



## Euro 4 – Euro 5 SCR versus EGR



The race to protect the environment has been underway for some years now. In the transport sector, it has centered mainly on the reduction of nitrogen oxide emissions (NO<sub>x</sub>) from heavy goods vehicle exhausts. This reduction is the subject of an evolving standard: the Euro standard. In order to meet the Euro 4 standard and soon the even more stringent Euro 5 standard, the manufacturers have a choice between two forms of technology: SCR (Selective Catalytic Reduction) or EGR (Exhaust Gas Recirculation), two techniques that work in completely different ways.

### BACKGROUND

Since 1988, emissions of pollutants from heavy goods vehicles with a total authorised weight of over 3.5 tons have been subject to increasingly demanding European directives introducing the Euro standards. An insight into the severity of the standards can be obtained by considering the fact that Standard 0 fixed the maximum rate of NO<sub>x</sub> at 14.4 g/kWh, whereas the Euro 4 standard (compulsory from 1 October 2006) sets this rate at 3.5 g/kWh. The Euro 5 standard, meanwhile, envisages a rate of 2.0 g/kWh. The standards currently in force have enabled the reduction of polluting emissions from HGVs to be reduced by around 70% in relation to Euro Standard 0, and Euro 4 will permit a further reduction in these emissions of approximately 30%. In order to meet this Euro 4 standard, the generalised installation of particle filters on all vehicles is essential, while the Euro 5 standard (compulsory from 1 October 2009) will impose the use of a Nox catalytic converter.

### CURRENT SITUATION

In order to comply with the Euro 4 standard, the manufacturers have looked into various possibilities, two of which stand out: SCR which stands for Selective Catalytic Reduction, and EGR, or Exhaust Gas Recirculation.

The first solution (SCR) consists of the reprocessing of exhaust gases with a urea resin called AdBlue. This intake of urea into the exhaust system permits the conversion of approximately 85% of the nitrogen oxide into water vapour and harmless nitrogen. The AdBlue is stored in a special tank added onto the vehicle's fuel tank.

The second technique (EGR) is based on cooling part of the exhaust gas before reintroducing it into the engine with the intake air in order to obtain a lower combustion temperature. This reduces nitrogen oxide emissions, while the higher injection pressure produces less harmful particles.



## The pros and cons

As one might expect, both techniques have their advantages and disadvantages.

The advocates of SCR have no shortage of arguments in their favour. Firstly, they point to a reduction in consumption compared with Euro 3 and also with vehicles using EGR technology (something which is denied by the EGR camp). They also highlight the simplicity of the system and the possibilities for subsequent development, and therefore the ability to respond to even more stringent future standards. It is also worth noting that the SCR technique has no impact on maintenance and oil change intervals are unchanged.

Of the disadvantages, the most obvious is the obligation to mount an extra tank on the vehicle. The weight of any such tank would reduce the vehicle's payload accordingly and could complicate the bodywork assembly. In addition, the driver will need to top up the tank, just as he currently does for the fuel. Where supplies are concerned, while the number of service stations offering AdBlue is growing, the network is still far from widespread. And lastly, urea has a tendency to harden at low temperatures [- 11°C].

As for EGR, its supporters put forward the persuasive argument that its use changes nothing for either the haulier or the driver. Other advantages include the absence of additional equipment (additive tank), the lack of any need for subsequent processing of additives, no reduction in payload, and no added inconvenience for the driver. In this case also, there is no impact on maintenance regimes, but the technique does have a few disadvantages. Most notably, any fall in the combustion temperature directly affects the performance of the engine. In addition, the much greater concentration within the engine of the recycled gases in particular can result in the pollution of the lubricating oil, which in turn necessitates an increase in the capacity of this oil to disperse particles, which are processed downstream of the engine courtesy of a filter in the exhaust silencer.

## The supply of AdBlue

Looking at the choices of Europe's 7 leading HGV manufacturers, the SCR technique is clearly gaining ground. DAF, Iveco, Mercedes-Benz, Renault Trucks and Volvo Trucks have all either totally or primarily opted for SCR technology. It should be noted, however, that Iveco is using EGR for the Daily. Scania, meanwhile, is offering both systems: EGR for 420 hp vehicles and SCR for Euro 5 and V8 vehicles, but the aim is to offer customers a full Euro 5 range equipped with EGR, including the V8s. But of the 7 main HGV manufacturers, the strongest advocate of EGR technology is MAN, although for customers wishing to switch to the Euro 5 early, the German firm is planning the MAN AdBlue system for 2006 on 400 and 436 hp engines in the TGA range.

