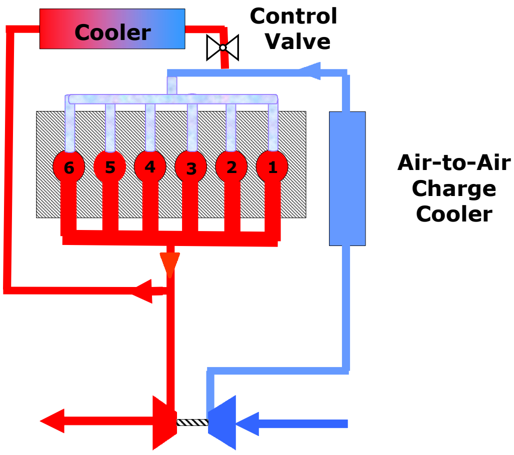
News Release

Perkins strikes low blow on emissions

There are a number of technologies available for the management of NOx. Previous emissions' tiers were managed successfully with in-cylinder technologies, changing the dynamics of the combustion process to achieve a cleaner burn, but this alone is insufficient to meet the levels of NOx reduction required for Tier 4 Interim.

After due consideration Perkins reached the conclusion that there were two viable technology paths; one is to use exhaust gases to cool the combustion process; the second to use a system called "selective catalytic reduction (SCR).

Cooling the Combustion

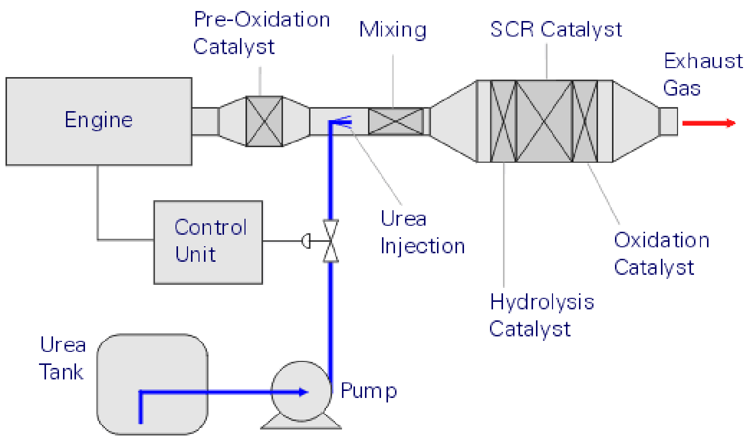


NOx is formed at very high temperatures within the engine's cylinder. A small proportion of exhaust gas can be cooled and introduced into the cylinder. As exhaust gas is high in water vapour (a by-product of the combustion process), this will act to cool the combustion and reduce NOx formation.

It is relatively cost effective, can be packaged tightly onto the engine and is expected to give a small improvement in fuel consumption over current Tier 3 product of around 3%.

In the past, Perkins was disinclined to use such technologies as soot and even sulphuric acid could collect on intake components and affect engine durability. But today lower sulphur fuels and low level of particulate output, means this technology is robust and appropriate for the industrial engine market.

Selective Catalytic Reduction (SCR)



Selective catalytic reduction (SCR) is a technology that is starting to be seen on- highway, especially in Europe.

The principle difference is that a second fluid is required in addition to the diesel fuel. Typically a second tank is fitted on the machine that the operator needs to fill regularly, perhaps every third or fourth time that the main fuel tank is refilled with diesel. This fluid, known as Adblue in Europe or Diesel Emissions Fluid in North America, contains a chemical called urea.

The urea is injected in small quantities (typically 4 to 5% of diesel fuel) into the exhaust system, where it is mixed with the exhaust gases. The hydrolysis catalyst converts the urea into ammonia, which reacts with the NOx in the SCR catalyst to produce nitrogen, water and carbon dioxide. A final stage of catalyst (oxidation catalyst) is required to clean up any ammonia left in the output gases, as it is potentially harmful and has an unpleasant odour.

SCR does enable a saving in diesel fuel consumption, of approximately 5% over other technologies. Although the total fluid consumption is actually extremely close. Whether the operator really saves money through SCR will depend on the relative cost of urea and diesel fuel in a particular country. Here in the UK, for example, Adblue is currently a little more expensive than the red diesel used by many operators of off-highway equipment, but cheaper than on-highway fuel. The production of Urea is energy intensive so is likely to closely track diesel fuel prices in the future.

