

Performance and Emissions of Heavy Duty Diesel Engine Fueled with Biodiesel Blends

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ABSTRACT

Biodiesel is defined as monoalkyl esters of long chain fatty acids derived from plant oil or animal fat used as an alternative fuel in diesel engines. In the U.S., biodiesel is normally blended with regular diesel fuel to eliminate some operational issues associated with using neat biodiesel (B100). This experiment was executed to demonstrate the differences in performance and emissions between various blends of canola biodiesel and No. 2 diesel fuel.

EXPERIMENTAL

Preparation of Biodiesel

Canola biodiesel was prepared via the conventional KOH-catalyzed transesterification with methanol at MSU-Northern's Biodiesel Pilot Plant. Biodiesel was blended with regular diesel No. 2 at different levels.



MSU-N Biodiesel Pilot Plant



CAT 3176 diesel engine mounted on 3100 Taylor water break dynamometer

Dynamometer Testing

a. Performance Testing

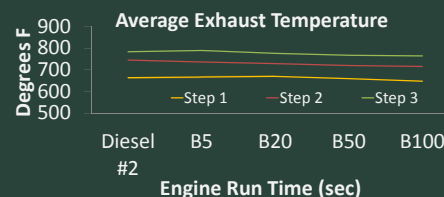
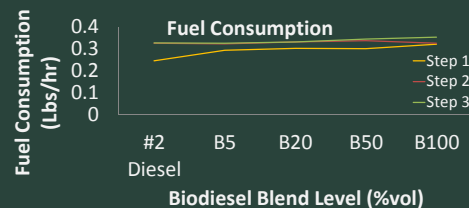
Steady state engine performance testing using diesel No. 2 and different blends of biodiesel was conducted using a 360HP 3176 CAT Diesel engine mounted on a 3100 Taylor Dynamometer, and data was recorded every three seconds.

Step tests were performed using typical agricultural application loads. Each run lasted for 60 minutes and consisted of three steps (20 mins/step) at 1400, 1775 and 1475 rpm with the corresponding torque of 475, 1000 and 900 ft/lb, respectively.

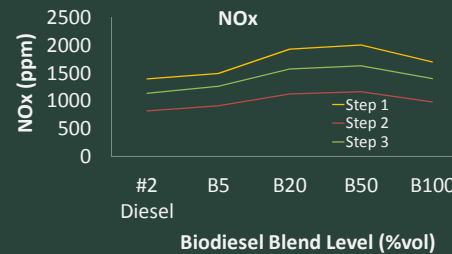
b. Emission Monitoring

An AVL SESAM FTIR emissions gas analyzer and an AVL 483 Micro Soot Measuring Unit were used to monitor emission gases in real time. Emission data was recorded every second.

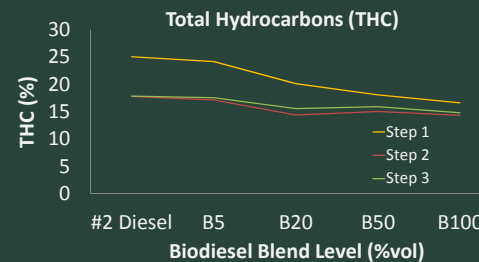
RESULTS



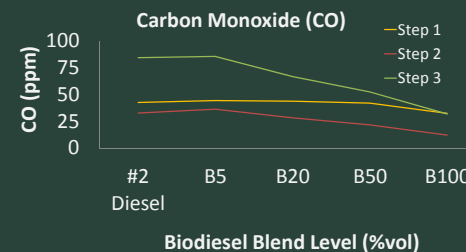
Fuel consumption and exhaust temperature of CAT 3176 diesel engine under different loads with increasing biodiesel blends.



Average NOx emissions of CAT 3176 diesel engine under different loads with increasing biodiesel blends.



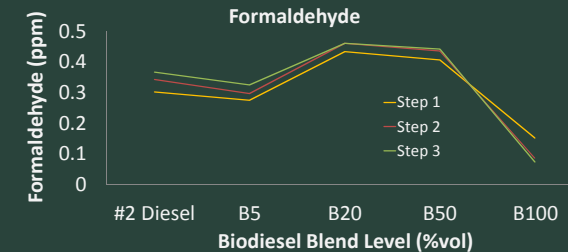
Average total hydrocarbon emissions of CAT 3176 diesel engine under different loads with increasing biodiesel blends.



Average carbon monoxide emissions of a CAT 3176 diesel engine under different loads with increasing biodiesel blends.



Average micro soot emissions of CAT 3176 diesel engine under different loads with increasing blends of biodiesel.



Average formaldehyde emissions of CAT 3176 diesel engine under different loads with increasing biodiesel blends.

SUMMARY

- Fuel consumption increased with increasing biodiesel blends only at lower engine load.
- Exhaust temperatures remained stable up to B50. However, the use of B100 resulted in lower exhaust temperatures particularly at higher engine load.
- Compared to regular No. 2 diesel, NOx emissions increased by 40% in B20 and B50 levels and only increased by 20% using B100 regardless of engine load.
- Total hydrocarbons, carbon monoxide, and soot emissions decreased significantly with increasing biodiesel blend levels reaching up to 34%, 60%, and 90% reduction, respectively, with the use of B100.
- Formaldehyde increased in all three steps with the use of B20 and B50 and decreased with the use of B100 compared to diesel No. 2.