

AFD-6550

PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

PERFORMANCE FEATURES

- ◆ KEEPS INJECTORS CLEAN
- ◆ SUPERIOR PERFORMANCE IN CUMMINS L-10 INJECTOR DEPOSITING TEST. CRC RATING < 10
- ◆ REMOVES AND PREVENTS DEPOSITS WHICH CAN DETERIORATE FUEL ECONOMY AND EMISSIONS
- ◆ PASSES CLASS 8 TRUCK FUEL FILTER PLUGGING TEST
- ◆ ENHANCES THERMAL STABILITY
- ◆ ENHANCES FUEL STABILITY DURING STORAGE
- ◆ CONTAINS DEMULSIFIERS FOR WATER INTERACTION CONTROL
- ◆ MEETS OR EXCEEDS THE JOINT EMA/TMC PUMP GRADE SPECIFICATION FOR DETERGENCY AND ACCELERATED THERMAL STABILITY
- ◆ MEETS OR EXCEEDS THE NCWM PREMIUM DIESEL FUEL SPECIFICATIONS FOR INJECTOR CLANLINESS AND THERMAL STABILITY
- ◆ MEETS OR EXCEEDS CUMMINS CES 60032 REQUIREMENTS



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CUMMINS L-10 TEST PROCEDURE:

- ◆ Using a 1990 Cummins L-10 engine, the procedure was designed to simulate the severe injector carbonizing problems that were first experienced in 1988 L-10 and NT engines. This field problem caused engines to lose as much as 15% of their maximum power in as little as 40,000 miles. The test cycle is as follows:

| <u>Step</u> | <u>Time</u> | <u>RPM</u> | <u>Load</u> |
|-------------|---|------------|--------------------------|
| 1 | 15 sec. | 2300 | 55-65 FHP |
| 2 | 15 sec. | 2300 | Closed throttle motoring |
| 3 | Repeat steps 1 and 2 for a total of 125 hours | | |

- ◆ To pass the L-10 test requires a CRC rating of the plunger of less than 10 and an average injector flow loss of less than 6%.

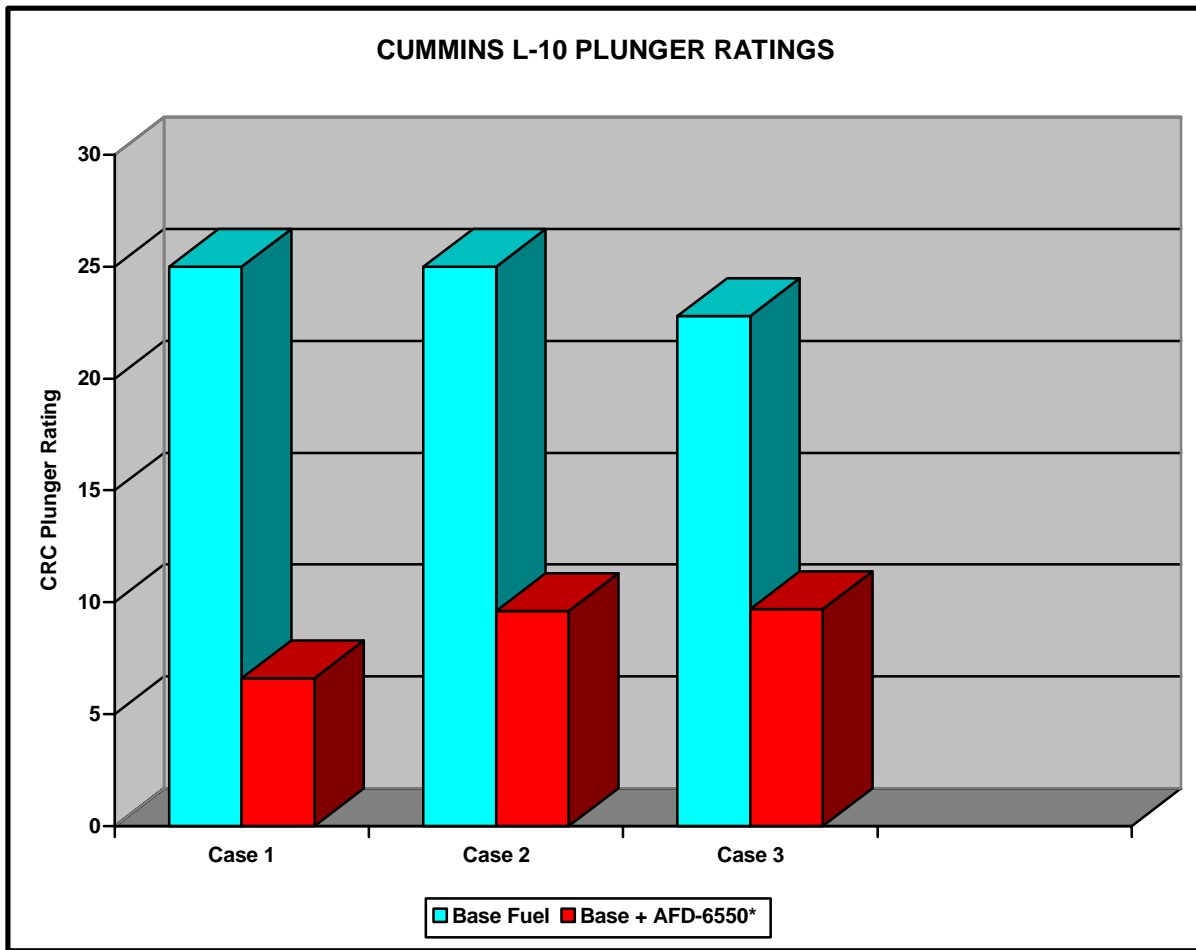
L-10 TEST ENGINE



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

CUMMINS L-10 TEST RESULTS



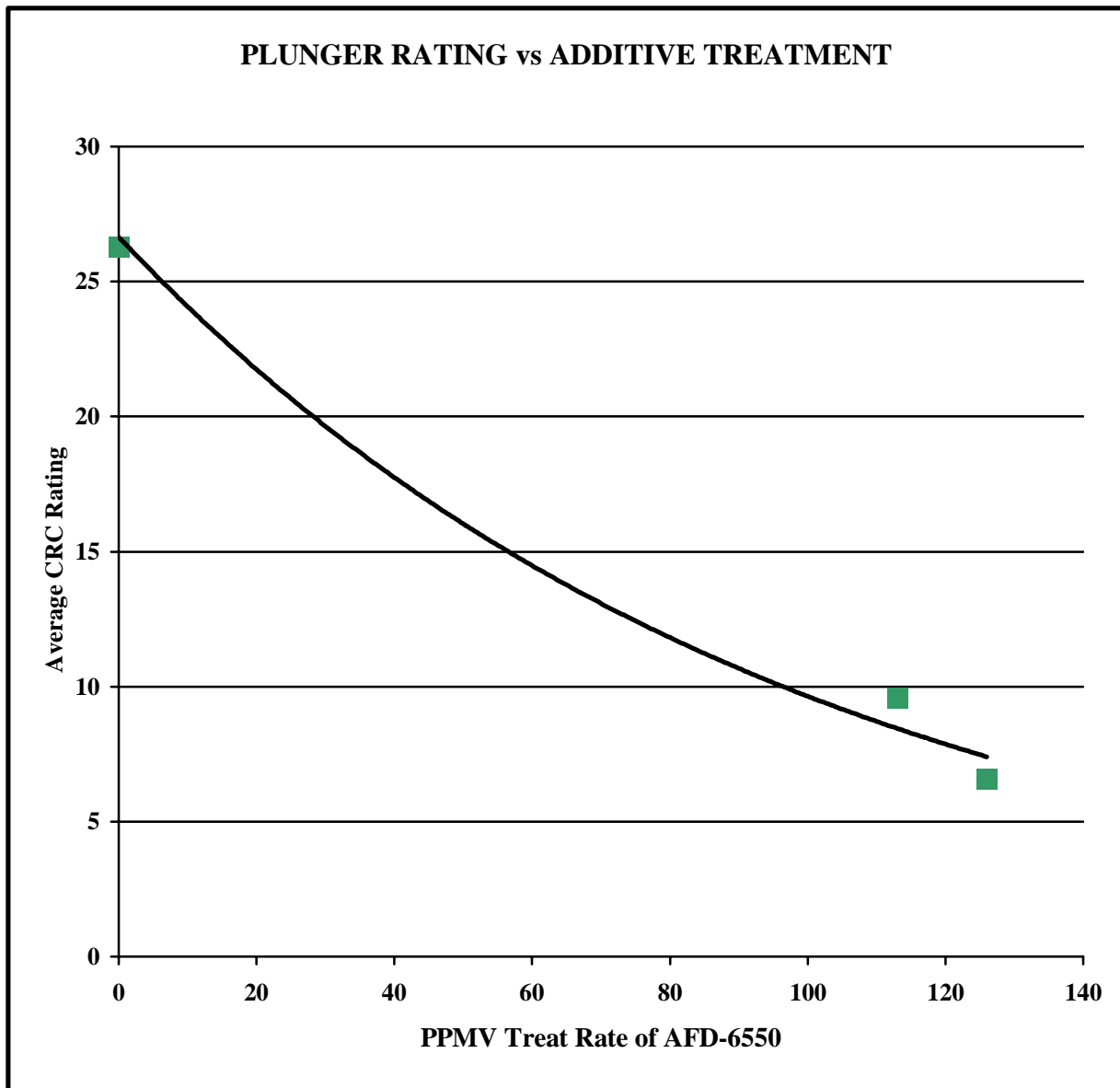
- ◆ BASE FUEL WAS CAT 1K
- ◆ CASE 1: FRONT ENGINE: ADDITIVE CONCENTRATION WAS 126 PPMV
- ◆ CASE 2: FRONT ENGINE: ADDITIVE CONCENTRATION WAS 113 PPMV
- ◆ CASE 3: REAR ENGINE: ADDITIVE CONCENTRATION WAS 333 PPMV
- ◆ A PLUNGER RATING OF LESS THAN 10 IS A “PASS”



