This month Stu gives you the lowdown on exhaust gas temperature.

I can’t believe it has been a month since I last wrote my Fast feature. Don’t forget, if you have any suggestions for topics you would like to cover in the future, drop us an e-mail.

So, let’s get to it. I’m sure that the majority of you have heard the term EGT, and a smaller proportion of you might know what it means. Rest assured that as from today you will all know more than just what it means. EGT simply stands for exhaust gas temperature and it’s a measurement of just that, the exhaust gas as it leaves the cylinder head and enters into the exhaust system.

What does EGT indicate?

EGT is an indication of how hot the combustion process is in the cylinders. This is directly related to the air/fuel ratio, which is mainly why we use the reading. Knowing the overall EGT is a great indication of the running mixture of the engine at that particular time and makes it easy to see if we are running lean or have issues such as retarded ignition.

Measuring EGT on each cylinder separately can even warn us of things in individual cylinders, such as failing injectors.

Can EGT be used to tune an engine?

EGT is often cited as the best way to tune an engine, but let’s get that statement sorted out right now: it is absolute rubbish. It’s easy to understand why this theory came about.

If you know from experience what sort of EGT any given engine will run when assembled with a known set of components and parameters, you can use it and find at peak power that it made 800 degrees C EGT with intake temps of 50 degrees C and found that as from today you will all know more than just what it means. EGT simply stands for exhaust gas temperature and it’s a measurement of just that, the exhaust gas as it leaves the cylinder head and enters into the exhaust system.

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Having worked as a tuner for 17 years, Stewart ‘Stu’ Sanderson is one of the most respected names in the business. A Level 5-trained fuel-injection technician, in the past Stu has worked for a Ford Rallye Sport dealer, a well-known fuel-injection specialist and various tuning companies.

Then seven years ago, he joined forces with Kenny Walker and opened up Motorsport Developments near Blackpool (01253 508460, www.remapping.co.uk), specialising in engine management live remapping, as well as developing a range of Evolution chips which are now sold all over the world.

He’s also jointly responsible with Webmaster, Petrucci for www.passionford.com. Started in 2003, it’s grown rapidly from a few friends contributing to the biggest Ford communities in the web. His new forum, www.fordrsforums.co.uk, is also up and running.

Stu’s enviable knowledge of the workings of modern-day Ford performance engines means that every month he’s just the man to explain how and why things work, and most importantly how they can be improved.
Excessive exhaust gas temp can cause varying forms of engine damage

and have a very short life span in the presence of race fuel. This is where your EGT gauges score as they don’t care less about such contaminants and will again be monitored utilising existing data collected on a dyno using AFR as a basis for the tune and EGT because of the correct tune.

WHAT FACTORS INFLUENCE EXHAUST GAS TEMPERATURE?

On a petrol engine, the EGT will normally be hottest around stoichiometry and cooler either side of that. If we add fuel at stoichiometry then we can have a high flow, but we cool off the EGT due to excess fuel. If we lean off from stoichiometry we cool down the EGT due to excess air. It’s worth noting that on a diesel engine it is much simpler. The more diesel you add to the combustion, the hotter the EGT gets, but bear in mind that a diesel engine’s EGT getting hotter may not only mean that you have too much diesel, it may simply mean you haven’t enough air, so look at dagged filters etc.

Spark advance also plays a large part in the temperatures seen at the exhaust. When the spark advance is at its optimum position in the cycle, the mixture is fired nice and early in the feeding water and air temperature information to EUCs. This type of device is a very fine wire encased in a sensor body often made of brass for its conductive and anti-corrosion properties.

As the temperature of the unit changes, the electrical resistance of the wire enclosed within it changes. By passing a small current through this wire and measuring the resistance, the temperature can be determined. This system is extremely reliable and accurate, but has a major drawback for us in an exhaust system, it would normally melt and the chances of the electrical connections working for any length of time are slim, and that is before we get into its relatively narrow measurement range.

