ALISSA RECKER
CATALYST KIT ENGINEER – PERFORMANCE & EMISSIONS

DAIMLER
Daimler Trucks North America


# ZEV FUTURE
Starts Now

**40+**
Trucks in customer test fleets

**45+**
Customers in the U.S. & Canada

**1.000.000**
Electric test miles

**22/23**
SOP eCascadia/eM2

# B20 Failure Modes

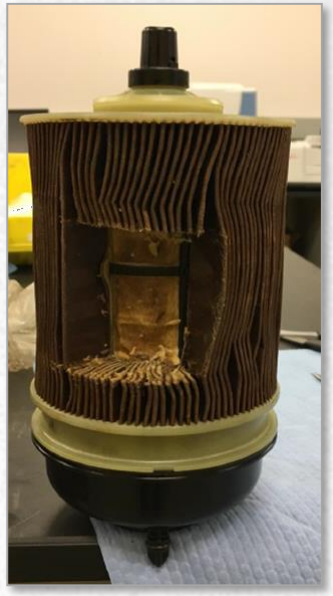
## Cost Fleets Significant Downtime

### Fleet Impacts:

- Engine oils must be sampled and monitored for fuel dilution. Shorter oil change intervals may be required.
- Fuel filters must be changed at 50% of the standard ULSD service interval.
- Vehicles parked for an extended period of time must have fuel system flushed before parking.

**New Filter**

**Used Filter**



**Cut Media**


**Biodiesel Oxidation Byproduct**

ASTM biodiesel specifications are not sufficient for modern engines.

**This B20 met all relevant ASTM specifications but caused fleet-wide failures.**

# B20 Usage Conflicts with NOx Reduction Goals

Up to **7%** direct NOx Increase

**Degrades emissions controls, further increasing NOx**

**B20**

**0%** $CO_2$ Reduction

Renewable Diesel offers a 9% reduction in NOx and 6% reduction in $CO_2$

**Requiring B20 for State Contracts:**

- Increases NOx emissions
- Does not reduce vehicle $CO_2$ output
- Eliminates Daimler product offerings

# Fuel Recommendations

## B20 Mitigation Strategies

**Blend B20 with Renewable Diesel**

- Reduces NOx bump
- Improves product quality

**Require Distillation of Biodiesel**

- Improves product quality

**Require Minimum 8hr B100 Stability**

- Reduces harmful fuel deposits
- Reduces operator downtime

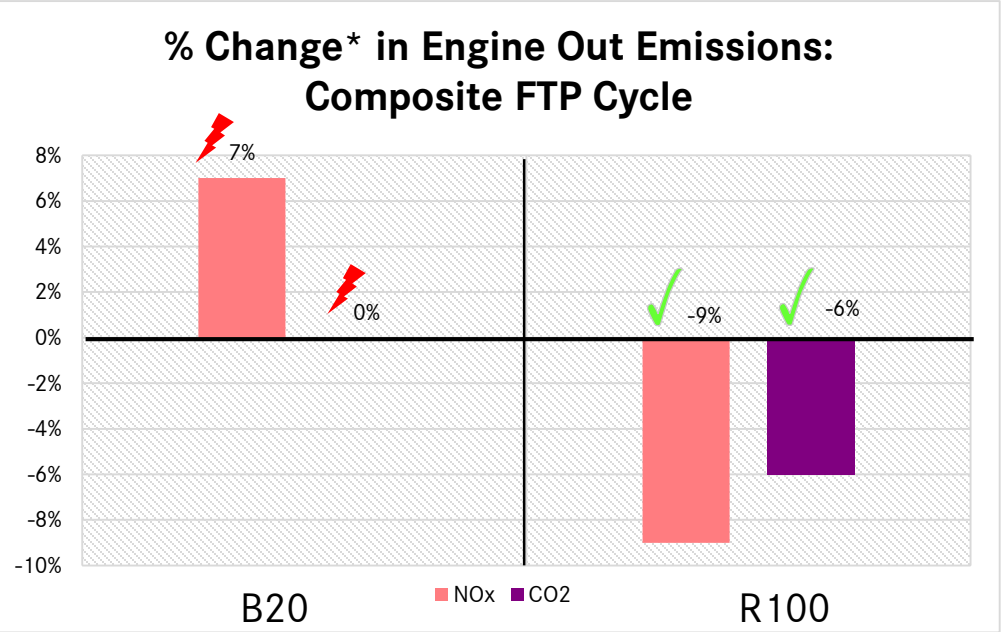
**Limit Metals to Non-Detectable Levels**