However at this juncture Perkins has not selected this technology for Tier 4 Interim / Stage 3b for two main reasons:

1) The inconvenience for the user of handling urea – purchasing, transporting, storing, filling. In some territories is it not at all certain whether the distribution infrastructure will be sufficiently developed in time for the 2011 emissions legislation introduction.

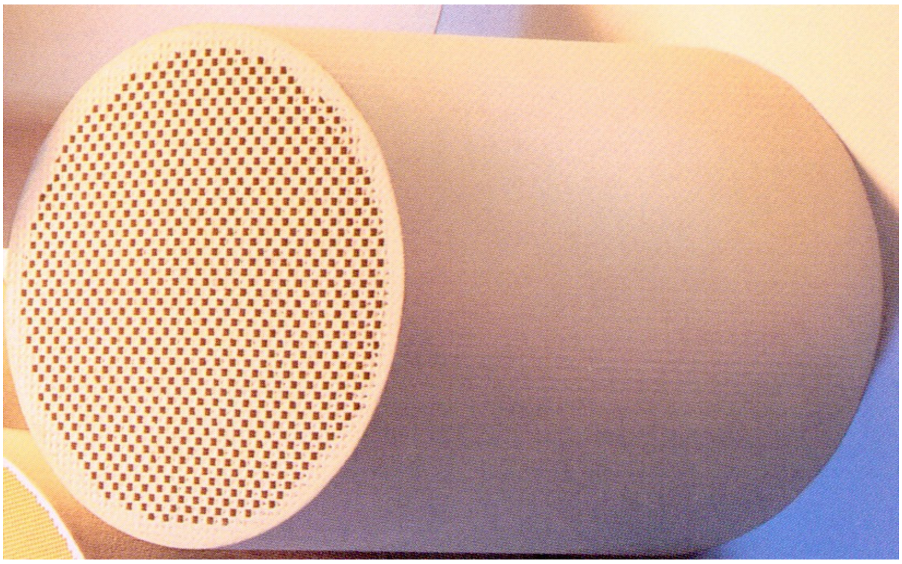
2) The complexity – there are a large number of components not on the engine that are required to make the system work. Urea freezes from around -9C and special heating arrangements are necessary for pipes and tanks.

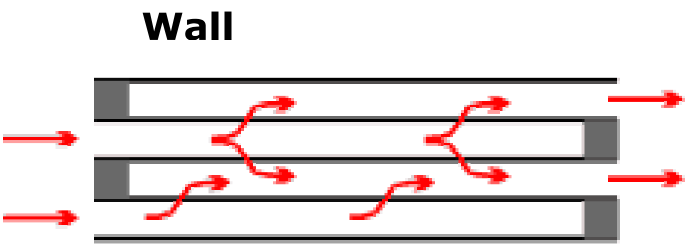
This technology is, however, an effective method of NOx reduction, and Perkins is likely to consider it as one of the options to meet the tighter NOx requirements at Tier 4 Final and beyond, although, this technology on its own would be unlikely to deliver all of the NOx management needed.

It is important to note that this system is only effective at reducing the NOx emissions, and that additional aftertreatment would still be required to manage particulate matter.

The Diesel Particulate Filter

For particulate reduction Perkins has chosen a cordierite diesel particulate filter (DPF). This porous ceramic material is highly efficient at removing particulate matter - 90% as a minimum - and often much higher.





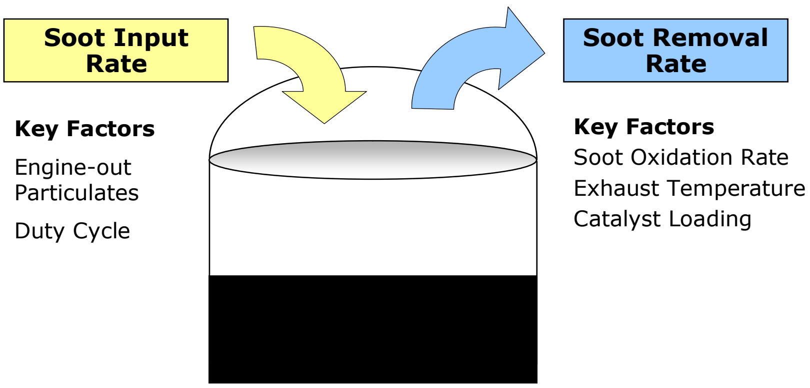
The exhaust gases actually flow through the porous walls of the material, depositing the particulate and leaving the exhaust gases clean.