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CUMMINS L-10 RESPONSE TO TREAT RATE



◆ THE FUEL USED IN THESE TESTS WAS THE CATERPILLAR 1K REFERENCE FUEL



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CUMMINS L-10 INJECTOR PLUNGER

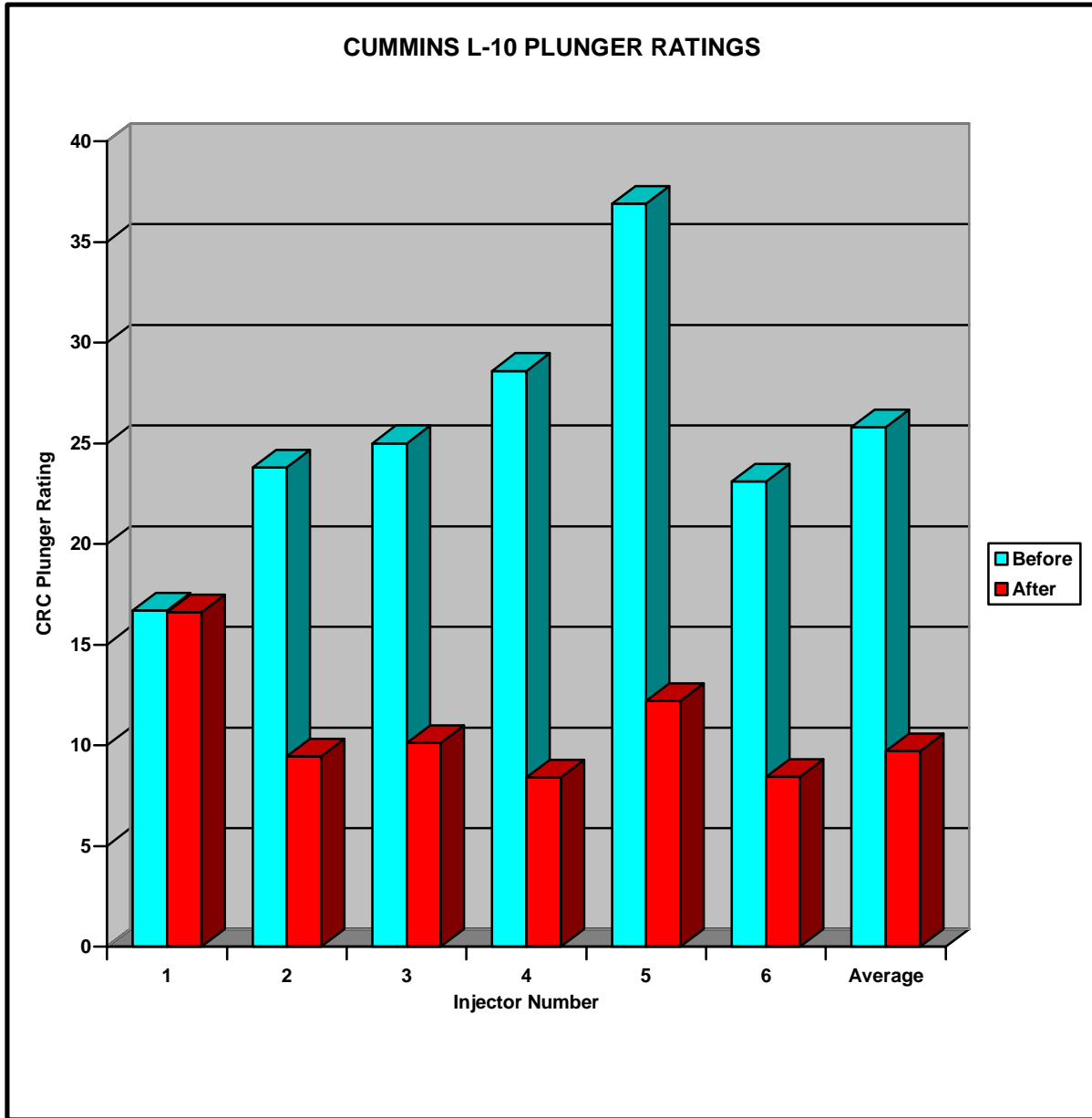


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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

CUMMINS L-10 DETERGENCY – 125-HOUR CLEAN UP RESULTS



◆ TREATMENT RATE FOR AFD-6550 IN ABOVE TEST WAS 303 PPM BY VOLUME



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

LONG TERM DETERGENT EFFECTS

- ◆ A THREE-YEAR PROGRAM INVOLVING NINE DIESEL VEHICLES WAS CONDUCTED TO QUANTIFY VEHICLE EMISSION PERFORMANCES.
- ◆ THE OBJECTIVE WAS TO EVALUATE ABILITY OF AFD-6550 TREATED FUEL TO:
 - CONTROL EXHAUST EMISSIONS
 - FUEL CONSUMPTION
- ◆ A FLEET OF FOUR SMALL DIESEL PASSENGER CARS AND FOUR HEAVY DUTY TRUCKS WAS SELECTED
- ◆ TEST PROTOCOL:

A HEAVY DUTY DI VEHICLES: FOUR TRUCKS WITH CUMMINS ENGINES WERE DRIVEN ON ROAD. TWO OF THEM WERE OPERATED WITH EUROPEAN COMMERCIAL DIESEL FUEL AND OTHERS WITH SAME FUEL BUT INCLUDING ADDITIVE AFD-6550 AT THE SELECTED CONCENTRATION. TYPE ONE TRUCKS WERE BRAND NEW AND TYPE-II TRUCKS WERE TWO YEARS OLD WITH NEW REPLACEMENT INJECTORS. THE TRUCKS TRAVELLED A COMBINED DISTANCE OF 450,000 KM.

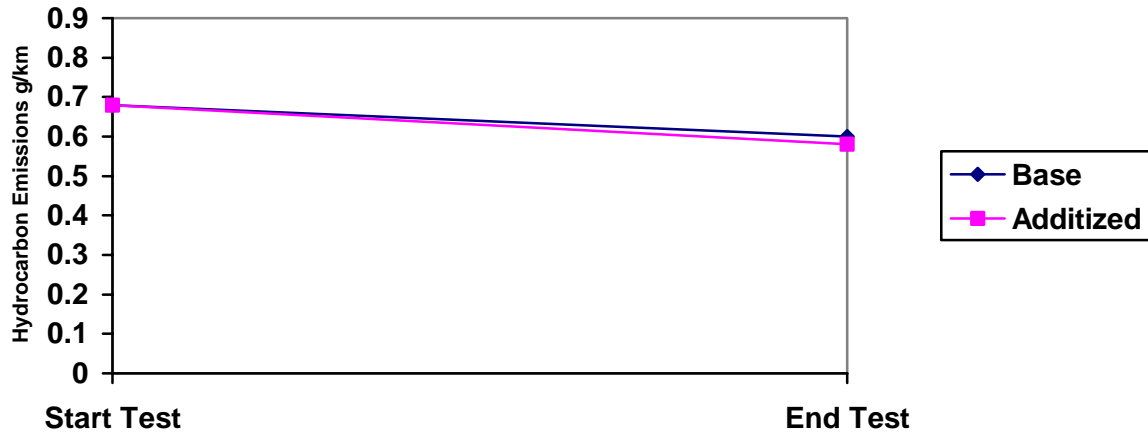
B. LIGHT DUTY PEUGEOT: TWO NEW MATCHED PEUGEOT 306 1.9 LITRE IDI DIESEL PASSENGER VEHICLES WERE RUN FOR 1000 KM USING A STANDARD DIESEL FUEL. THE CARS WERE THEN TRACK TESTED TO ENABLE A ROAD LOAD POWER CURVE TO BE OBTAINED FROM THE COAST-DOWN TIMES TO ENSURE ACCURATE SETTING OF TEST DYNAMOMETERS. THIS PROCEDURE WAS REPEATED WITH THE VEHICLES FULLY LADEN. NEW FLOWED AND MATCHED INJECTORS WERE INTRODUCED TO BOTH ENGINES AND THESE REMAINED WITH THE SAME VEHICLE THROUGH ALL TESTING. FROM THIS POINT THE VEHICLES WERE DESIGNATED AS A BASE OR AN ADDITIZED CAR AND A STRICT FUELLING REGIME WAS FOLLOWED DURING TESTING.



