

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 (NO_x) 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 engine¹ (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 NO_x emissions from BD (i.e., NO_x 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 NO_x emissions from BD may not be fully controlled in NTDEs. To further investigate NO_x emissions from NTDEs, CARB contracted CE-CERT to evaluate NO_x 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 NO_x emissions from BD were shown to be not fully controlled relative to reference CARB diesel. Excess NO_x is any additional NO_x produced from the use of BD in NTDEs relative to conventional CARB diesel.

In both NTDEs tested, blending of RD with BD was shown it did not reduce excess NO_x emissions from BD. This differs from legacy engines, where RD reduces excess NO_x 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 NO_x 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 NO_x 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 NO_x 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 NO_x.

30 percent. In the legacy engine tested RD was shown to also reduce excess NO_x 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 NO_x and PM emissions from the use of RD/BD blends in NTDEs. Results show that NO_x emissions in RD/BD blends were shown to be higher in the NTDEs tested than observed in some previous studies, and that NO_x 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 NO_x excess emissions from NTDEs?
- How might these findings impact NO_x 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.