NEW FIAT ENGINE TECHNOLOGY WILL CUT FUEL BILLS BY 25 PER CENT

Already a leader in advanced diesel technology, Fiat has launched 'Multiair' a fundamental breakthrough in petrol engine design that will cut fuel consumption by up to 25 per cent, as well as boosting power and torque, cutting carbon dioxide emissions by up to ten per cent and up to a 60 per cent reduction in other engine pollutants.

With two generations of its common rail, direct injection diesel engine technology, Unijet and Multijet, for which it owns the patents having invented this technology, Fiat dramatically improved diesel engine performance, economy and emissions. With Multiair, Fiat has brought together expertise and technology from right across the company, not just in normal research and development, but also the Ferrari Formula One Team to make one of the single largest leaps forward in petrol engine design since the car was invented.

The Multiair Technology benefits for petrol engines are as follows:

* Maximum Power is increased by up to 10 per cent thanks to the adoption of a power-oriented mechanical cam profile.

* Low engine speed Torque is improved by up to 15 per cent through early intake valve closing strategies that maximize the air mass trapped in the cylinders.

* Elimination of pumping losses brings a 10 per cent reduction of Fuel Consumption and CO2 emissions, both in Naturally Aspirated and Turbocharged engines with the same displacement.

* Multiair Turbocharged and downsized engines can achieve up to 25 per cent Fuel Economy improvement over conventional Naturally Aspirated engines with the same level of performance

* Optimum valve control strategies during engine warm-up and internal Exhaust Gas Recirculation, realized by reopening the intake valves during the exhaust stroke, result in emissions reduction ranging from 40 per cent for unburnt hydrocarbons and carbon monoxide and up to a 60 per cent cut in oxides of Nitrogen.

* Constant upstream air pressure, atmospheric for Naturally Aspirated and higher for Turbocharged engines, together with the extremely fast air mass control,

cylinder-by-cylinder and stroke-by-stroke, result in a superior dynamic engine response.

* Using technology already in use of millions of diesel engines ensures built in reliability and fail-safe designs.

* As well as petrol, can also be used on LPG and hydrogen fuel.

* Can also be adapted for diesel engines to reduce their NOx emissions and make particulate filters significantly more effective.

In short, an engine with Fiat Multiair is quicker, more responsive across the entire engine speed range, uses considerably less fuel, cuts vehicle weight and reduces all types of exhaust emissions by a substantial amount. It will also enable Fiat to maintain its edge in low emissions and low fuel consumption technology, which has seen Fiat crowned for the past two years as the number one car maker for the lowest range wide CO2 emissions and which enables it offer the car with the lowest fuel consumption for sale in Australia.

The first new engine to be equipped with Multiair will be the 1.0 and 1.4 litre family of engines and the first car to see the new engine installed will be the Alfa Romeo Mito at the end of 2009, with a possible Australian and New Zealand launch in late 2010. Its second application will be a new two cylinder engine that will be used in an as yet unlaunched model which could provide the fuel consumption and emissions of a hybrid for a fraction of the cost. This two cylinder engine could also provide the basis for a new hybrid engine system for larger vehicles. A Multiair diesel engine family is also under development.

As with Fiat's Unijet diesel system, which is licensed to other car makers for their own engines, Fiat plans to license Multijet, which cost the company more than Euro 100 million and three years to develop, to enable other car makers to benefit from Fiat's technical expertise.

The Development of the Fiat Multiair system

In the last decade, the development of the Common Rail technology for Diesel engines marked a breakthrough in the passenger car market. To be competitive also in the field of gasoline engines, Fiat Group decided to follow the same approach and focus on breakthrough technologies.

The aim was to provide customers with substantial benefits in terms of fuel economy and fun-to-drive while maintaining the engine intrinsic comfort characteristics, based on a smooth combustion process and on light structures and components.

The key parameter to control Diesel engine combustion and therefore performance, emissions and fuel consumption is the quantity and characteristics of the fuel injected into cylinders. That is the reason why the Common Rail electronic Diesel fuel injection system was such a fundamental breakthrough in Direct Injection Diesel engine technology.

The key parameter to control gasoline engine combustion, and therefore performance, emissions and fuel consumption is the quantity and characteristics of the fresh air charge in the cylinders. In conventional gasoline engines the air mass trapped in the cylinders is controlled by keeping the intake valves opening constant and adjusting upstream pressure through a throttle valve. One of the drawbacks of this simple conventional mechanical control is that the engine wastes about 10% of the input energy in pumping the air charge from a lower intake pressure to the atmospheric exhaust pressure.

A fundamental breakthrough in air mass control, and therefore in gasoline engine technology, is based on direct air charge metering at the cylinder inlet ports by means of an advanced electronic actuation and control of the intake valves, while maintaining a constant natural upstream pressure.

Research on this key technology started in the 80's, when engine electronic control technologies reached the stage of mature technologies.

