FSCCA Technical Bulletin: Detonation
August 18, 2006

Enterprises has had 3 engines come into us over the last 2 months that have failed. I wanted to report what I have seen as the causes for such failures. The situation was the competitor in all three cases had not had problems previously. Yet for no apparent reason to them their motor expired. In one case a new motor was installed and the second motor failed for the same reason shortly after installation.

What I am seeing is detonation and surface Ignition. These cause the aluminum to be melted away in very small quantities until it eventually ruins the block, head, and piston. Once the piston is damaged enough, the upper ring fails causing the engine to smoke. It can also eat away at the block and head surface area, which causes the head gasket to let go. Both of these end results cause unrepairiable damage to the block and head.

The causes of detonation are multiple, but they are all related to the temperature in the combustion chamber. As the temperature in the combustion chamber rises the requirements of the fuel used changes. If the temperature rises either the fuel must change or the cause of the rising temp determined and eliminated. The following are some items that cause higher combustion chamber temps.

1. Fuel: If the fuel used has a faster burn rate the timing of the power will push on the piston at the incorrect time raising temps.
   Typical causes:
   : If octane rating of fuel is to low, the fuel will ignite too early
   : If oxygen level in fuel increases and A/F ratio is not correct
   : The burn rate of a fuel will vary
   : The heat BTU's per lb of air varies from fuel to fuel
2. Coolant temperature goes up causing the head to rise in temp.
   Typical causes:
   : Low water level in cylinder head. Air pockets in cylinder head.
   : No antifreeze in coolant. Water boils introducing air in the head
   : Radiator obstruction. Less air through radiator means less cooling

I each case the owners were not aware that they changed anything, and they had been successful running their cars many times previous to the failure. So what Changed?

First: Your street car has a Mass Air Flow engine management system. It has the ability to adjust the A/F ratio as it is driven based on the monitoring of air flowing into the engine. It also has an O2 sensor in the exhaust that monitors the A/F ratio and Adjust

A/F ratio when needed. The thermostat adjusts the coolant temperature accordingly. This is referred to as closed loop operation and can easily adjust for small changes in operating conditions. Your FSCCA car has a Speed density system. This means it runs to a preset standard and is manually adjustable. There is no monitoring of changes in A/F by the engine management system, and therefore no changes of A/F ratio while the conditions the engine is operating under are potentially changing. This is called open loop. The FSCCA car runs in open loop 100% of the time. Speed Density systems are generally used on racecars because they are easier to adjust and less expensive. This means that some conditions have to be monitored and adjusted for.

FUELS

One of the bigger factors that change is gasoline. One component of gas that changes regularly is the oxygen content. This is normally recognized as Ethanol, Methanol, ETBE, MTBE, or Ether. Another is Temperature.

What I believe is happening is that as the price of gas rises the quantity of ethanol mixed in has increased. Ethanol has an A/F ratio of 9 to1 and gas has an A/F of 14 to 1 as the quantity of Ethanol (or any oxygenate) goes up the A/f ratio needs to decrease, which means you have to enrich the fuel mixture. The way you do that on the FSCCA car is to raise the fuel pressure. As the fuel mixture gets richer the combustion chamber temperature drops eliminating the need for higher octane fuels to stop detonation. As the temperatures rise higher, higher octane of fuel will be required. If running pump gas the detonation begins earlier and is more likely to detonate with smaller increases in temperature. At Enterprises we use Fire Power 324, which is, 100 octane unleaded adjusted to A/F ratio of 12.6 to 1 to insure repeatability. This fuel is available from Precision Auto Research. 630-766-4402.

COOLANT TEMPS

Another problem is that these failures are happening during the hottest time of the year. As outside temps rise, coolant temp goes up, so does combustion chamber temp. The FSCCA car should be running around 85 degrees C or 180 degrees F maximum. I see temperatures in the 100Degrees C (210 –220) degrees F on many of your cars. When over 200 degrees F it is very easy to boil the water in the cylinder head, which produces air bubbles. These air bubbles do not cool the engine as well and they collect in the top of the cylinder head, as this is the highest location in the cooling system of a FSCCA car. This causes the head to get hotter. Once the head is over heated, it will not matter what kind of fuel you have in the car, the car will detonate, until it cools off again. Running straight water in the cooling system can also make this problem much worse as water boils at a lower temp then antifreeze. I know water cools better then antifreeze however water corrodes the inside of the motor and has too low of boiling point to be used by its self.

Another problem related to cooling is that the radiator air passages become blocked with off track use. Just cleaning the grass out is not good enough, long term. Air passages fill with dirt and reduce cooling capacity. If you mount items behind the radiator it will block airflow just as if you blocked the airflow in front of the radiator. A FSCCA,

with a clean radiator, and proper A/F ratio should be able to maintain well under 200 degrees. In fact you should be closer to 180 degrees. When the whether is cool out you should have to tape off part of the radiator in order to get the engine temp up to 180 degrees. There is no thermostat in a FSCCA car. The coolant temperature should be cold if any thing, not hot.

Conclusion:

As the operator of a FSCCA car you have to adjust the A/F ratio depending on the type of fuel you are using. Pump gas is never the same and requires regular adjustment. I would suggest the use of a recording Lambda (O2) meter to keep this adjusted correctly. A second alternative would be to pick a racing gas, which comes in a can not a pump, take your car to a chassis dyno and use a gas analyzer to set the A/F ratio and then use that gas all the time. Weather (temperature) is more consistent during a race but changes a lot from spring to summer to fall. As the temperature rises the Ethanol will vaporize must easier and cause the fuel mixture to lean out. In extreme cases of heat ethanol can cause vapor lock and the engine quits or misses. A not so extreme case of heat causes a lean A/F mixture.

The cooling system needs to be adjusted and serviced every time the car is on the track. Coolant temp should be adjusted to 180 Degrees F or 85 degrees C. The cooling system needs anti boiling/ anti corrosion substance added like antifreeze and the radiator needs to be free of dirt and debris on the outside as well as the inside. It is just as important to keep the obstructions from behind the radiator as in front.

Finally: Your FSCCA is a racecar. It does not adjust itself like your street car. Small factors can change things that effect expensive items.

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