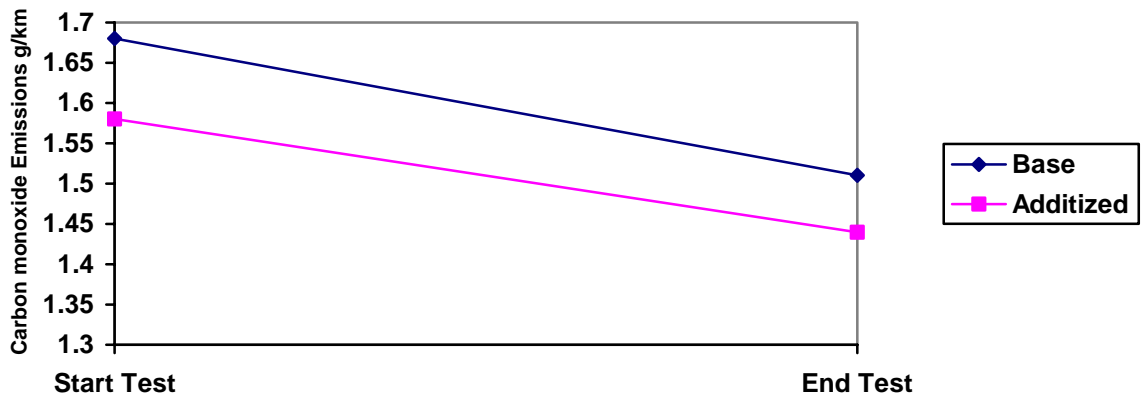
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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

HEAVY DUTY DI VEHICLES – HYDROCARBON EMISSIONS



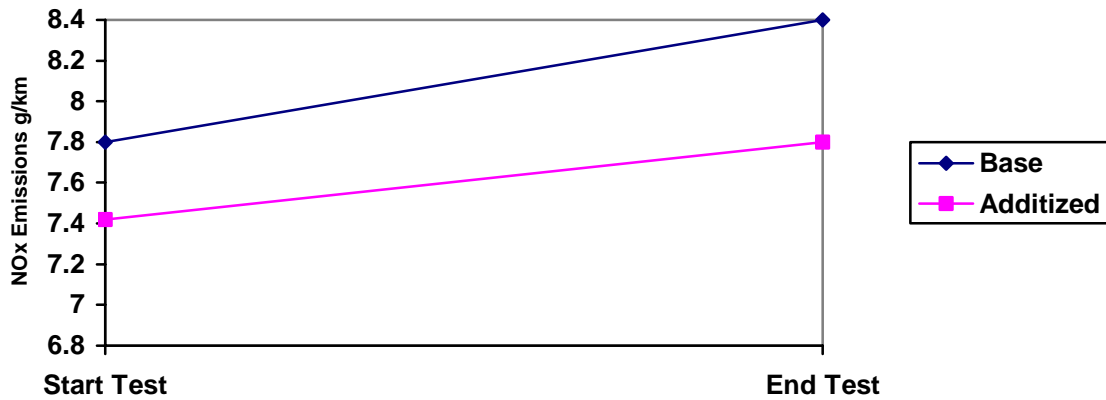
HEAVY DUTY DI VEHICLES – CARBON MONOXIDE EMISSIONS



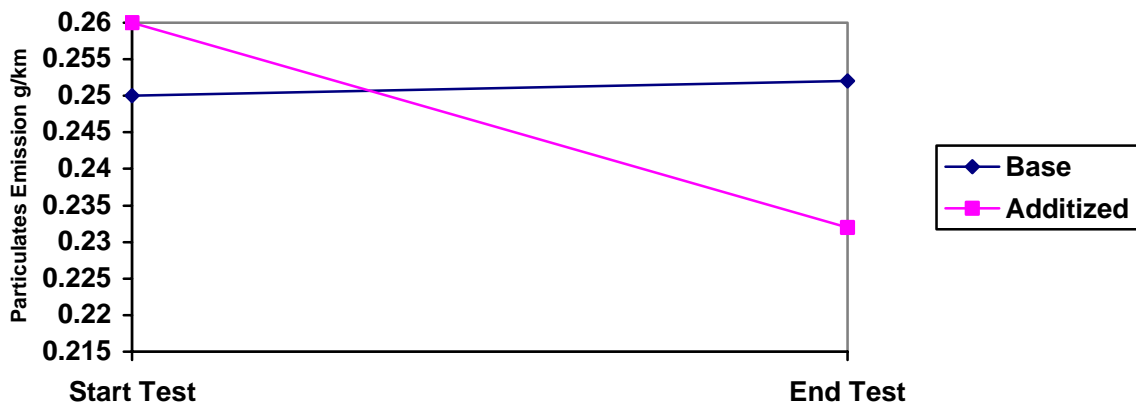
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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

HEAVY DUTY DI VEHICLES – NO_x EMISSIONS



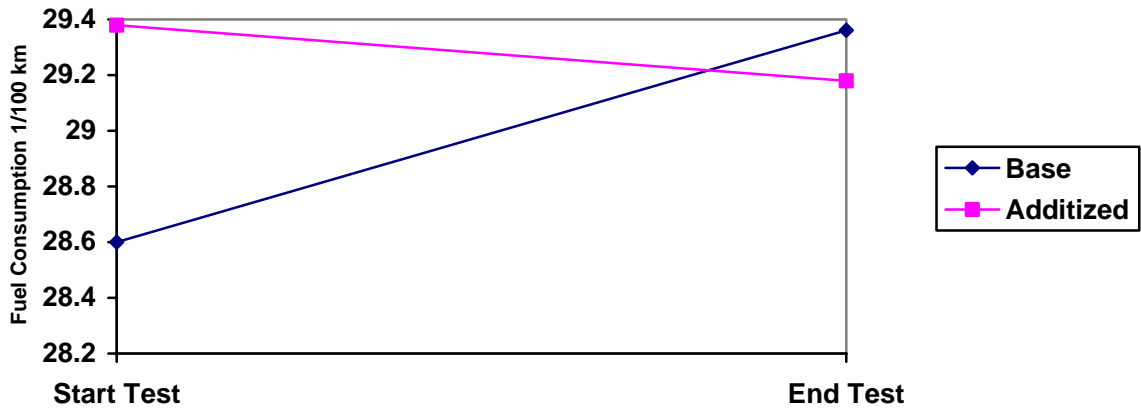
HEAVY DUTY DI VEHICLES – PARTICULATES EMISSIONS



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

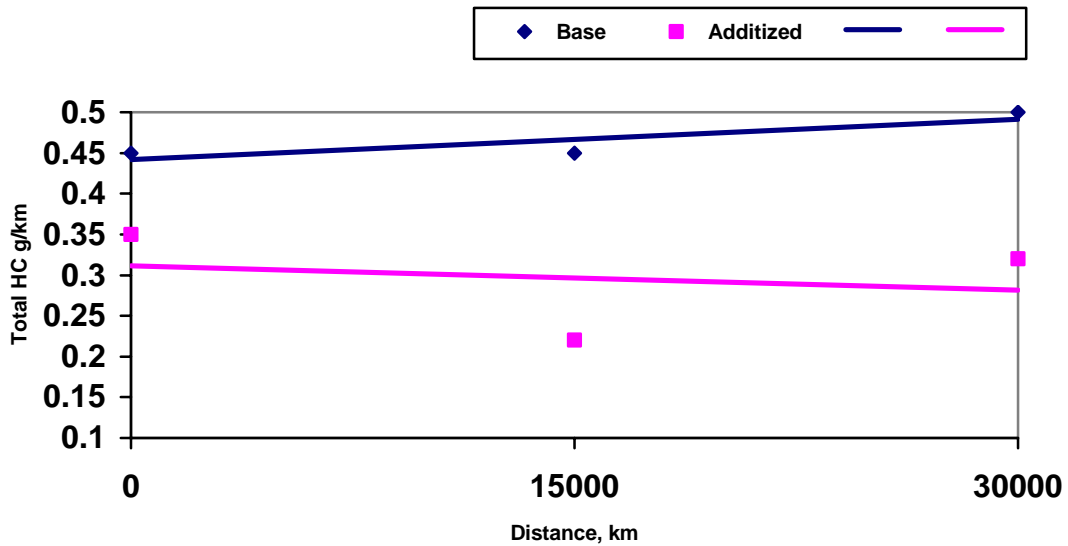
HEAVY DUTY DI VEHICLES – FUEL CONSUMPTION



