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## ENGINE MANAGEMENT AND EXHAUST MODIFICATION

I can imagine that on the day the first Model T rolled off the assembly line there was someone in the crowd of curious onlookers wondering ... how can we make it go faster? Well it wasn't long before someone put that question to the test. All through the history of the automobile we have tinkered, modified, fabricated and changed it to suit our needs or personal preference.

Whether a member of a race team or just an enthusiast, for many of us the idea of modifying our ride ranks right up there with breathing. Whether the motivation is Speed or Show, our love of the automobile is a story that has been told over and over. Unfortunately, like the rest of our lives this pastime is not as simple as it once was. Technology is everywhere and with it comes challenges.

Now don't get me wrong, even in the early days of modifying our cars, challenges were always part of the game. After all, you can get a car to run really fast but at the same time you have to also be sure it can really corner and stop.

All of this brings us to the world of cars today. Computers have taken over most functions of the automobile and it all started with engine management. The purpose of computerized engine control has always been in lowering emissions. Fuel economy, smooth idle, precise shifting, ABS and traction control are all by-products of the same technology. Most vehicles today are not meant to be modified or even repaired by anyone other than a certified technician. Although the technological challenges may seem more complicated, technology can also be the answer.

Let's look at the exhaust. When a customer comes to us with an idea for boosting the performance of their vehicle, the exhaust will be one of those systems that we will take a long hard look at. The three areas we must consider are Sound, Performance and Quality. There will be a compromise but with careful thought and consideration of all areas affected, we should be able satisfy all involved.

The first area of concern is the size of the tubing we may want to use when modifying the exhaust. Here an understanding that "bigger is not always better" is crucial. General rule of thumb is to bump up one half inch in size from the original, 2" to 2.5", 2.5" to 3.0", 3.0" to 3.5", etc. There are many factors involved including OEM spec, naturally aspirated, super or turbo charged, and type of muffler being used.

Understanding exhaust flow is crucial here. The exhaust flows out of the combustion chamber in pulses as opposed to a constant flow like a dryer vent. These pulses have different pressure areas. The low pressure trailing edge of the pulse helps to pull the next pulse along. The term we use is "scavenging". There are several things that can be done to enhance scavenging in the exhaust system as well as the engine itself. Properly designed headers and the proper use of an "X" pipe, enhances scavenging and pulls the exhaust gas out faster and with less turbulence. Valve timing and specifically valve overlap actually allows us to use this natural scavenging event to pull air into the combustion chamber more efficiently.

There are two areas of concern on today's cars when it comes to modifying the exhaust; Catalyst Efficiency and Exhaust Gas Recirculation (EGR). For the EGR system it is changes in backpressure that typically cause the Malfunction Indicator Light (MIL) to illuminate. Catalytic Converter Efficiency codes come into play with changes in temperature, air fuel mixture and flow or duration (amount of time exhaust gas spends in the converter).



Most of us see exhaust backpressure as a bad thing. It robs the engine of horsepower and typically becomes a key consideration in any performance based modification. Today however we must consider backpressure when upgrading a system because the computer is watching it closely.

EGR systems are used in the reduction of NOx or Oxides of Nitrogen. Typically high levels of NOx are created in the combustion chamber when temperatures exceed 2500° F. On the engine side NOx reduction is accomplished one of two ways. EGR (Exhaust Gas Recirculation) which introduces exhaust gas back into the cylinder or in some cases valve timing by leaving a little exhaust gas behind to help cool the cylinder. Post combustion reduction of NOx is the job of the catalytic converter. Many EGR systems measure the flow of exhaust gas back to the cylinders using a calibrated pressure sensor. When we modify an exhaust system we most likely will affect backpressure and could end up with a Check Engine Light on and possible P0401 or P0402 codes. Usually this can be avoided by doing a pre-test of the EGR system (check for good flow) and minimizing the change in backpressure through proper pipe sizing.

Catalytic Converters have been a staple of the automotive exhaust for over 35 years and have always been a thorn in the performance world's side. In 1996 with the advent of mandatory OBD II the thorn became bigger. Included in this new on-board diagnostic process was the catalyst efficiency monitor. Now the PCM had the ability and responsibility to test the efficiency of the catalyst and report through the MIL when it was not operating up to standard (P0420 code). Modification of the exhaust can affect the converter by changing duration, temperature and air fuel ratio (AFR).

Typically most dramatic changes to AFR occur on the engine side. Taking the time to make sure all is well with the engine prior to making changes in the exhaust will help in minimizing issues after the work is done. Properly functioning Oxygen Sensors are critical.

Maintaining good operating temperature of the converter (750° F light-off) is a must and since moving the converter generally is considered tampering by the EPA and CARB, it is best to leave it as close to the OE position as possible. Lastly is duration. Everyone wants a "high flow cat". The good news is all aftermarket converters are high flow in comparison to OE. The concern is that we must give the gas enough time in the converter for reduction and oxidation to take place.

I mentioned earlier that although technology may have created some new roadblocks, it could also be the answer. Enter the world of performance tuning. Legal issues aside, having the ability to reprogram the PCM to adjust for mechanical changes made during modification has been good for the performance industry. Mostly used in racing and on diesel trucks this technology has given us the advantage we have been looking for. Tuning is an art in itself. Learn to make small changes and then evaluate the results before moving on. Check with the manufacturer for any legal issues and remember that when it comes to tuning, patience is the key.

Cleaning up the environment...one converter at a time

Gary

