Introducing the HPi Petrol Engine

While we've been waiting patiently for the automotive engineering community to perfect the likes of Flubber, Cold Fusion and Anti-Matter containment, Citroën has recently revealed an all new High Pressure Injection (HPi) petrol engine that will power their company into future, and hopefully the North American market.

Designed and developed in just 121 weeks with a total investment budget of $60M, the new 2.0 liter HPi engine is the first direct injection petrol engine produced by a European car maker and it will be manufactured at the rate of 200 units a day.

The kissing-cousin to this engine is the diesel HDi introduced in late 1998 whose fuel delivery system operates under much the same principal as the HPi. Development of the HDi, required an effort of 156 weeks and an investment of $430M, so it is readily apparent that much of the R&D money from that project was recycled into the HPi.

The next generation Xantia and Xsara will be powered by the new power plant and will enjoy several benefits including fuel consumption savings of **19 to 21%** when compared to the current 2.0 liter engine while at the same time enjoying a 9.6% boost in torque.

At a capacity of 1,998cc, the HPi engine develops a power output of 143bhp and 125ft-lbs of torque at 2000rpm which makes for a flexible, easy to drive power plant.

The new engine also receives kudos for lowered emissions that meets not only the Euro3 clean air rules due for launch in 2001, the new HPi engine also meets the even tougher Euro4 rules set for launch in 2005.

To achieve these targets, Citroën formed a strategic alliance with Mitsubishi Motors to design the HPi engine using the most advanced technology available today: ***lean burn stratified charge direct fuel injection.*** This involves introducing the fuel/air mixture as close as possible to the spark plug and then filling the rest of the combustion chamber with air. This requires a remarkably high level of precision in injecting the fuel to match engine speed and demands.

As if this was not technically difficult enough, the engine runs in this lean

burn mode up to 3500 rpm, the speeds used in urban driving, and above this engine speed it switches to normal stoichiometric mode, for performance driving. It should be noted that from the top of the block on down (not counting the pistons) the HDi engine is identical to it's EW type indirect-injection predecessor.

The high-pressure pump for the HPi engine is totally new and is based on an unique concept developed through a joint venture with Siemens. The pump is a two-stage design where the first level consists of a hydraulic pump placed in an oil-bath and the second level corresponds to the distribution of high pressure petrol and then returning the excess.

Compared to existing technologies, this design offers the following benefits:

1) All mechanical parts in motion are in oil, without contact with the petrol thus ensuring a high service life and a good operation at high pressure that makes it possible to use standard materials.

2) Pumping is performed by three pistons that are driven by an inclined rotating plate. This plate is placed on a hydrostatic bearing and driven by the camshaft. This provision limits the internal friction and the driving torque.

3) The axial piston layout selected made it possible to design the most compact and lightest pump on the market. With a weight of 900 grams, it is twice as light as existing pumps.

The pump supplies injection pressures between 435 and 1,450psi, compared to 50psi in a normal petrol fuel injection pump. This high pressure combined with the stratified charge, and a piston designed with an off center bowl and a unique intake plenum (Citroën calls it the "deviated jet combustion chamber") enables significantly less fuel to be used for combustion and thereby lead to fuel savings.

Utilizing an air/fuel mixture of 30:1 (compared to 12:1 in a conventional engine) the HPi lean burn engine does leave considerably more oxygen in the exhaust gas and to prevent the release of excessive amounts of nitrogen oxides (NOx), Citroën has developed a sequential NOx treatment system based on the storage-release principle. Exhaust gases pass into a chamber filled with salt derived from a Barium alkaline-earthy metal that has a specific chemical affinity for nitrogen oxides then collects, stores and chemically interacts with NOx fumes as well as carbon monoxide (CO) and unburned hydrocarbons (HC) to be later purged as Nitrogen (N_2) during a cleaning cycle which is performed by the engine management system for three seconds during every minute of operation, and is transparent to the driver.

Another concern is sulfur content in our fuels, both petrol and diesel. Sulfur can combine in the combustion process into sulfur dioxide (SO_2) which will degrade the efficiency and life of the Barium chambers. Levels of 150ppm are now common, with hopes that this number will decline to 10ppm in the near future. Japan has already achieved this low level which allows them to tune ***ultra-lean*** burn engines to 50:1 air/fuel mixtures.

So exactly how low are the emissions? The HPi engine tests out at 0.5 CO / 0.075 HC / 0.06 NOx which is good news indeed for our planet.

The HPi engine will be produced in the same facility as the HDi at Trémery (Moselle) in Eastern France. A new production area was designed for the HPi cylinder heads which required an investment of $40M to include 48 digital high-speed machining centers. 60 workers in three shifts per day will produce 1,400 HPi heads per day.