Modified) we must change the rear axle to a quickchange for modified. Anyone wish to donate a used quickchange? More as the engines come out and the dyno days start in.

www.gasolinealleyshops.org

—Jim Linder, The Injector "Guru"

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AUTOMOTIVE SOLUTIONS FOR TODAYS TECHNICIANS!

CONGRATULATIONS, SCOT!!

Congratulations to Scot Manna of MB Automotive in Des Plaines, IL. Back in our July newsletter, we mentioned that Scot (who taught for us at this year's LTS Technician Training Conference) was one of the finalists for the ACDelco Technician of the Millennium contest. The final competition was held at the end of October during the ACDelco National Convention in Las Vegas. Scot prevailed over 7 other U.S. and Canadian automotive technicians who qualified for the finals by winning their regional competitions.

The 8 finalists (whose independent service centers participate in ACDelco's Total Service Support Program) competed in a timed, hands-on skills contest and were judged on their professionalism, speed and accuracy in the diagnosis and repair of a "bugged" 2007 Chevy Impala.

In addition to earning the title of Technician of the Millennium IV, Scot won the grand prize worth more than $41,000. The prize package included among other things a 2006 GM Vehicle and an adventure trip to the Bahamas.

What wonderful recognition for such a great guy. We are proud to have had him on our "team" of instructors in the past and look forward to working with him again in the near future.

Congratulations, Scot, from the entire Linder Tech Crew!