

this time. As discussed in section III.H, we have proposed that a technology assessment occur in 2007 which would evaluate the status of emission control technologies for engines less than 75 hp, and such a review would revisit this issue.

In addition, we have not proposed to apply particulate filter based standards for engines less than 25 hp. As discussed in sections III.E.1 through 4, there are two basic types of particulate filter systems we believe could be used by engine manufacturers. The first is a CDPF which uses post-injection from a common-rail electronic fuel injection system in order to ensure filter regeneration. The second type of system would use a CDPF with a stand-alone (*i.e.*, independent from the engine's fuel system) fuel injection system to ensure filter regeneration. In either case, an electronic control system is required, as well as the CDPF. Such systems are not being developed for engines of this size for either highway light-duty or heavy-duty diesel applications, and (as noted earlier) it is unclear whether the technology development which is being done for the highway market will transfer down to engines in this power category. In addition, based on currently available information, we believe the cost of these technologies are relatively high compared to the overall cost of the equipment. As discussed in section III.H, we have proposed that a technology assessment occur in 2007 which would evaluate the status of emission control technologies for engines less than 75 hp, and such a review would revisit this issue.

6. Meeting the Crankcase Emissions Requirements

The most common way to eliminate crankcase emissions has been to vent the blow-by gases into the engine air intake system, so that the gases can be recombusted. Prior to the HD2007 rulemaking, we have required that crankcase emissions be controlled only on naturally aspirated diesel engines. We had made an exception for turbocharged diesel engines (both highway and nonroad) because of concerns in the past about fouling that could occur by routing the diesel particulates (including engine oil) into the turbocharger and aftercooler. However, this is an environmentally significant exception since most nonroad equipment over 70hp use turbocharged engines, and a single engine can emit over 100 pounds of NO_x, NMHC, and PM from the crankcase over its lifetime.

Given the available means to control crankcase emissions, we eliminated this

exception for highway engines in 2007 and are proposing to eliminate the exception for nonroad diesel engines as well. We anticipate that the diesel engine manufacturers will be able to control crankcase emissions through the use of closed crankcase filtration systems or by routing unfiltered blow-by gases directly into the exhaust system upstream of the emission control equipment. However, the proposed provision has been written such that if adequate control can be had without "closing" the crankcase then the crankcase can remain "open." Compliance would be ensured by adding the emissions from the crankcase ventilation system to the emissions from the engine control system downstream of any emission control equipment. We propose to limit this provision for controlling emissions from open crankcases to turbocharged engines, which is the same as for heavy-duty highway diesel engines. We request comment on extending this provision to naturally aspirated engines, as we did for marine diesel engines in our 1999 final rule (64 FR 73300, December 29, 1999).

We expect that in order to meet the stringent tailpipe emission standards set here, that manufacturers will have to utilize closed crankcase approaches as described here. Closed crankcase filtration systems work by separating oil and particulate matter from the blow-by gases through single or dual stage filtration approaches, routing the blow-by gases into the engine's intake manifold and returning the filtered oil to the oil sump. Oil separation efficiencies in excess of 90 percent have been demonstrated with production ready prototypes of two stage filtration systems.²¹⁴ By eliminating 90 percent of the oil that would normally be vented to the atmosphere, the system works to reduce oil consumption and to eliminate concerns over fouling of the intake system when the gases are routed through the turbocharger. Hatz, a nonroad engine manufacturer, currently has closed crankcase systems on many of its turbocharged engines.

F. Why Do We Need 15ppm Sulfur Diesel Fuel?

As stated earlier, we strongly believe that fuel sulfur control is critical to ensuring the success of NO_x and PM aftertreatment technologies. In order to evaluate the effect of sulfur on diesel exhaust control technologies, we used

three key factors to categorize the impact of sulfur in fuel on emission control function. These factors were efficiency, reliability, and fuel economy. Taken together these three factors lead us to believe that diesel fuel sulfur levels of 15 ppm will be required for the nonroad emission standards proposed here to be feasible. Brief summaries of these factors are provided below.

The *efficiency* of emission control technologies to reduce harmful pollutants is directly affected by sulfur in diesel fuel. Initial and long term conversion efficiencies for NO_x, NMHC, CO and diesel PM emissions are significantly reduced by catalyst poisoning and catalyst inhibition due to sulfur. NO_x conversion efficiencies with the NO_x adsorber technology in particular are dramatically reduced in a very short time due to sulfur poisoning of the NO_x storage bed. In addition, total PM control efficiency is negatively impacted by the formation of sulfate PM. As explained in the following sections, the CDPF, NO_x adsorber, and urea SCR catalyst technologies described here have the potential to make significant amounts of sulfate PM under operating conditions typical of many nonroad engines. We believe that the formation of sulfate PM will be in excess of the total PM standard, unless diesel fuel sulfur levels are at or below 15 ppm. Based on the strong negative impact of sulfur on emission control efficiencies for all of the technologies evaluated, we believe that 15 ppm represents an upper threshold of acceptable diesel fuel sulfur levels.

Reliability refers to the expectation that emission control technologies must continue to function as required under all operating conditions for the life of the engine. As discussed in the following sections, sulfur in diesel fuel can prevent proper operation of both NO_x and PM control technologies. This can lead to permanent loss in emission control effectiveness and even catastrophic failure of the systems. Sulfur in diesel fuel impacts reliability by decreasing catalyst efficiency (poisoning of the catalyst), increasing diesel particulate filter loading, and negatively impacting system regeneration functions. Among the most serious reliability concerns with sulfur levels greater than 15 ppm are those associated with failure to properly regenerate. In the case of the NO_x adsorber, failure to regenerate the stored sulfur (desulfate) will lead to rapid loss of NO_x emission control as a result of sulfur poisoning of the NO_x adsorber bed. In the case of the diesel particulate filter, sulfur in the fuel reduces the reliability of the regeneration function.

²¹⁴ Letter from Marty Barris, Donaldson Corporation, to Byron Bunker U.S. EPA, March 2000. Copy available in EPA Air Docket A-2001-28.