Making 2010 On-Highway Engine Certification Possible

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Meeting the 2010 EPA on-highway diesel emissions standards is on the minds of many engine manufacturers. As everyone knows, on-highway diesel emissions have been drastically reduced in the past ten years and must be reduced even further by the year 2010. The allowable level of particulate matter emissions was reduced to 0.01-g/hp-hr in 2007 and will remain the same for 2010. This will allow the engine manufacturers and OEM's to utilize the technologies currently in place for controlling particulate matter emissions. The major change that will take place in 2010 is the allowable levels of NOx emissions. Allowable levels of NOx emissions will be reduced to 0.2-g/hp-hr from the current standard of 2.5-g/hp-hr. The EPA has put forth a phase-in process that allows engine manufacturers to certify 50 percent of their production engines at the 0.2-g/hp-hr level and the other 50 percent may remain at the 2.5-g/hp-hr level, until 2010, when 100 percent of production engines must meet the 0.2-g/hp-hr level. Engine manufacturers are also being allowed to average out this phase-in process which will allow them to certify all of their engines at a level of about 1.2-g/hp-hr until the year 2010 (Cummins Inc, 2007, p. 4).

The major question is, what technologies are the engine manufacturers going to implement to meet this 92 percent reduction in NOx emissions levels by the year 2010? There are multiple options for the engine manufactures to consider to obtain the allowable NOx emissions levels. Some of those options include additional components in the after treatment devices that are currently being used. Other options include no changes to the after treatment devices, but changes to the on engine components and systems. A third option would be a complete redesign of the combustion processes in the diesel engine.

NOx absorbers and selective catalytic reduction (SCR) are two types of after treatment devices that reduce NOx levels. The NOx absorber is a catalyst that uses a chemical reaction to basically store the NOx during lean operating conditions, low fuel to air ratio. Lean operating conditions are what is normally present in a diesel engine. Once the storage capabilities of the NOx absorber are filled, the engine will be forced into a rich operating condition. This will be done by late fuel injections or injecting fuel directly into the exhaust stream. Causing a rich operating condition will regenerate the NOx absorber by releasing the stored NOx across the catalyst. This will cause another chemical reaction that will convert the NOx to nitrogen gas and water vapor. One of the drawbacks of the NOx absorber is that it will also store sulfur. When the NOx absorber stores sulfur, there is less space to store NOx. Sulfur can also be released with a regeneration process much like the release of the NOx, but it requires higher temperatures than the NOx regeneration. Cummins has implemented the use of a NOx absorber on the 6.7L ISB used in the Dodge Ram pickup trucks. This engine currently passes the 2010 EPA emissions standards (Cummins Inc, 2007, p. 12). SCR is the other form of after treatment device used to reduce NOx emissions. SCR systems use a chemical reductant, such as urea, that is injected into the exhaust steam. The urea reacts with the NOx when they pass over a catalyst forming nitrogen gas and water vapor (MECA, 2007, p. 28). Some of the downfalls of an SCR system are the need for a storage tank to carry the chemical reductant, the infrastructure required to make the chemical reductant widely available, and the operator interaction required to keep the system operating properly.

Cummins has claimed that they will use SCR systems on their mid-range engines, but will not use SCR systems on their heavy-duty engines (Berg, 2007).

There are two companies that claim they will not use SCR systems on at least some portion of their engine lineup. Cummins will be using more precise turbocharging and increasing the amount of cooled exhaust gas that is recirculated into its heavy-duty engines. They will also be changing their heavy-duty fuel system to a common rail type of fuel system with higher injection pressures, over 32,000psi. Using these systems will reduce NOx levels internally with no need for additional NOx after treatment. The engines will still require the diesel particulate filter (DPF) for particulate matter emissions control. Cummins claims that this approach will work on the heavy-duty engines but is not as successful on the mid-range engines (Berg, 2007). International Truck and Engine Corporation will be coming out with two new class 8 engines in 2008 and have said that their engines will not be using SCR systems. They will be using their own type of advanced fuel, air, and control systems to achieve the correct combustion to reduce NOx levels internally (Koc, 2007).

One other option for NOx reduction is homogeneous charge compression ignition (HCCI). In an HCCI engine the diesel fuel and air are mixed before combustion. The mixing of the fuel and air before combustion creates multiple ignition points in the combustion chamber rather than a single ignition point at the injection nozzle. This process lowers particulate matter emissions. Precise controlling of the lean combustion created by HCCI leads to lower flame temperature which directly relates to lower NOx emission levels (UC Berkley, 2001). Caterpillar is a lead partner in a UK project that is focused on developing a practical HCCI engine. It is not clear what type of emissions control systems Caterpillar will be using to certify their engines in 2010 (Cat leading HCCI effort, 2007).

So what will make 2010 on-highway certification possible? There are many options for the engine manufactures to utilize when attempting to meet the strict 2010 emissions levels. Some will use after treatment systems, some will fine tune the processes and systems they are currently using, and some may even try to redesign the combustion processes of the diesel engine itself. All the industry can do now is learn how to operate, maintain, and repair the systems that the manufacturers choose to utilize. That includes the off-highway portion of the industry. As history has shown, the off-highway product will soon see changes very similar to those of the on-highway product.

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