- Prevents degradation of emissions control catalysts

**Detailed fuel recommendations, including full property specifications, can be found in our publically available service literature.**

# Additional Material

# CO2 and NOx Impact of B20 vs. Renewable Diesel

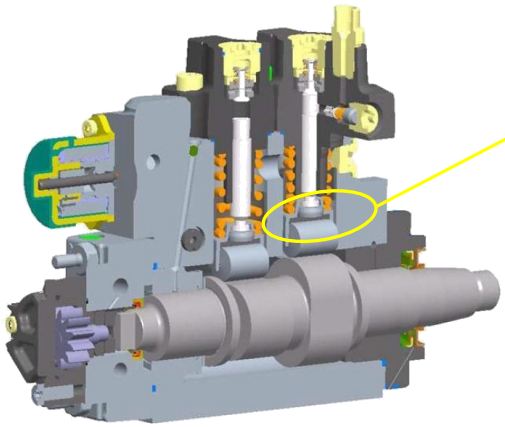



- Compared to a ULSD baseline, B20 does not offer a tailpipe CO2 reduction & results in higher engine out NOx emissions.
- The NOx increase is caused by the higher oxygen content of biodiesel and some increase is expected regardless of engine make or model year.
- Renewable diesel offers NOx and CO2 reductions.

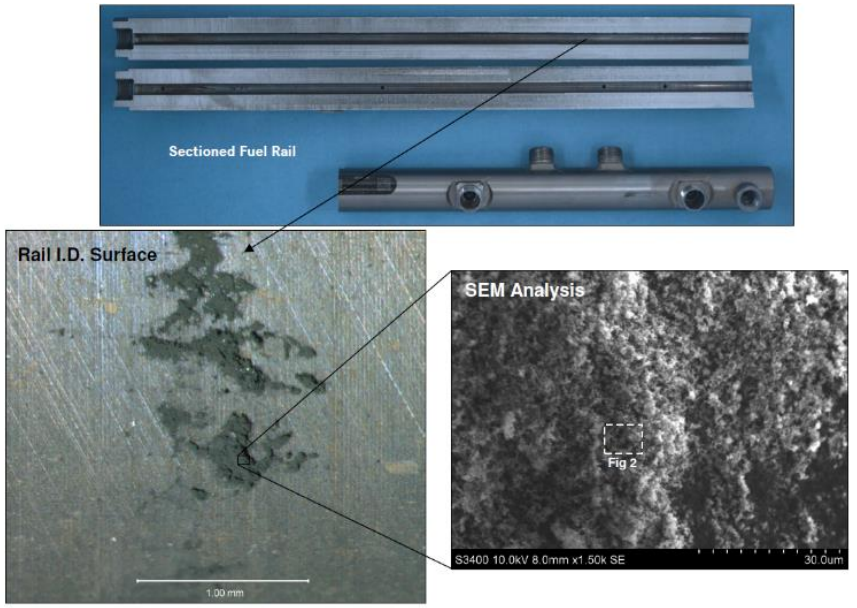
***Renewable diesel is a better alternative for NOx and GHG reductions, as well as engine operability.***

*compared to baseline ULSD engine out emissions tested on a GHG17 HD engine.

# B20 Fuel Injection System Damage




Deposits causing material transfer between camshaft and roller due to poor stability of B20 in a high pressure fuel pump, resulting in repairs and vehicle downtime.