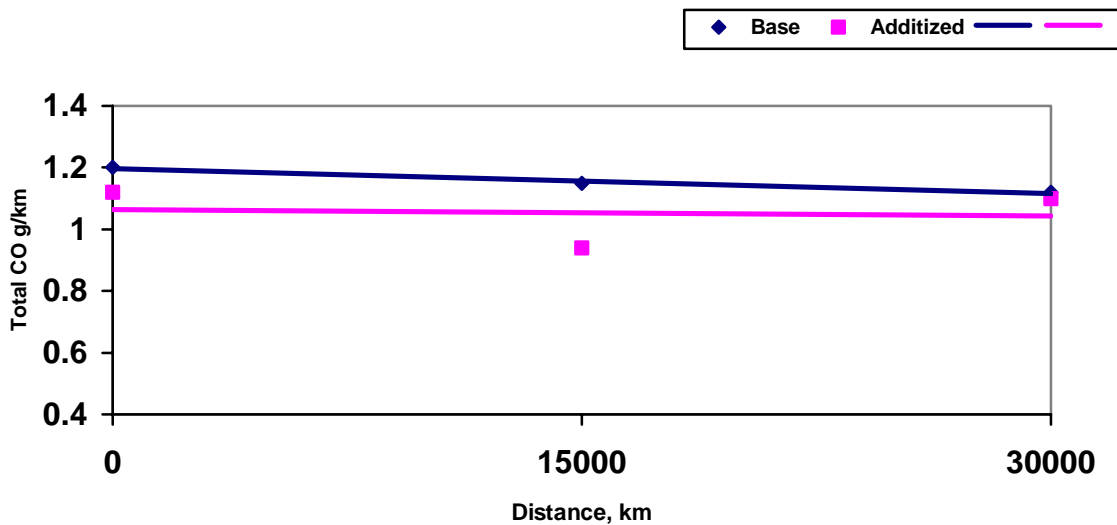
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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

PASSENGER VEHICLES – HYDROCARBON EMISSIONS (PEUGEOT 306)



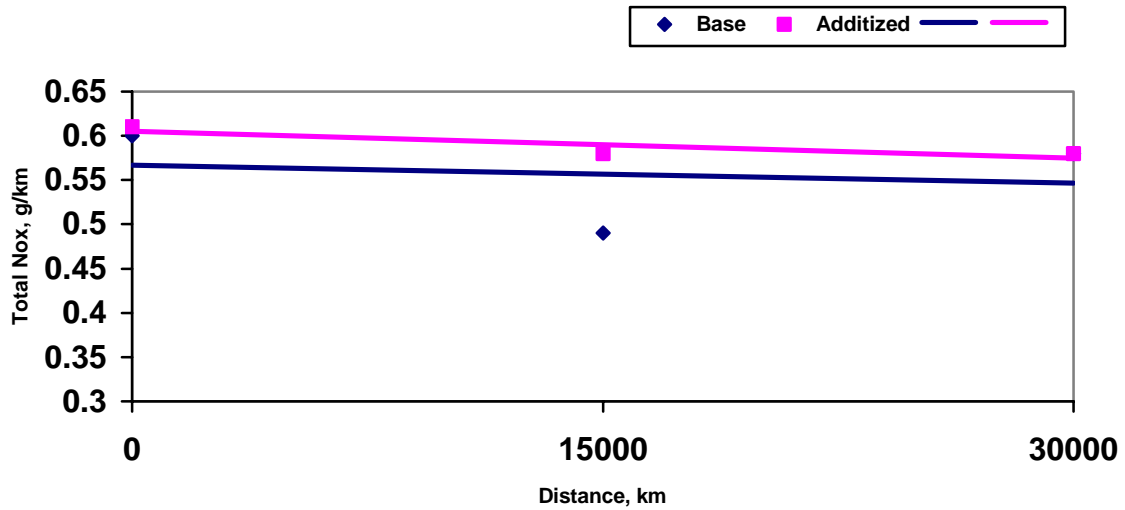
PASSENGER VEHICLES – CARBON MONOXIDE EMISSIONS (PEUGEOT 306)



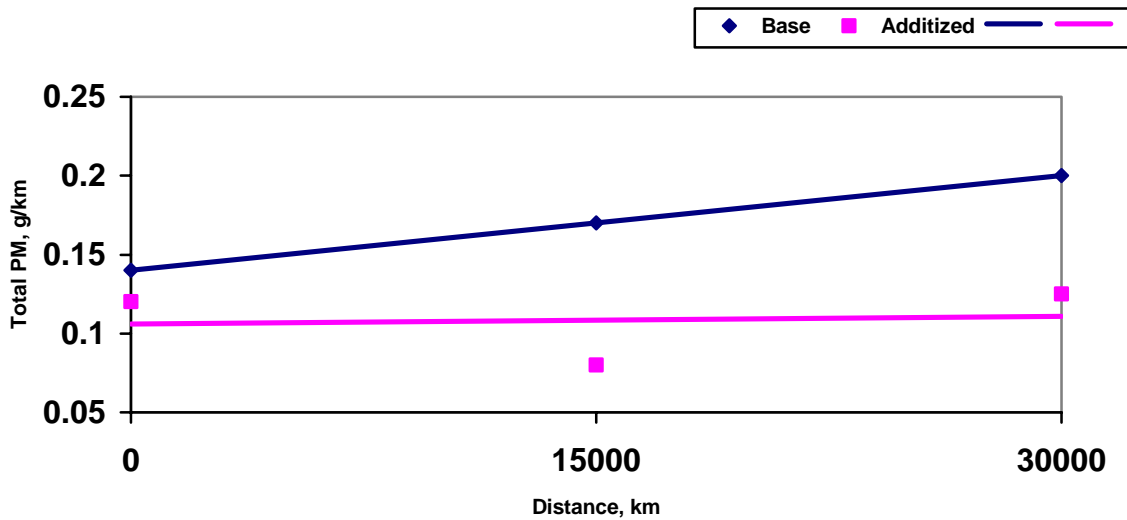
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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

PASSENGER VEHICLES – NO_x EMISSIONS (PEUGEOT 306)



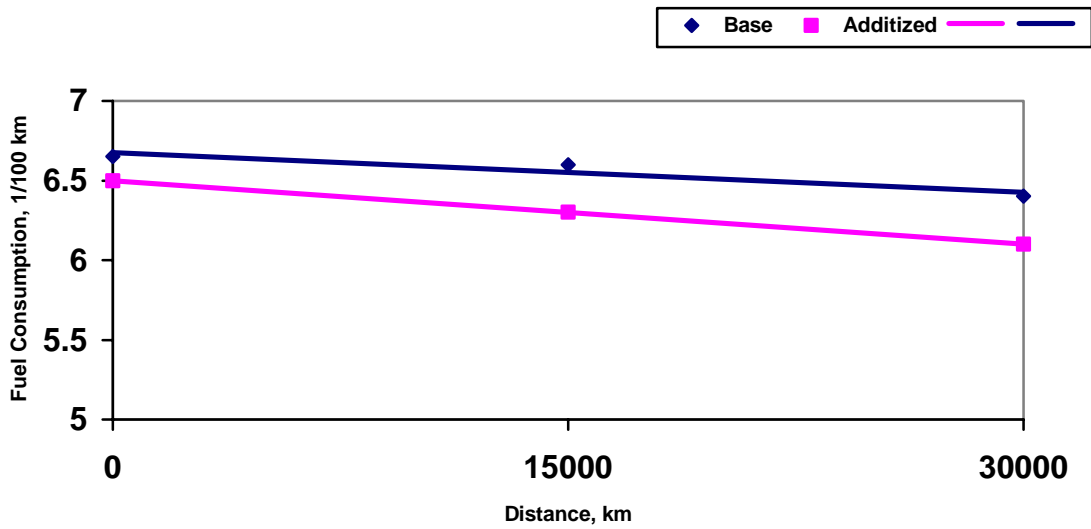
PASSENGER VEHICLES – PARTICULATE EMISSIONS (PEUGEOT 306)