Diesel Oxidation Catalyst

The diesel particulate filter on its own cannot remove all the legislated gases. Hydrocarbons, carbon monoxide and the 'soluble organic fraction' must also be managed. So the DPF is used in combination with another device called a diesel oxidation catalyst (DOC). The DOC is a similar cordierite material but uses a through flow principle. The gases pass straight through the device rather than through the walls. The DPF and DOC are combined together in the same canister in the machine.

Through

DPF Regeneration



As the diesel particulate cleans the particulate matter from the exhaust gases, soot will start to accumulate in the filter. This needs to be cleaned out through a process called "regeneration". The rate at which the filter fills depends on how clean the engine is and it is certainly desirable to make the particulate output of the engine as low as possible. The operating cycle of the machine also has some effect on the rate of soot accumulation.

There are basically 2 forms of regeneration that can clean the soot from filters – a continual process called low temperature regeneration or an occasional process called high temperature regeneration.

Low Temperature Regeneration

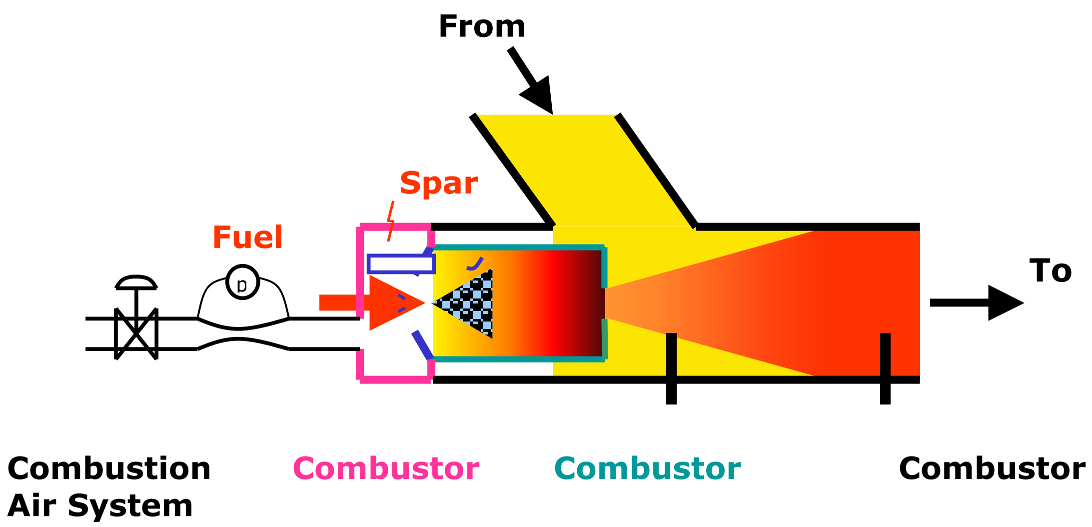
For low temperature regeneration, a catalyst of precious metal helps create NO_2 in the exhaust gas which oxidises carbon at temperatures of around 250 °C or higher.

One limitation of this technology is that it requires some NOx to make the process work, usually a minimum ratio of 25:1 NOx to particulates is required, with 40:1 being desirable. Even though the particulate output of the engine is very low, it is only really viable in engines up to 130kW where a little more NOx is allowed by the legislation.

This process occurs continuously, so the operator will normally not notice anything different during the duty cycle, and will not need to take any exceptional actions.

After extensive field research which measured the operating cycles of a large number of different off-highway machines, Perkins is confident that for the majority of machines there will be sufficient working periods where the exhaust temperature will be higher than 250 °C for the filter to regenerate effectively by this method. But there will be some applications, notably in cold temperatures or very light duty cycles, where some additional help will be needed to raise the exhaust temperature. A simple mechanical device will be fitted to Perkins engines to assist regeneration in these special circumstances.

