Running on liquid gold?

Forced by changing regulations to consider an alternative method of powering its Ford-based BTCC cars to keep them competitive, Mountune turned to LPG

BY SAM COLLINS

Alternative fuels are often used as a marketing ploy, something to get a sponsor onboard or to get extra media exposure. It is rare for them to be employed for purely performance reasons, but that's exactly what Mountune has done with its new British Touring Car engine, as fitted to the Ford Focus of Arena Motorsport.

For 2010 the British Touring Car Championship (BTCC) has introduced a new, spec 2.0-litre turbocharged engine as part of its NGTC regulations (more on that next month). 'It became apparent that with the new TOCA NGTC engine coming out, there was no way we would get any Ford support fitting that engine,' explains Dave Mountain, founder of the Essex, England-based engine builder. 'The Ford support is technical not financial, so there was no way forward. We couldn't stay where we were because we probably wouldn't have been competitive.'

> **everyone was very nervous about the safety aspect**

The turbocharged NGTC engine could, in principal, have better torque than the normally aspirated Super 2000-spec engines used in 2009, and those of teams opting against the new engine for 2010 (series organiser, TOCA, will not allow other petrol turbocharged engines until next year).

However, Liquefied Petroleum Gas (LPG) gave Mountune the way forward it was looking for. 'We worked with TOCA and he formulated the regs. We run the same boost limit (0.8bar) and rpm limit (7000rpm) as the NGTC,' reveals Mountain.

Using LPG fuel was nothing new for Mountune's engineers, as the company has worked with it before on a range of corporate experience and driver development cars used by Palmersport at Bedford Autodrome. It therefore already knew that with LPG-fuelled cars weight is an issue, due to the fuel cell requirements. Although LPG has a high octane rating, it does not have the same calorific value as petrol, so more fuel is required, therefore increasing the tank size. The tank in the Aon Focus, for example, weighs in at 30kg, making the car around 20kg overweight. 'The tanks have to be pressurised to over 30bar and signed off to a standard, so they are massively over engineered,' explained Mountain. 'We obviously want to get as much weight out [of the car] as possible, but everyone was very nervous about the safety aspect and that is something you have to be aware of. You also have issues like valve seat recession and piston bore wear, because it [LPG] does not have the lubrication properties of petrol. Some people have separate systems, which effectively drop oil into the combustion chambers, but in a racing engine you are only going to do 5000 miles so it is not a problem.

The difference between 'normal' LPG-fuelled engines and this one is that the charge is injected in as a liquid, not a gas. To maximise the advantages this process offered, Mountune added an extra set of injectors. These are sited in a remote injector block

'But on the Palmersport cars we have seen those engines that have done 20-30,000 miles, so you can end up wearing your valve seats out, losing your tappet clearances and then losing compression.'

Whilst Mountune built the Arena Ford engines in 2009, the 2010 spec engines are very different. 'What helped us turn it round so quickly last year when we joined the programme mid-season was the work we did on the S2000 rally engine (see RE V17N6). The big mistake with that project though was that the car just didn't have the mid-range torque, and for rally cars you want good mid-range performance to propel the car out of corners. The work we have done with turbo rally engines though meant we could get LPG working well with the turbocharger fairly quickly. So the only real learning curve we had was the LPG liquid system, which we had never run before. Once we got over the early problems, it has been very good.'

LIQUID INJECTION

The Touring Car engine has a significant difference to the Palmersport units in that it has a liquid injection system, whilst the Bedford cars have gas injection. 'It is very efficient when the liquid turns to gas as there is a big cooling effect. It also simplifies the system as you don't need an evaporator, which is quite a big, heavy thing,' reasons Mountain. 'We started off with the injectors fairly close to the inlet port as it evaporates pretty much straight away but, because it was so close to the cylinder head, we think we were getting part-liquid, part-gas going into the cylinders. We were getting a very strange pick-up problem around the top ring, which is unusual, and we think it was a super cooling effect. It's unusual because it was the opposite of what you usually get. So we gave it more time to evaporate and that seems to have cured the problem.'