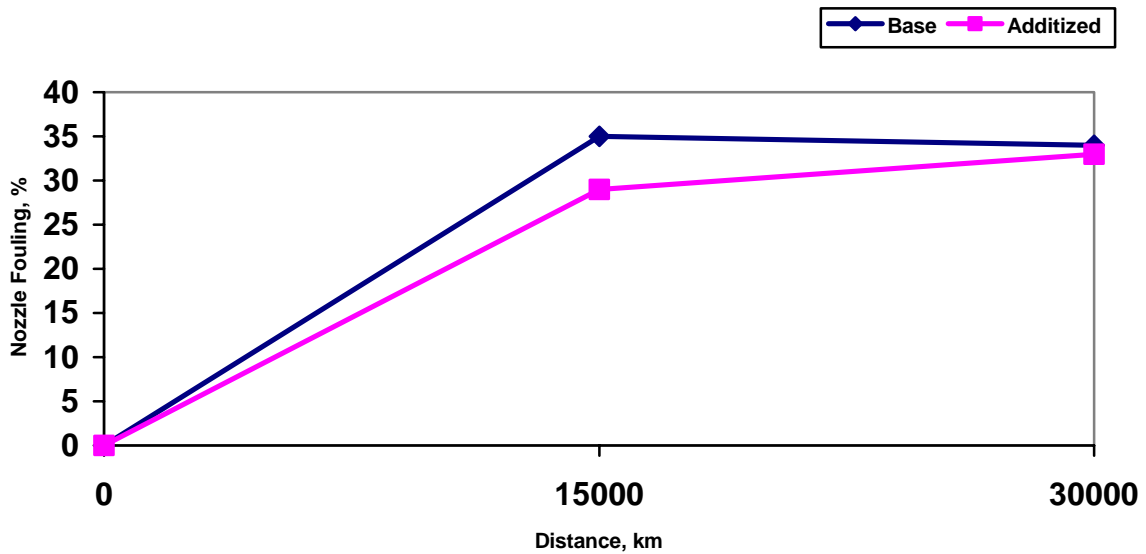
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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

PASSENGER VEHICLES –FUEL CONSUMPTION (PEUGEOT 306)



PASSENGER VEHICLES –NOZZLE FOULING (PEUGEOT 306)



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

SHORT TERM NO HARM EFFECTS - HEAVY DUTY DI ENGINE

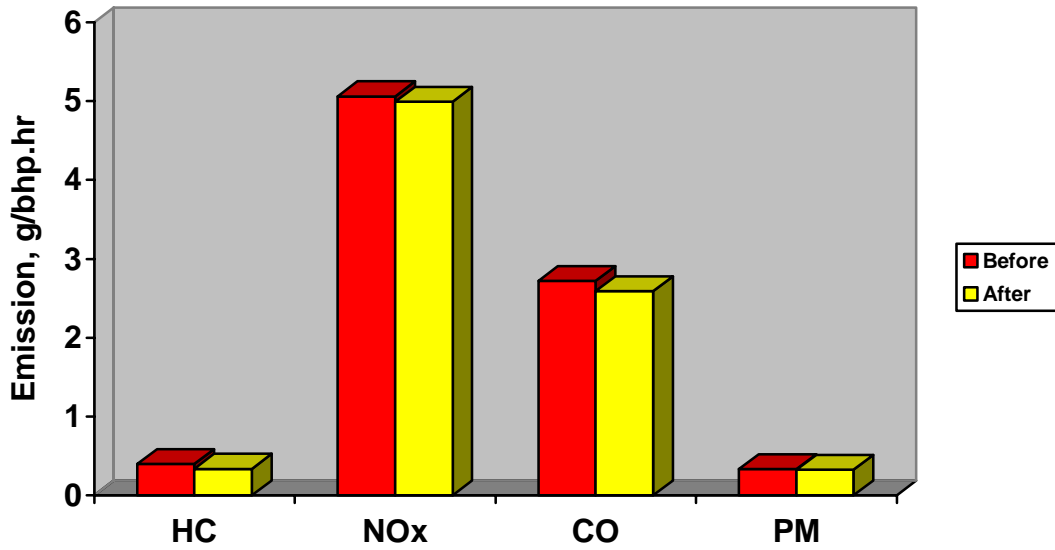
- A CUMMINS L-10 TEST BED ENGINE WAS USED TO DETERMINE THE POTENTIAL FOR INJECTOR DEPOSIT CLEAN-UP USING AFD 6550 AND TO ASSESS WHETHER A CHANGE IN ENGINE OUT EMISSIONS OCCURRED AS A CONSEQUENCE OF THIS CLEAN UP.
- THE ENGINE WAS RATED AT 225 KW @ 2100 RPM. THE TEST CYCLE WAS DIVIDED INTO FOUR PHASES:
 - PHASE 1 COMPRISED THE STANDARD 125-HOUR INJECTOR CUMMINS L-10 DEPOSITING TEST PROTOCOL 14183. CAT 1-K FUEL WAS USED DURING THIS DIRTY UP PHASE.
 - PHASE 2 WERE EMISSION TESTES PERFORMED ACCORDING TO THE EPA PROCEDURE FOR CERTIFICATION FOR HEAVY-DUTY DIESEL ENGINES, AS FOUND IN THE CODE OF FEDERAL REGULATIONS. A BASELINE USING AN UNTREATED CAT-1K FUEL WAS ESTABLISHED.
 - PHASE 3 WAS A CLEAN-UP CYCLE USING APPROXIMATELY 1140 LITERS OF COMMERCIALY AVAILABLE DIESEL FUEL EQUIVALENT TO ONE TANK FULL. THE ENGINE WAS OPERATED OVER A CYCLE OF 20 MINUTES EPA TRANSIENT CYCLE; 15 MINUTES RATED CONDITIONS AND 25 MINUTES AT A SPEED AND LOAD EQUIVALENT TO 60 MPH OPERATION, FOR A TOTAL OF 35 HOURS.
 - PHASE 4 WAS A FURTHER SET OF EMISSIONS TESTS USING UNTREATED CAT-1K TO ESTABLISH ANY CLEAN UP BENEFITS COMPARED TO THE INITIAL TEST MEASUREMENTS.



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

SHORT TERM NO HARM EFFECTS – CUMMINS L-10 ENGINE



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

SHORT TERM NO HARM EFFECTS – PASSENGER VEHICLES

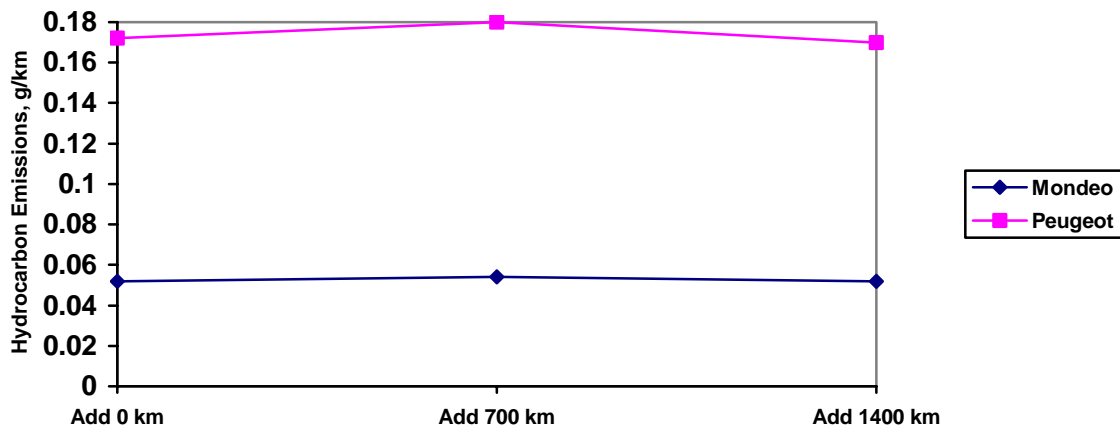
- A 1.9 LITRE NORMALLY ASPIRATED INDI PEUGEOT 306 AND A 1.8 LITRE CATALYSED INDI FORD MONDEO TURBO WERE CHOSEN TO QUANTIFY THE EMISSIONS IMPACT OF DETERGENT AFTER TWO TANK FULLS.
- THREE ECE URBAN AND EXTRA URBAN EMISSION TESTS WERE COMPLETED ON EACH VEHICLE AT THEIR 'AS FOUND' CONDITION USING COMMERCIAL FUEL ADDITIZED WITH THE DETERGENT PACKAGE.
- A CLEAN UP DISTANCE OF 700 KM WAS THEN ACCUMULATED ON BOTH VEHICLES AT A FULLY LADEN ROAD LOAD USING THE ADDITIZED FUEL TO ESTABLISH THE EFFECT OF APPROXIMATELY ONE "TANK FULL".
- THREE ECE URBAN AND EXTRA URBAN EMISSION TESTS WERE CARRIED OUT TO ASSESS EMISSION CHANGES. THE CLEAN UP PHASE WAS EXTENDED TO INCLUDE ANOTHER 700 KM USING FUEL ADDITIZED WITH DETERGENT AND EMISSION TESTS WERE REPEATED.



