**Appendix A.** Emissions Information

Fig. A1a

**Figure A1.** Plots showing the linear reductions in both NOx and PM emissions for BD/RD blends up to 20 vol% biodiesel from three different engine platforms. A) REG data was generated using a 1991 Detroit Diesel 60-series engine [1]. B) CARB 2011 data was generated using a 2006 Cummins ISM engine on the FTP cycle [2]. the CARB 2010 B20/R80 data represents soy-based biodiesel only and the B100 data represents an average of soy-based and animal fat-based biodiesel results. C) The CARB 2021 data was generated using a 2014 GE Locomotive engine [3].

**Figure A2.** Demonstration of consistently linear reductions in NOx and PM emissions across full range of biodiesel and renewable diesel blends from the three separate data sets shown in Figure A1.

**Figure A3.** Cumulative increase in NOx, PM, THC, and CO emissions benefits across full range of biodiesel and renewable diesel blends from the three separate data sets shown in Figure A1 [1].

**Figure A4.** Demonstration of consistently linear reductions in (a) NOx and (b) PM emissions for biodiesel and renewable diesel blends when blended with petroleum diesel. Data was generated by REG using a 1991 Detroit Diesel 60-series engine [1].

**Appendix B: Operational Information**

**Table B1.** Applicability of concerns raised in Staff Report: Initial Statement of Reasons, Appendix E with respect to both biodiesel and renewable diesel.

|  |  |  |
| --- | --- | --- |
| **Concern raised in Appendix E** | **Biodiesel?** | **Renewable Diesel?** |
| “not chemically similar to…petroleum diesel” | Yes  (BD is methyl esters) | Yes  (RD lacks cyclics & aromatics, causing substantial differences) |
| “different physical properties…compared to PD” | Yes  (higher density, surface tension, and bulk modulus than PD) | Yes  (lower density, surface tension, and bulk modulus than PD) |
| Elastomer compatibility issues in “older engine fuel systems” compared to PD | Yes  (potential for increased elastomer swell in older engines compared to PD) | Yes  (potential for elastomer shrinkage in older engines compared to PD) |
| Concerns about the potential for increased free water and microbial growth in storage tanks compared to PD | No  (As noted, BD holds more water in solution, thus reducing the potential for free water which is required for microbial growth) | Yes  (RD increases the likelihood of free water which is required for microbial growth) |
| Concerns about cold weather operation compared to PD | Yes  (BD cloud point is typically higher than PD cloud point) | Yes  (RD cloud point can be similar to PD’s but can also be much higher. RD freezes differently than PD: freezes solid and at temperatures well above its cloud point) |
| Concerns about engine manufacturer support for B6 – B20 (R99 is comparison fuel) | No for B6 – B20  Billions of gallons of B6 – B20 have been successfully used since the 2006 reference that is cited for this was written | Yes for R99  Some engine and component manufacturers still limit RD content to R30 – R50. Pipelines still limited to R5. |

**Figure B1.** Change in volume of elastomer seals and gaskets for blends of biodiesel and renewable diesel for two common elastomers: fluorine rubber (FKM, also known as Viton) and Nitrile Butadiene Rubber (NBR) [1]. Negative values indicate shrinkage and positive values indicate swell.

It is also important to note that B20 blends have repeatedly been shown to be compatible with elastomers commonly used in fueling systems [4, 5, 6, 7, 8, 9, 10, 11, 12, 13]. Furthermore, a 2010 report written by CARB staff demonstrated that blends up to B20 blends have been used extensively in the state of California, without issue [14].

**Appendix A & B References:**

[1] REG internal data.

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