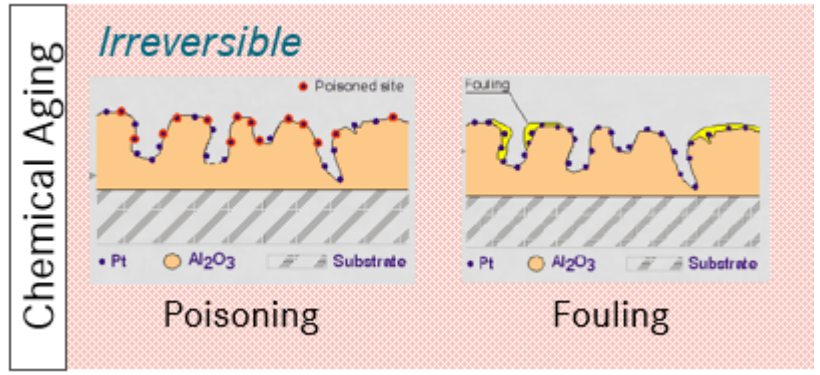

Deposits due to B20 found in the high pressure common rail resulting in additional maintenance procedures.

***B20 that meets all industry specifications still causes issues in the fuel injection system, resulting in additional downtime and requiring replacement of multiple components.***

# Impacts on Aftertreatment

- Chemical degradation of the aftertreament catalyst kit occurs when foreign material selectively attaches to catalyst sites (poisoning) or non-selectively forms a layer on top of the catalyst (fouling)
- B100 in the US is permitted to contain levels of Ca, Mg, Na, K, and P that once diluted to B20, still allow up to 5 kg of contaminants to be ingested from the fuel alone
- Calcium and magnesium form ash in the diesel particulate filter and may result in a drop in fuel economy and shorter DPF change interval
- Sodium, potassium, and phosphorous have been shown in industry research to degrade Diesel Oxidation Catalyst (DOC) efficiency, as well as Selective Catalytic Reduction (SCR) efficiency, directly resulting in reduced emissions performance


- Kröger, V., Kanerva, T., Lassi, U., Rahkamaa-Tolonen, K., Vippola, M., & Keiski, R. L. (2007). Characterization of phosphorus poisoning on diesel exhaust gas catalyst components containing oxide and Pt.*Topics in Catalysis,45*(1-4), 153-157.
- Cavataio, G., Jen, H., Dobson, D. A., & Warner, J. R. (2009). Laboratory Study to Determine Impact of Na and K Exposure on the Durability of DOC and SCR Catalyst Formulations. *SAE Technical Paper Series*.


| | B100 | | | R100 |
|---|---|---|---|---|
| Contaminant Limits (ppm) | ASTM D6751 | EN 14214 | CGSB 3.524 | EN15940 |
| S | 15 | 10 | 15 | 5 |
| Ca + Mg | 5 | 5 | 2 | - |
| Na + K | 5 | 5 | 4 | - |
| P | 10 | 4 | 4 | - |

***The increased chemical poisoning caused by B20 increases vehicle emissions over time and may result in complete aftertreatment replacement being required.***

# Renewable Diesel Landscape

Cummins has fully released Renewable Diesel for B4.5, B6.7, and L9 with no change in maintenance requirements or warranty.
https://www.cummins.com/news/releases/2017/05/31/cummins-announces-compatibility-select-renewable-diesel-fuels-b67-and-l9

Paccar approves Renewable Diesel with no impact on warranty.
https://static.nhtsa.gov/odi/tsbs/2019/MC-10154731-9999.pdf

Volvo approves Renewable Diesel with no impact on warranty.
https://www.volvogroup.com/en/news-and-media/news/2015/dec/news-151323.html

Navistar is listed on the OEM approval list for NESTE Renewable diesel, but a warranty statement does not appear to be publically available.
https://www.neste.com/neste-my-renewable-diesel/product-information/oem-approvals

# Additional Resources

- CARB study confirms higher NOx output with B20 and above (pg 28-31):
  - https://www.arb.ca.gov/fuels/diesel/altdiesel/20111013_carb%20final%20biodiesel%20report.pdf?_ga=2.40070119.490785917.1643917682-1130326436.1638454797

- Top Tier was developed by OEMs to address fuel quality issues.
  - https://www.toptiergas.com/toptier_diesel_fuel/
  - NESTE Renewable Diesel is Top Tier certified
  - B20 has difficulty meeting the 20 hour stability requirement