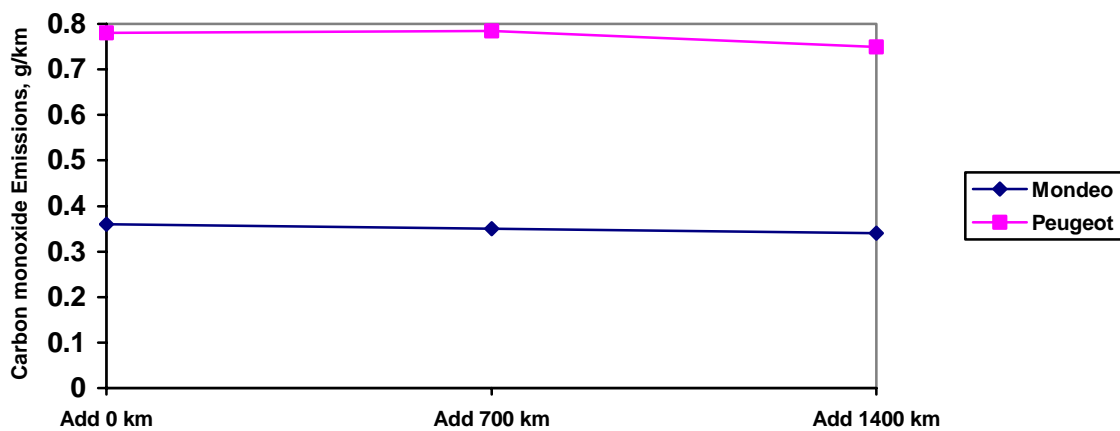
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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

SHORT TERM NO HARM EFFECTS – HYDROCARBON EMISSIONS



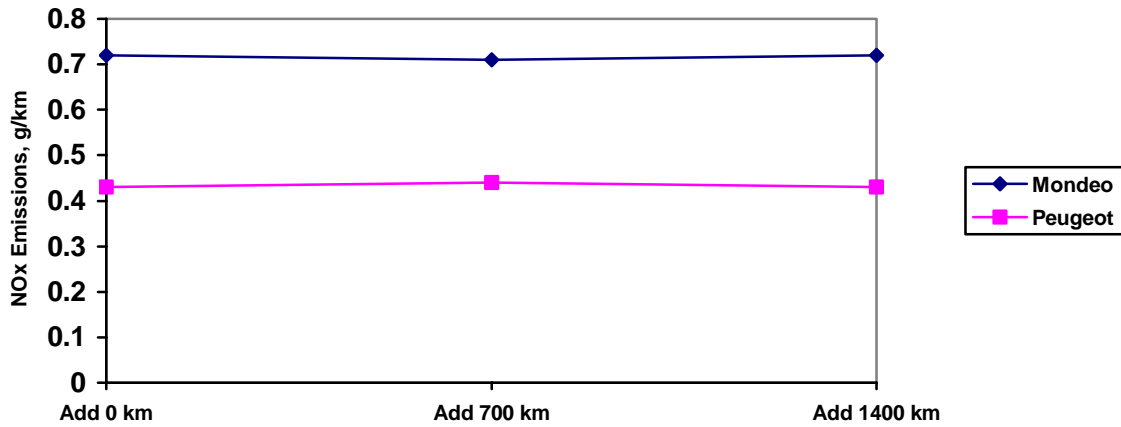
SHORT TERM NO HARM EFFECTS – CARBON MONOXIDE EMISSIONS



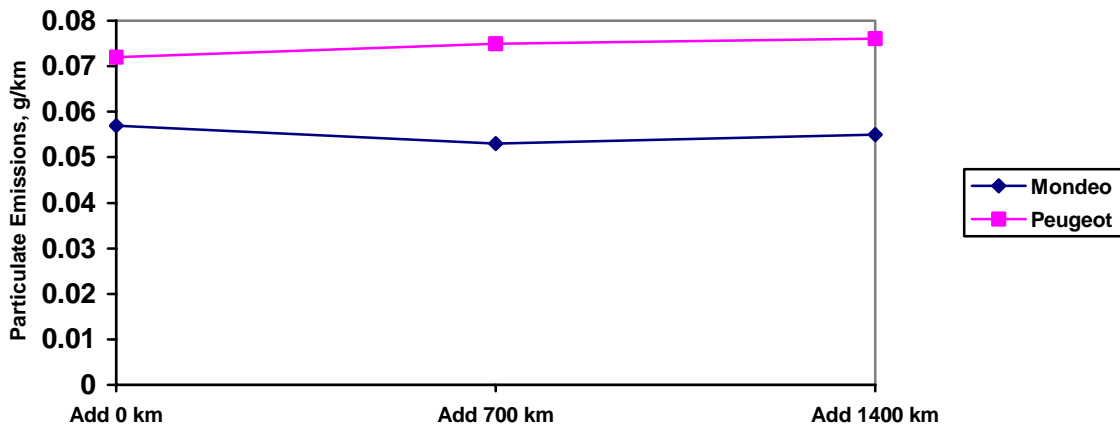
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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

SHORT TERM NO HARM EFFECTS – NO_x EMISSIONS



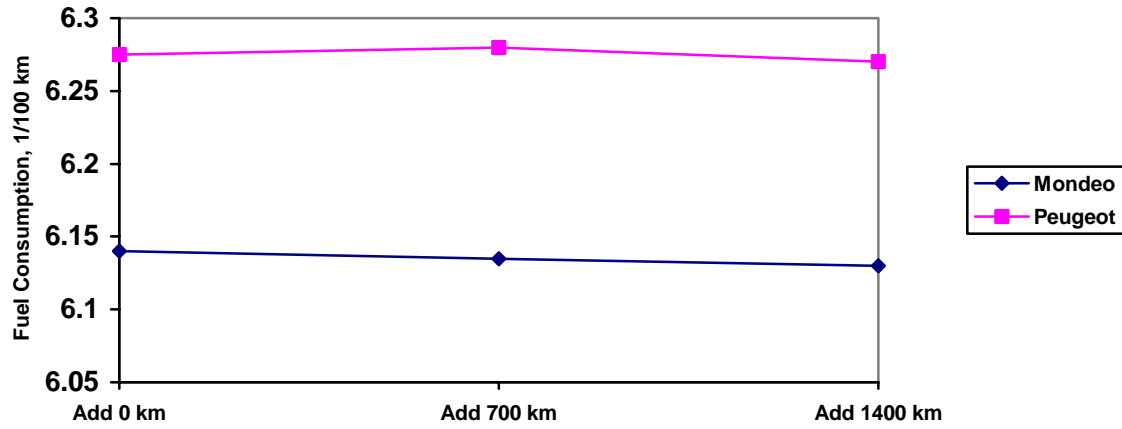
SHORT TERM NO HARM EFFECTS – PARTICULATE EMISSIONS



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

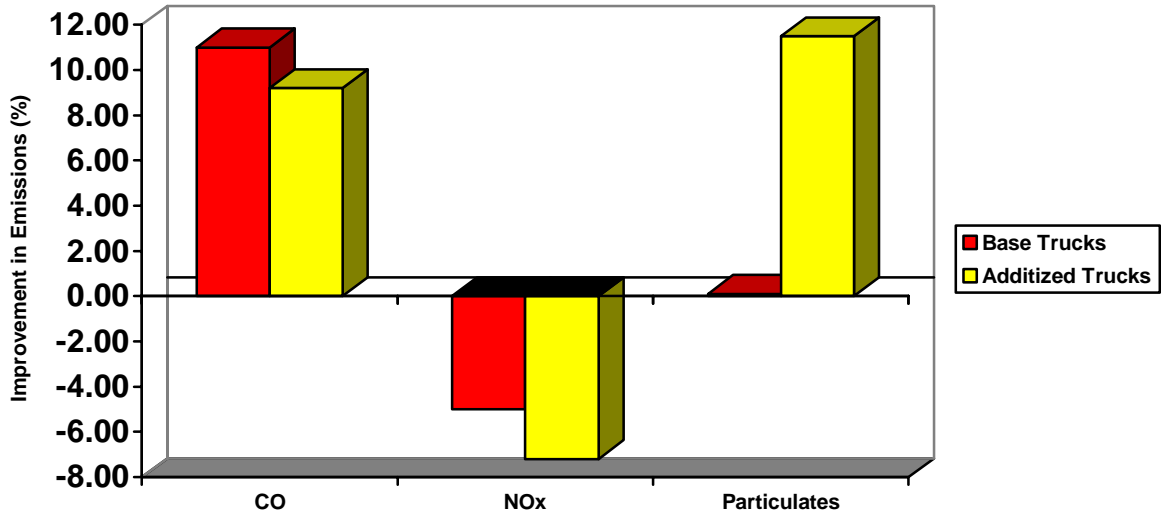
SHORT TERM NO HARM EFECTS – FUEL CONSUMPTION