The alternative is known as a thermocouple. There are several different types of thermocouples, which utilise different materials for different temp ranges, but they all operate on the same principal. A thermocouple consists of two completely different metals welded or fused together. For the temperature range we are most interested in with a car’s exhaust gas temperature the K-type thermocouple is the most suitable. This tends to have a maximum temperature of around 1100 degrees Celsius (approx. 2000 degrees Fahrenheit). The K-type thermocouple, two of the most commonly used metals are chromel and alumel.

A small piece of each of these metals is fused together and then the whole assembly is encased in an electrically insulated sleeve, while the other end of the sensor is connected to an accurate voltmeter. Amazingly, once heated this completely unpowered unit generates its own electrical current, which while only a few millivolts (millivolt = thousandths of a volt), is accurate enough to be related to temperature.

WHERE DO WE MONITOR EGT?
The thermocouple probe is carefully fitted into the exhaust system relatively close to the engine’s exhaust valv. For maximum accuracy you want the tip of the thermocouple to be centred in the exhaust gas stream as it comes out of the engine. It doesn’t matter a great deal where the probe is fitted as long as it’s not too far away from the engine, although it is worth bearing in mind that on a turbocharged car you will get different readings if you fit the thermocouple before the turbo as opposed to after it. This is due to the components and thus lead to inaccurate readings. If you decide to monitor each cylinder individually instead of collectively, make sure each thermocouple is the same distance from the exhaust valves to ensure balanced readings.

WHAT TEMPERATURES ARE WE TALKING ABOUT?

This will vary from one engine to the next as it depends on many factors. As a rule of thumb I like to see the exhaust gas temperature maintained at no higher than 850 degrees Celsius when a petrol engine is held flat out, and a max of 700 degrees Celsius on diesel. Counterpart due to the somewhat weaker turbine materials generally used. Less is better if your AFR etc doesn’t have to be too rich to achieve it, just don’t forget that the turbine response will suffer if you go too low on a turbocharged engine.

WHAT HAPPENS IF THE EGT GOES TOO HIGH?

Excessive EGT can cause varying forms of engine damage and to be more specific we would have to talk about individual engines. However, you can expect that the turbocharger will be one of the first items to fail on a turbocharged motor, as the turbine blade edges will start to break away as
they are thinnest and weakest parts. Excessive EGT will also often crack the turbine housing and wastegate area. If the turbo doesn’t fail first, then excessive sustained EGT can damage the engine internals too. Damage can include exhaust valves, cylinder heads and even piston deformation. Melting, burning, holes and cracking of pistons are all common symptoms of excessive EGT.

It’s worth noting that the damage is almost always cumulative, so if you slightly burn a piston top the engine may continue to run without problems but the next time you run excessive EGT more damage may be done, and so on, until failure occurs. Piston failure is usually catastrophic and extremely expensive to rectify.

WAYS TO CONTROL EGT
In the main, EGT can only be controlled by adding more fuel or spark advance, although changes to the EGT can be made by altering engine components, maybe to cut down on exhaust restriction by fitting a bigger turbine housing for instance. These are dramatic engine characteristic altering changes, and really only fuel and spark advance revisions will make the difference you need if your engine is running too hot. Remember, going too cool on a turbocharged engine will affect engine response and performance as your turbocharger is powered by heat, so response can be badly affected by too much cooling of the EGT. It’s all about balance...

THERMAL MANAGEMENT
It may interest you to know that modern vehicles, most notably German ones, now have K-type thermocouples as standard feeding the ECU with EGT information, allowing it to tune the AFR and spark lead to suit the running conditions. This means we no longer have to map modern cars rich at top end to ensure safe EGTS as the modern ECU has the capability to richen it up when required all on its own. So that’s exhaust gas temps in a nutshell. I hope you found it interesting and will join me next month when I look at the differences between high and low compression, and which one you should choose for your engine.