High temperature Regeneration



High temperature regeneration is an occasional process that is used to burn off the accumulated soot after a few hours of operation. There are several different methods, but the one preferred by Perkins, for engines over 130kW, is to use a burner in the exhaust stream, which heats the exhaust gases to over 600 °C, directly oxidising the accumulated soot in a well controlled manner.

This system is robust and highly controllable compared to some competitive systems, as it is possible to start and stop the regeneration at any time. The process is most fuel efficient at lower speeds, and once again from the measurement of machine cycles it is clear that there will be plenty of opportunities in almost all machine types for this to occur without operator intervention.

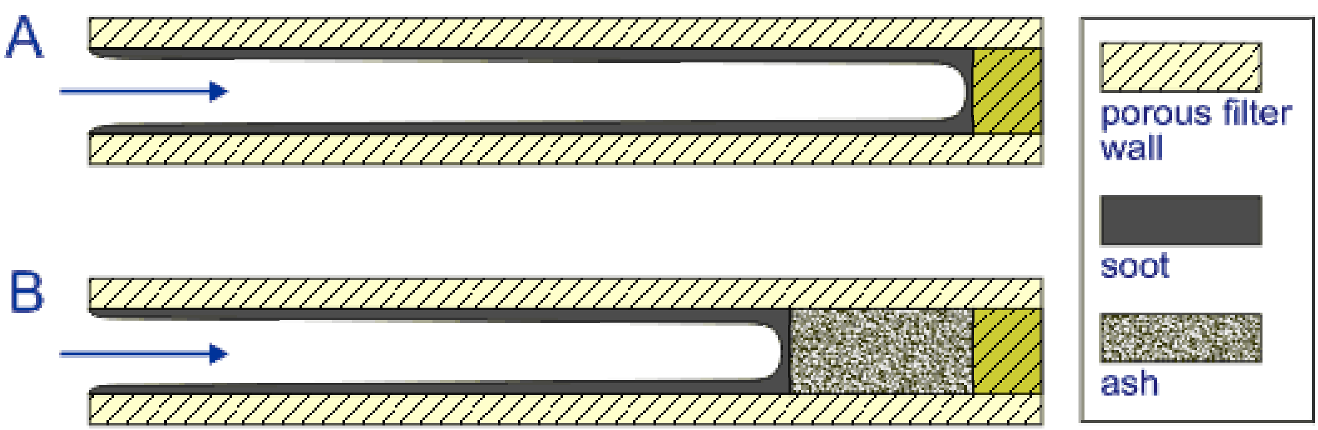
Ash

Although almost all the particulate matter in the filter will oxidise completely in regeneration, there are tiny quantities of minerals (e.g. phosphates) in engine lube oil that do not combust. These result, over many hours of operation, in the accumulation of "ash" in the channels of the diesel particulate filter. These eventually reduce the volume of the filter and increase the backpressure, resulting in deterioration in fuel economy and performance.

Ash does not regenerate so it needs to be cleaned out using a special machine. In North America the Environmental Protection Agency (EPA) specifies that the first ash service should not be sooner than 3000 hours for engines less than 130kW, and 4500 hours for engines above 130kW.

In Europe, although it is not specified by the legislation, Perkins feels that ash service is an inconvenience to the machine owner and should be avoided as far as possible.

By a small increase in filter size at the lower power end, Perkins has managed to avoid ash service altogether for some of its engine range.



Sulphur

Sulphur in fuel is a problem not only for Perkins but the whole industry. Sulphur reacts with precious metal catalysts and prevents them from working correctly. The legislators recognise this and new "Ultra Low Sulphur Diesel" standards are being introduced for off-highway fuel. Typically this will mean sulphur levels of less than 15 parts per million, similar to those of modern on-highway fuels.

But there are issues with this change in fuel. For example, will storage tanks really be completely empty before new ultra low sulphur diesel is added, for example?
With this in mind Perkins is making it an imperative that its technologies are designed to be robust in the face of occasional misfueling.

Ends