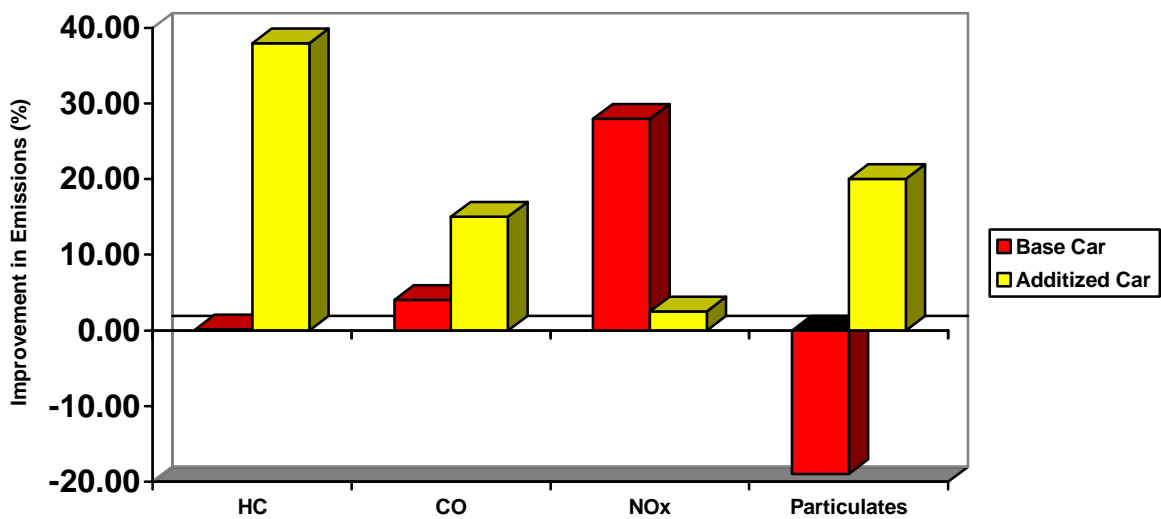
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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

PERCENTAGE EMISSION IMPROVEMENTS – TRUCKS



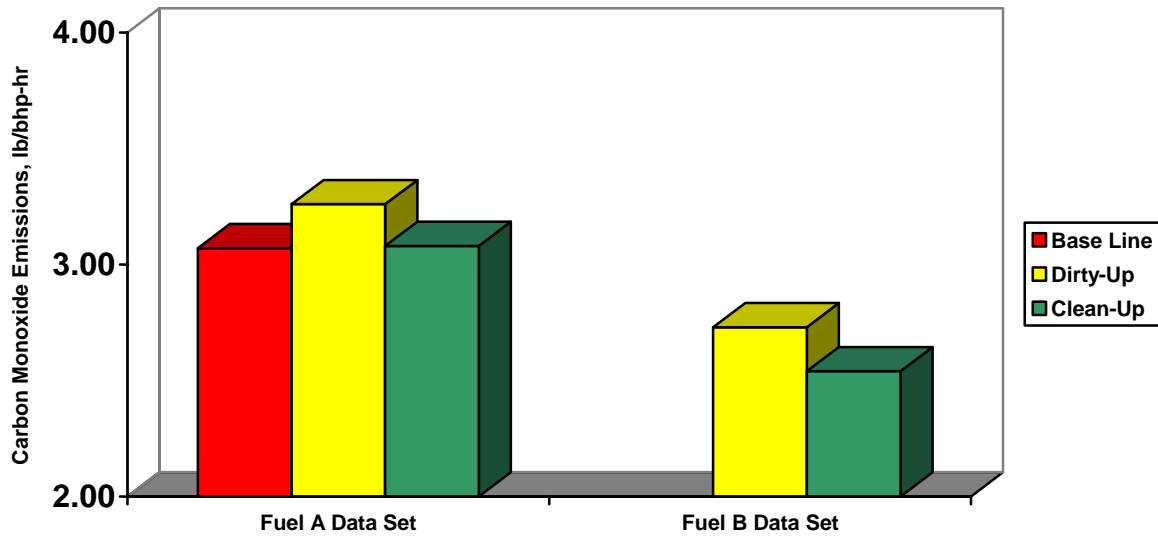
PERCENTAGE EMISSION IMPROVEMENTS – CARS



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

CARBON MONOXIDE EMISSIONS DATA



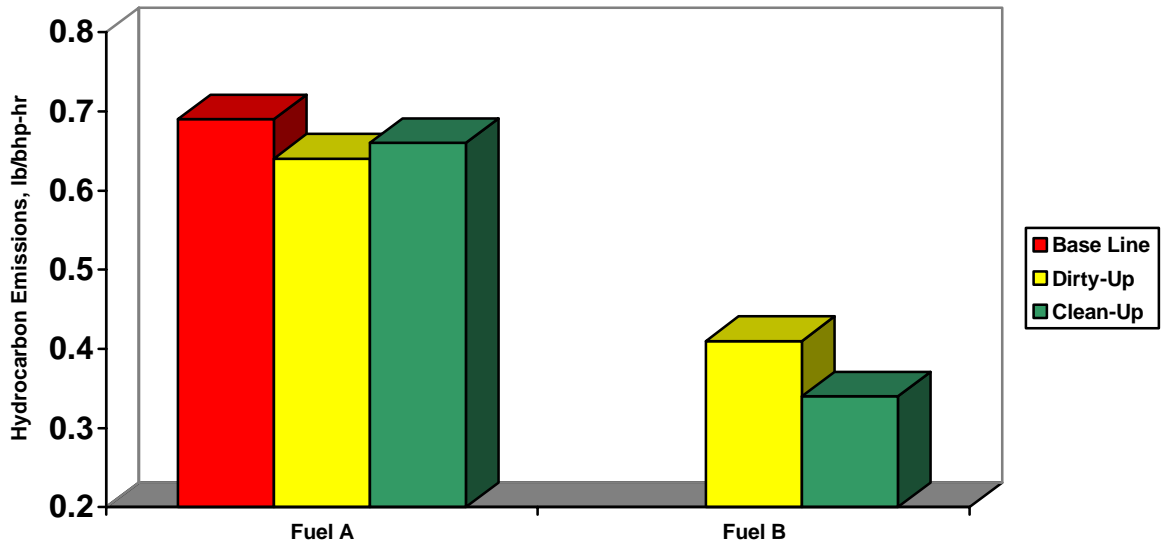
- DIRTY-UP FUEL FOR FUEL “A” DATA WAS COMMERCIAL LOW SULFUR
- DIRTY-UP FUEL FOR FUEL “B” DATA WAS CAT-1K (0.4% S)
- TREATMENT RATE FOR FUEL A WAS 110 PPMV OF AFD-6550
- TREATMENT RATE FOR FUEL B WAS 123 PPMV OF AFD-6550



