CALIFORNIA AIR RESOURCES BOARD

Contract No. 18ISD027

CARB Notice

Low Emission Diesel (LED) Study: Biodiesel and Renewable Diesel Emissions in Legacy and New Technology Diesel Engines

Background

The California Air Resources Board (CARB) contracted with the University of California at Riverside (UCR) Bourns College of Engineering – Center for Environmental Research and Technology (CE-CERT) to evaluate oxides of nitrogen (NOx) and particulate matter (PM) emissions from the use of renewable diesel (RD)/biodiesel (BD) blends in one on-road and one off-road new technology diesel engine[1] (NTDE) with selective catalytic reduction (SCR) and diesel particulate filter (DPF) exhaust aftertreatment systems, and one off-road non-NTDE (legacy engine) without DPF and SCR.

Previous studies using diesel engines with experimental or first generation SCR indicated that SCR fully controls NOx emissions from BD (i.e., NOx emissions due to BD do not exceed those from conventional diesel in the same engine). However, more recent studies with newer, more mature original engine manufacture SCR systems indicate that NOx emissions from BD may not be fully controlled in NTDEs. To further investigate NOx emissions from NTDEs, CARB contracted CE-CERT to evaluate NOx and PM emissions from the use of RD/BD blends in NTDEs with mature, modern emissions control systems.

Testing Results Summary

In both NTDEs tested, excess NOx emissions from BD were shown to be not fully controlled relative to reference CARB diesel. Excess NOx is any additional NOx produced from the use of BD in NTDEs relative to conventional CARB diesel.

In both NTDEs tested, blending of RD with BD was shown to not reduce excess NOx emissions from BD. This differs from legacy engines, where RD reduces excess NOx from BD. In the NTDEs tested, PM emissions were shown to be very low and near background levels for all blends and there were no statistically significant differences.

In the non-NTDE (legacy) engine tested, results were shown to be within the range of prior studies. RD100 reduced NOx emissions by about 5 percent and PM by about

[1] New technology diesel engine (NTDE) means a diesel engine that meets at least one of the following criteria (in summary):
(1) 2010 CARB emission standards for on-road heavy duty diesel engines (0.20 g/bhp-hr NOx and 0.01 g/bhp-hr PM),
(2) Tier 4 emission standards for non-road compression ignition engines (2014 and higher – 0.30 g/bhp-hr NOx and 0.01 g/bhp-hr PM for 130-560 hp engines), or
(3) employs a diesel emissions control strategy which uses selective catalytic reduction (SCR) to control NOx.

30 percent. In the legacy engine tested RD was shown to also reduce excess NOx from BD in the RD/BD blends. In the legacy engine tested, for PM, the greater the BD concentration in the RD/BD blends, the greater the observed PM emissions benefits.

Staff Summary

CARB contracted CE-CERT to evaluate NOx and PM emissions from the use of RD/BD blends in NTDEs. Results show that NOx emissions in RD/BD blends were shown to be higher in the NTDEs tested than observed in some previous studies, and that NOx emissions from RD100 were shown to be no different than conventional diesel.

The results of this study raise additional questions, for example:

- How do these results align with previous studies on BD and RD emissions performance in legacy engines and NTDEs? Are there additional data or testing results that CARB should be aware of to further evaluate BD and RD emissions performance?
- How representative of NTDEs used in California are the engines used in this study?
- How representative are the test cycles in this study to in-use activity cycles?
- Would the addition of a low-load test cycle contribute to the accuracy of calculating in-use NOx excess emissions from NTDEs?
- How might these findings impact NOx emissions estimates from BD and RD fuel use?

Next Steps

CARB staff has identified several questions about the study results that require further discussion and evaluation. Staff invites stakeholders to evaluate the questions above and offer feedback on what additional considerations or other data we should include in our evaluation. Feedback on this report and the questions above will be accepted until January 31, 2022, and should be sent by email to adf@arb.ca.gov. Feedback received will be considered public information and may be posted.