MAF sensor , MAP Sensor and Controlling Fuel usage

The Tuning of any petrol fuelled engine relies on the tuning of the following sensors so as to attain a Stoichiometric ratio of 14.7:1. This is the ratio of the mass of air injected to the mass of the fuel injected at STP. Modern computer fuel injected engines aim to maintain this AFR ratio and monitor several sensors which signal the Engine ECU/PCM to maintain this ratio. These sensors are the

1. mass air flow sensor (MAF),
2. Air intake sensor
3. Precat oxygen sensor (also known as the AFR sensor)
4. Precat oxygen sensor
5. Coolant temperature sensor
6. Manifold Air pressure sensor- (MAP) (also known as the Boost pressure sensor).

When all sensors are in agreement with loading conditions, the ECU/PCM will fuel injection pulse length to supply sufficient fuel for the loading conditions on the engine.

The MAF sensor adjusts the fuel input measured in Grams of fuel per second. This measurement is dependent upon the temperature of the of the input air temperature (at constant Pressure P) as with increasing temperature the volume of gas increases according the universal gas law

P.V = n.R.T

Volume of gas $V = \frac{nRT}{P}$

Increasing the temperature (T) of the gas results in the reduction of number of moles (n) of oxygen gas, per litre of air, present for the combustion reaction. As a result the engine ECU/PCM reduces the mass of fuel / second, injected into the engine so as to maintain its desired stoichiometric ratio of 14.7:1. This is also be explained by the fact that Colder air is denser that warm air.

The initial Primary fuel control mechanism is dependent upon the MAF sensor and Air intake sensor , which is then adjusted and trimmed by the MAP sensor , AFR sensor, oxygen sensor and coolant temperature sensor to attain the desired stoichiometric ratio of 14.7:1.

There are a range of MAF sensors that are designed to measure the air intake volume.

Typically older engines use Hot wire MAF sensors that are analog sensors and show a change in voltage across the hot wire as more air flows past the sensor. Increasing airflow reduces the temperature of the hot wire and increases its electrical resistance and thus increasing the voltage of the signal sent of the ECU/PVM. This is a slow response system and has been replaced in modern engines by Digital systems the adjust/ increase the frequency of the signal sent to the ECU/PCM as more air flows past the MAF sensor.

In GM engines there is both a MAP sensor and a MAF sensor which control the engine ECU/PCM. In the case of GM , Holdens , the MAF sensor is the primary sensor controlling the air/ fuel ratio of the engine and the MAP is a backup sensor on the case of failure of the MAF sensor.

In other older vehicles there is no MAF sensor and the MAP sensor is the primary control sensor for the stoichiometric air fuel ratio control.

At Idle the air pressure sensor in the manifold reads a low pressure (high vacuum) just as it is on engine deceleration . This equates to a low loading condition where little fuel is required and sends a low voltage signal from the MAP to the ECU/CPM. Conversely under a large load a low pressure and high voltage signal is sent to the ECU/CPM indicating more fuel is required for engine operation.

As can be seen , by adjusting the voltage signal from the MAP sensor to a lower value , will inform the engine ECU/PCM that less fuel is required because the engine is under less loading.

Now lets consider the electronic fuel enhancer unit as used on vehicles with hydrogen on demand systems. Even though a Stoichiometric ratio of 14.7:1 is what the engine is tuned to run with, by reducing the amount of fuel used , then the Stoichiometric ratio will raise much higher than 14.7:1 and the computer will try and adjust by adding extra fuel. To strop that happening , the MAF sensor must adjust to read a lower mass of fuel by

a. Reducing the frequency of the digital MAF sensor
b. Reducing the output voltage of the analog MAF sensor

Secondly the Ait intake sensor reinforces this by indicating a higher air temperature with lower percentage oxygen per litre of air to reduce the fuel input

Next the Oxygen / AFR sensor is adjusted to read a lower percentage oxygen in the exhaust --- that equates to a rich exhaust and therefore reduce the amount of fuel so as to get the Stoichiometric ratio to what the ECU /CPM thinks is 14.7:1

Sensors such as the Coolant temperature sensor and postCat oxygen sensor are fine tuning sensors to get the best possible airfuel ratio

To summarize : The sensors are adjusted to deliver a very lean mixture that the ECU/CPM is tricked into accepting as the Stoichiometric ratio of 14.7:1.

Is there a danger of using a lean mixture on an engine? The answer is Yes , for normally fuelled engines without Hydrogen. However because of the much, much, much, much….higher flame speed of the hydrogen fuel mixture, and because the reduction in particular matter , and because of the much cleaner burn with no deposits, and because of the improved conditions of the exhaust gases emitted, then a much higher Stoichiometric ratio can be achieved delivering greater power output and again requiring less fuel energy used per second to maintain the Vehicle speed / loading .

In the case of older engines without a MAF sensor then its role is taken on by the MAP Sensor.