> **It is very efficient when the liquid turns to gas as there is a big cooling effect**

The cylinder head is therefore fitted with two injectors per cylinder to get sufficient fuel to the combustion chamber. 'We were pushing the boundaries in injecting liquid. To us it looked like a technical advantage and we wanted to go that way. It was a big risk, but I am sure now it has been the right decision. The injectors actually run remote from the manifold, then there is a short pipe that comes from the injector to the plenum. We have in fact placed that injector block in front of the radiator so it gets some warm air to prevent these

Lawrence Butcher

After a few early teething problems were sorted, the LPG cars proved faster than the petrol cars on the straights

TECH SPEC

BTCC FORD FOCUS

Engine: 2.0-litre Ford Duratec, built and prepared by Mountune Racing

Power: 300+bhp at 7000rpm

Torque: 300+Nm

Bore: 87.5mm

Stroke: 83.1mm

Turbo: Garrett GT28 roller bearing

Valves: 35mm inlet 30mm exhaust 5.5mm stem diameter

problems. You have to be careful and we have tried to get some hot air over the system. The injectors are side fed because if you use an end-feed injector the needle struggles to open and shut and control the fuel as the pressures are quite high. Also you have to try not to put too much heat into the liquid through the injector.'

As you might expect, starting the engine is not as straightforward as with the petrol units,' as Mountain explains: 'With road car conversions you usually have a system where you start the cars on petrol and then switch over to gas. That's because LPG doesn't ignite at very cold temperatures. With racing we don't need that, but when you listen to the racecars they don't fire up instantly, even though they are pre-heated. You have to crank them and crank them and eventually they fire.'

TECHNICAL PARTNERS

Mountune and Arena had a number of partners and official suppliers on the Ford project, including Prins, Calor and Millers Oils. The fuel injection system was supplied by one of those partners, Prins. 'It is a marketing and technical project for them,' explains Mountain. 'Calor have been brilliant because, from our point of view, we are geared up to fuel up with petrol, so Calor have put up all the pumps and procedures. Whilst it is a standard fuel we use, they make sure it is as purified as it can be. For standard road usage, it is 95 per cent pure, and we are running at 98 per cent. Refuelling the car at the moment is a case of dropping the tank, filling it up on a set of scales so they can see how much is going in and then re-fitting the tank to the car.'

With LPG fuel there are a number of further considerations beyond refuelling and supply, as Mountain explains: 'Combustion temperatures tend to be a bit lower because of the cooling effect you get when it evaporates. It is almost like having a big intercooler. The exhaust temperatures seem to be that little bit lower too, compared to what we were seeing on petrol. The heat transfer is still similar though. We haven't been testing in any high ambient temperatures, so we haven't been able to prove whether we can run a smaller radiator yet. Logically, we should be able to, but what we don't want to be is marginal on cooling. One of the problems is that we have had to homologate a lot of this stuff and we have not done a lot of testing. Now there are some jokers that can be applied for, so if there is something we find that can be an advantage we can do it.'

> **"we were quite conservative... what we wanted was reliability"**

The engine's components, like most Touring Car and GT projects, lie somewhere between tuned OE and purpose built racing engine. 'The cylinder block is production. As the boost levels are fairly low we can run with it. They are only about 1.8bar absolute, so 0.8 bar of boost,' continues Mountain. 'But con rods, pistons, crankshaft, all of that has changed. For the first time as a company we are using CP pistons. We were up against it and they seemed to be out to impress us and made some pistons very quickly. The rods are Arrow [Precision], as is the crank. Because we were quite conservative, it is rock solid. Possibly we could have saved a few grams off the crank and rods, but what we wanted was reliability. It is a low revving engine, it only sees 7000rpm, so there is not a lot to be gained out of taking any big risks.

The valve size is totally standard, but the material is obviously improved. The head is fully ported but, unlike the naturally aspirated engines, we don't do big ports, we just do some work around the bowl area and the valve seat to tidy it up. Being forced induction you don't need to run hulking great ports. The port diameter remains standard, so you get good air speed and driveability. We use Supertech valves and they hold an awful lot of Duratec stuff on the shelves. We have really struggled in the UK to get a really good valve supplier. Then we use Kaufmann springs, which are a very expensive spring, but you just fit them and forget about them. The camshaft is designed by us and ground by Piper, but is nothing really radical. The valve lift is limited to 11mm by the regs and, being a turbocharged engine, you can run pretty short periods, as we are doing. It is conservative. The real learning curve was getting the LPG to work properly. To begin with we thought were in for some serious trouble, but it worked out well.'

In fact, it possibly worked out too well as, following the pre-season group test at Brands Hatch, some teams complained that the LPG fuel gave the Arena cars an advantage as they were clearly quickest down the straights. For the minute it seems the team may have found an advantage, but it remains to be seen how long this lasts and whether TOCA will decide to further restrict the LPG cars as this season progresses.