At the beginning world-wide research efforts were focused on the electromagnetic actuation concept, following which valve opening and closing is obtained by alternatively energizing upper and lower magnets with an armature connected to the valve. This actuating principle had the intrinsic appeal of maximum flexibility and dynamic response in valve control, but despite a decade of significant development efforts the main drawbacks of the concept - its being intrinsically not fail-safe and its high energy absorption - could not be fully overcome.

At this point most automotive companies fell back on the development of the simpler, robust and well-known electromechanical concepts, based on the valve lift variation through dedicated mechanisms, usually combined with cam phasers to allow control of both valve lift and phase.

The main limitation of these systems is low flexibility in valve opening schedules and a much lower dynamic response; for example all the cylinders of an engine bank are actuated simultaneously thereby excluding any cylinder selective actions. Many similar electromechanical valve control systems were then introduced over the past decade.

In the mid 90's Fiat Group research efforts switched to electro-hydraulic actuation, leveraging on the know-how gained during the Common Rail development. The goal was to reach the desired flexibility of valve opening schedule air mass control on a cylinder-by-cylinder and stroke-by-stroke basis.

The electro-hydraulic variable valve actuation technology developed by Fiat was selected for its relative simplicity, low power requirements, intrinsic fail safe nature and low cost potential.

The Fiat Multiair Technology: how it works

The operating principle of the system, applied to intake valves, is the following: a piston, moved by a mechanical intake cam, is connected to the intake valve through a hydraulic chamber, which is controlled by a normally open on/off Solenoid Valve.

When the Solenoid Valve is closed, the oil in the hydraulic chamber behaves like a solid body and transmits to the intake valves the lift schedule imposed by the mechanical intake cam.

When the solenoid valve is open, the hydraulic chamber and the intake valves are de-coupled; the intake valves do not follow the intake cam anymore and close under the valve spring action.

The final part of the valve closing stroke is controlled by a dedicated hydraulic brake, to ensure a soft and regular landing phase in any engine operating conditions.

Through Solenoid Valve opening and closing time control, a wide range of optimum intake valve opening schedules can be easily obtained.

For maximum power, the Solenoid Valve is always closed and full valve opening is achieved following completely the mechanical cam, which was specifically designed to maximize power at high engine speed (long opening time).

For low-rpm Torque, the Solenoid Valve is opened near the end of the cam profile, leading to early intake valve closing. This eliminates unwanted backflow into the manifold and maximizes the air mass trapped in the cylinders.

In engine part load, the Solenoid Valve is opened earlier causing partial valve openings to control the trapped air mass as a function of the required torque. Alternatively the intake valves can be partially opened by closing the Solenoid Valve once the mechanical cam action has already started. In this case the air stream into the cylinder is faster and results in higher in-cylinder turbulence.

The last two actuation modes can be combined in the same intake stroke, generating a so-called "Multilift" mode, that enhances turbulence and combustion rate at very low loads.

Further Potential of the Multiair Technology

All breakthrough technologies open a new world of further potential benefits, which are usually not fully exploited in the first generation, in order to minimize industrial risk.

The Common Rail technology, a Fiat worldwide premiere in 1997, paved the way to more than a decade of further technological evolutions such as "Multijet" for multiple injections, Small Diesel Engines and the very recent Modular Injection technology, soon to be launched on the market.

Similarly, the Multiair technology, a Fiat worldwide premiere in 2009, will pave the way to a wave of further technological evolutions for gasoline engines:

* Integration of the Multiair Direct air mass control with Direct gasoline Injection to further improve transient response and fuel economy.

* Introduction of more advanced multiple valve opening strategies to further reduce emissions.

* Innovative engine-Turbocharger matching to control trapped air mass through combination of optimum boost pressure and valve opening strategies.

While electronic gasoline fuel injection developed in the 70's and Common Rail developed in the 90's were fuel specific breakthrough technologies, the Multiair Electronic Valve Control technology can be applied to all internal combustion engines whatever fuel they burn.

Multiair, initially developed for Spark Ignition engines burning light fuel ranging from gasoline to Natural Gas and hydrogen, has wide potential also for Diesel engine emissions reduction.

Intrinsic NOx reduction of up to 60% can be obtained by internal Exhaust Gas Recirculation (iEGR) realized with intake valves reopening during the exhaust stroke, while optimal valve control strategies during cold start and warm-up bring up to 40% HC and CO reduction of emissions. Further substantial reduction comes from the more efficient management and regeneration of the Diesel Particulate Filter and NOx Storage Catalyst, thanks to the highly dynamic air mass flow control during transient engine operation.

Diesel engine performance improvement is similar to that of the gasoline engine and is based on the same physical principles. Instead, fuel consumption benefits are limited to few percentage points because of the low pumping losses of Diesel engines, one of the reasons of their superior fuel economy.

In the future, powertrain technical evolution might benefit from a progressive unification of gasoline and Diesel engines architectures.

A Multiair engine cylinder head can be therefore conceived and developed, where both combustion systems can be fully optimized without compromises. Moreover the Multiair electro-hydraulic actuator is physically the same, with minor machining differences, while internal subcomponents are all carry over from the Fire and SGE applications.