LOTUS EXIGE 270E TRI-FUEL

(Old Link: http://www.lotuscars.com/ENGINEERING/LOTUS-EXIGE-270E-TRI-FUEL)

The Exige 270E Tri-fuel is part of Lotus' research to understand the complex combustion process involved in running on mixtures of alcohol fuels and gasoline, which will be important for a successful transition from today's fuels to the sustainable, synthetic fuels of the future.

Engine

The heart of the Exige 270E Tri-fuel is a Roots-type supercharger (with a sealed-for-life internal mechanism meaning that it does not require the use of the engine's oil) and air to air intercooler attached to the tried and tested 4-cylinder, 1.8 litre 2ZZ-GE VVTL-i engine. Using a development of the supercharger and intercooler package from the Exige S, the Exige 270E has peak power of 270 HP (201 kW) at 8,000 RPM, 184 lb/ft (260 Nm) of torque (at 5,500 RPM) up by 51 HP (38 kW) or 19% and 25 lb/ft (45 Nm) or 21% over the standard gasoline Exige S. Maximum engine speed is 8,000 RPM (8,500 RPM transient for up to 2 seconds).

ALCOHOL FUELS

The low carbon number alcohol fuels methanol and ethanol give more power when burned in the engine than conventional gasoline (petrol) fuel. The performance benefits come largely from the high heats of vaporization of methanol and ethanol, which give strong charge-cooling effects, and the increased octane ratings. There are other secondary thermodynamic effects. Methanol's higher heat of vaporization leads to a slightly higher performance relative to ethanol.

The roof scoop ensures that the air-to-air intercooler works as efficiently and effectively as possible in all climates and environments. All charge air ducting has been kept as short as possible with large diameter pipes making sure that the bends in these ducts are not too tight, to the benefit of throttle response and efficiency. The Roots-type Eaton M62

supercharger is run from the crankshaft, and has an integral bypass valve for part load operation. The 2ZZ VVTL-i engine has two cam profiles a high speed cam and a low speed cam.

The seamless switch point between these two cams is completely variable depending upon driving conditions and engine load. This gives the Lotus Exige 270E Tri-fuel a smooth and linear surge of power from idle speeds all the way to the maximum 8,500 RPM. An electronic drive-by-wire throttle ensures the quickest engine response possible whilst keeping the emissions as clean and as low as possible, to meet relevant legislative demands. Six fuel injectors have been fitted to increase fuel flow to the engine at normal and higher engine speeds and loads.

SUSTAINABLE ALCOHOL FUELS

Methanol (CH_3OH) can be produced synthetically from CO_2 and hydrogen. Ultimately, emerging processes to recover atmospheric CO_2 will provide the required carbon that can entirely balance the CO_2 emissions at the tailpipe that result from the internal combustion of synthetic methanol. The result is that a car running on synthetic methanol, such as the Exige 270E Tri-fuel would be environmentally neutral.

As well as being green, the great benefit of synthetic methanol is that it would use similar engines and fuel systems to those in current cars; and synthetic methanol can be stored, transported and retailed in much the same way as today's liquid fuels such as petrol, gasoline and diesel.

Synthetic methanol also possesses properties better suited to internal combustion than today's liquid fuels, giving improved performance and thermal efficiencies. And it is ideal for pressure-charging turbos and superchargers already being introduced by manufacturers to downsize engines in a bid to reduce emissions and vehicle weight.

Lotus Engineering's Lotus Exige 270E Tri-fuel technology demonstrator illustrates how easy it is for synthetic methanol to be embraced over time as a future fuel for road transport.