So what about refuelling with AdBlue? Three "networks" are currently under development:

- the additive manufacturers are setting up a system of direct distribution to the fleets,
- the petrol retailers, supplied by the manufacturers, are putting in place their own network. Stations are already up and running in Germany and others are opening in numerous locations. Further development plans are currently underway...
- HGV manufacturers like Iveco and Volvo are setting up their own distribution circuits via their dealership networks. For the Italian manufacturer, this set-up will take place



in collaboration with an international partner. Courtesy of 113 operational distribution centres around Europe in 2006, Iveco will undertake to supply the product within 48 hours. Three different forms of packaging will be provided: 10-litre nonreturnable containers, 1,000-litre returnable containers (IBC) and 10,000-litre bulk containers (MiniBulk).

There are already several producers of AdBlue present on the market, most notably Yara (linked to Total), Univar and GreenChem. And the networks are taking shape. Yara, for example, has just reached an agreement with Brenntag (one of the world's top distributors of chemical products) for the distribution of AdBlue throughout Europe. Univar and GreenChem are expected to follow suit.

## PROSPECTS

Possessing the technical capacity to meet the Euro standards is good, but controlling compliance with these standards is even better. Consequently, Euro 4 vehicles circulating after 1 October 2006 (1<sup>st</sup> October 2005 for new registrations) must be fitted with a diagnostic system (On Board Diagnostic) for the functioning of the exhaust reduction system. In the case of SCR, the driver will be alerted by means of an LED indicator when the level of AdBlue falls below a certain threshold, while the "faulty engine operation" danger indicator will be illuminated when the tank is empty.

With a 1-year delay in relation to the application dates of the 1<sup>st</sup> stage (1 October 2006 for new type approvals, 1 October 2007 for new registrations of existing types), all Euro 4 vehicles (SCR or EGR) must be equipped with a system "facilitating compliance with the law." If the nitrogen oxide content exceeds the maximum authorised value by a certain quantity, the message "faulty engine operation" will be visible on the dashboard and the defect will be memorized in the onboard computer. In the event that the warning level continues to be exceeded (or if the AdBlue tank is empty), after the vehicle's first stop, an engine torque reduction procedure will be applied via the electronic fuel injection management system.

Manufacturers must ensure that their vehicles (over 16 t) comply with the emission levels for 500,000 km or 7 years. For those under 16 t, the limit is 250,000 km and six years. Lastly, the government of each European country needs to put in place a procedure for inspection by accredited operators, which will examine the contents of the onboard computer's memory in order to ensure that the engine has functioned continuously under the Euro 4 conditions.

Beyond the Euro standard itself, there is general agreement that the diesel engine will continue to be the main energy source for long-distance transport (also for the Euro 6 and subsequent standards) in the years to come. Exotic alternatives such as hybrid drives and fuel cells will be mostly found in niche markets like public transport or distribution. Diesel is capable of complying with ever-more rigorous environmental standards, provided new techniques are used. These include HCCI (Homogeneous Charge Compression Ignition). Once this technique has been mastered, emissions of particles and NO<sub>x</sub> will be practically eliminated. Synthetic diesel and fuel based on renewable products should also be developed in the more or less near future. In view of current fuel prices, it seems the logical way to go...



## Key figures

- Euro 4: compulsory on all vehicles from 1 October 2006
- Euro 5: compulsory on all vehicles from 1 October 2009
- Euro 6: 2012
- In 20 years:
  - NOx (nitrogen oxide) 1/7 of present level
  - CO (carbon oxides) 1/7 of present level
  - Hydrocarbons 1/5 of present level
  - Particles 1/20 of present level
- An AdBlue tank can hold between 40 and 80 litres
- The AdBlue market is destined to become very large. For France alone, it is estimated that it will reach 600 million tons by 2012
- The price per litre of AdBlue should fluctuate between €0.50 and €0.70.
- Vehicles consume approximately 1.5 litres of AdBlue per 100 km
- The cost of using German roads differs for everyone: a Euro 4 vehicle should pay 0.10 euro/km, a Euro 2-3 vehicle 0.12 euro/km, and a Euro 0-1 lorry 0.14 euro/km.