Synthetic methanol's green credentials arise from its potential to be CO_2 completely neutral. The most likely future mass-production of the fuel is by using electrochemical techniques to combine oxygen, hydrogen and carbon:

Carbon could be sourced from carbon dioxide recovered from the atmosphere using either large scale extraction facilities or biomass.Oxygen would be taken from the atmosphere and Hydrogen would be acquired through the electrolysis of water; challenges remain in the electrical power required; in a green future, this could be

supplied from renewable sources, an issue already being addressed by supporters of hydrogen as a fuel

Techniques for the production of synthetic methanol are well developed and understood, although not yet at an industrial scale. An early solution would be the co-location of a nuclear or hydroelectric powerplant with a conventional power station the hydrogen generated by hydrolysis of water would be combined with CO_2 from either fossil or biomass sources to make liquid methanol. In the future, large volumes of CO_2 could be extracted from the atmosphere.

ENGINE MODIFICATIONS

As well as being green, another crucial advantage of synthetic methanol is that it can be introduced relatively simply. As the Exige 270E Tri-Fuel demonstrates, only small changes to engines are required, such as:

- Sensors to detect alcohol content
- Slightly modified software for engine management controls/ECUs over ethanol/gasoline and flex fuel
- Fuel lines compatible with alcohol
- Higher flow rate fuel pump and injectors
- Fuel tank material, compatible with alcohol

In addition, as a liquid, synthetic methanol can be transported, stored and sold to motorists exactly as today's liquid fuels are, with only minor modifications.

Synthetic methanol is better suited to spark-ignition combustion than today's liquid fuels, delivering better performance and thermal efficiencies, due to its higher octane rating and better resistance to 'knock'. As a result, it is a fuel that will benefit the motorists in terms of driving experience. For example, the Exige 270E Tri-fuel is quicker to 60 MPH from standstill and has a higher top speed when using 100% synthetic methanol fuel than with conventional petrol/gasoline. Synthetic methanol is also ideally suited to pressure charging, a trend already well underway as car makers look to downsize engines to cut emissions.

TOWARDS CARBON NEUTRAL DRIVING

Lotus Engineering regards sustainable alcohols as the third step in a process towards carbon neutral driving. The current E85 (85% ethanol and 15% petrol/gasoline) based movement represents the first stage in building momentum towards sustainable fuels. The valuable learning from the current bio-ethanol vehicles on the market means that synthetic methanol would be managed technically and within the existing transport, storage and distribution infrastructure.

1st Generation

There is a handful of current bio-ethanol models on sale around the world. These cars run on E85 bioethanol, which is produced from valuable arable crops (food). This is unsustainable in the short and medium term as global demand for fuel will outstrip the supply available from farmland to the detriment of food production.

2nd Generation

The next generation bioethanol fuels will be based on biomass waste, for example crop stubble, waste vegetable-based oils and any biodegradable waste matter. This is thought also to be unsustainable in the medium to long term as the required volume of biomass increases beyond that which can be supplied.

3rd Generation

Sustainable alcohols such as synthetic methanol that can be produced from entirely sustainable, readily available inputs, with an environmentally neutral overall impact.

4th Generation

Direct Methanol Fuel Cells: over the longer term, sustainable alcohols in internal combustion will facilitate the soft introduction of direct methanol fuel cells as a long-term sustainable future fuel.
Lotus Engineering believes governments, fuel suppliers and car manufacturers have a key role to play in the adoption of sustainable alcohols as a future green fuel.

LOTUS EXIGE 265 BIO-FUEL

The 265E started off as a production specification Exige S. It then underwent a series of modifications to allow it to run on the E85 fuel.

Four enlarged fuel injectors have been fitted to increase fuel flow into the engine under normal operating conditions. Two additional fuel injectors have been fitted at the supercharger inlet to increase the amount of fuel being injected into the engine under higher engine speeds and loads. This has also enabled the engineering project team to take advantage of ethanol's higher cooling effect to further cool the charge air prior to combustion, which in turn reduces the amount of power required to operate the supercharger.

The Lotus T4e Engine Management System then had to be calibrated to optimise engine performance when running on various mixes of the high-octane bioethanol fuel and gasoline. The re-calibrated EMS coupled with an ethanol sensor in the fuel system provides true flex-fuel capability.