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

HYDROCARBON EMISSIONS DATA



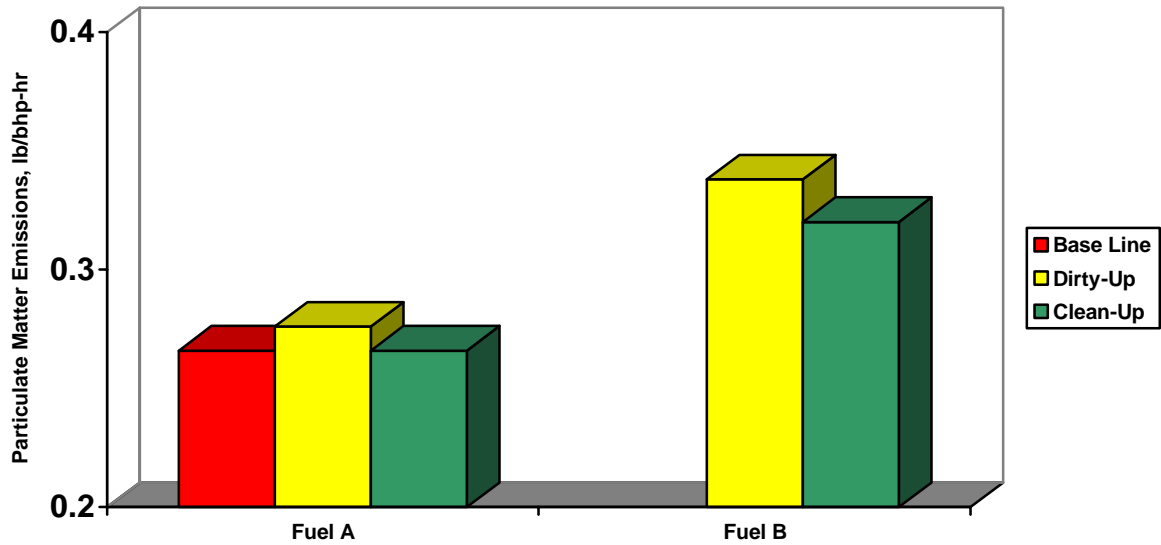
- DIRTY-UP FUEL FOR FUEL "A" DATA WAS COMMERCIAL LOW SULFUR
- DIRTY-UP FUEL FOR FUEL "B" DATA WAS CAT-1K (0.4% S)
- TREATMENT RATE FOR FUEL A WAS 110 PPMV OF AFD-6550
- TREATMENT RATE FOR FUEL B WAS 123 PPMV OF AFD-6550



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

PARTICULATE MATTER EMISSIONS DATA



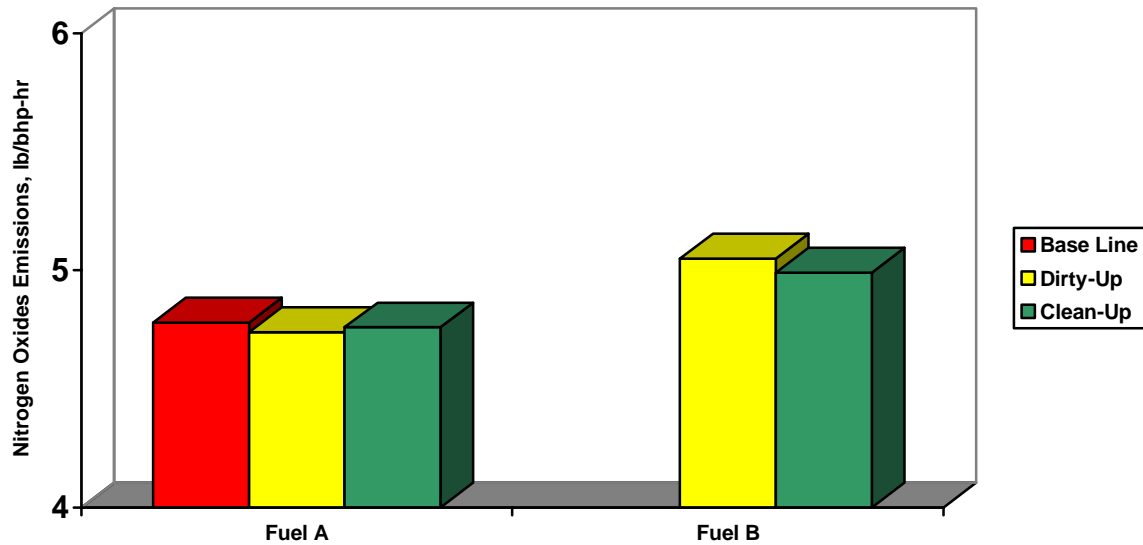
- DIRTY-UP FUEL FOR FUEL “A” DATA WAS COMMERCIAL LOW SULFUR
- DIRTY-UP FUEL FOR FUEL “B” DATA WAS CAT-1K (0.4% S)
- TREATMENT RATE FOR FUEL A WAS 110 PPMV OF AFD-6550
- TREATMENT RATE FOR FUEL B WAS 123 PPMV OF AFD-6550



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

NITROGEN OXIDES EMISSIONS DATA



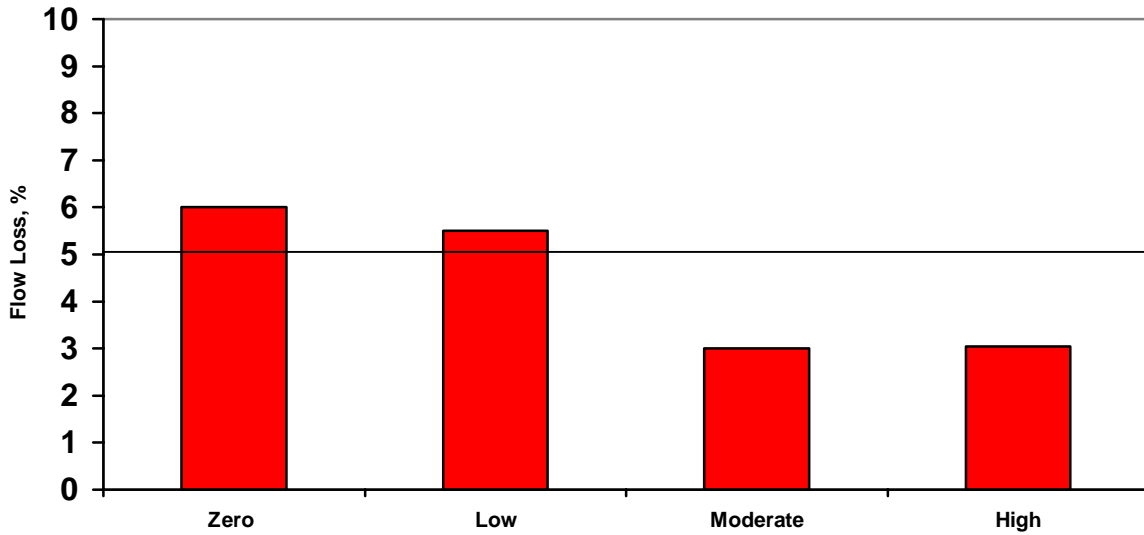
- DIRTY-UP FUEL FOR FUEL “A” DATA WAS COMMERCIAL LOW SULFUR
- DIRTY-UP FUEL FOR FUEL “B” DATA WAS CAT-1K (0.4% S)
- TREATMENT RATE FOR FUEL A WAS 110 PPMV OF AFD-6550
- TREATMENT RATE FOR FUEL B WAS 123 PPMV OF AFD-6550



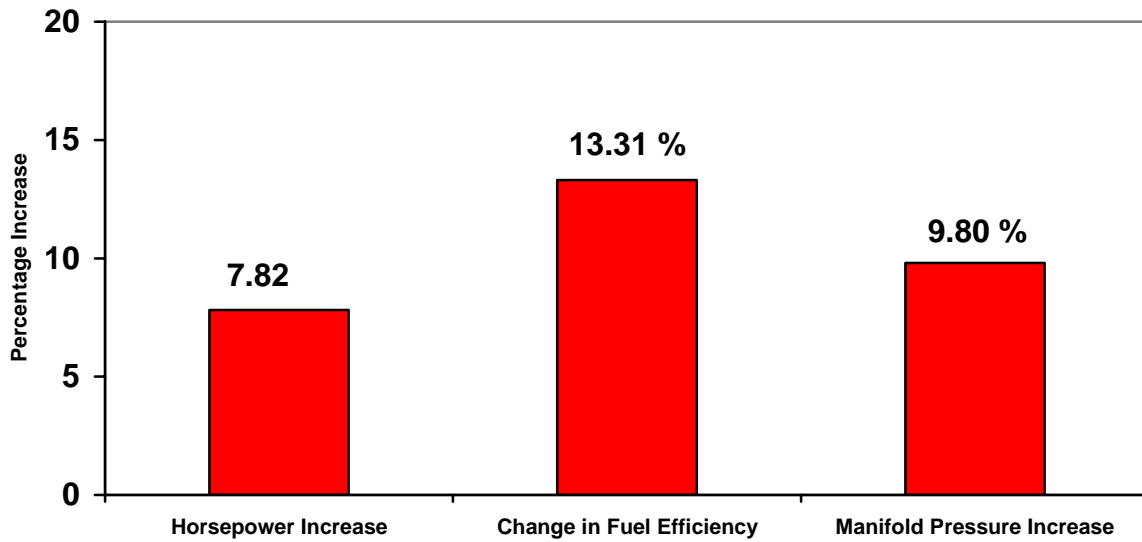
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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

FUEL ECONOMY – INJECTOR FLOW LOSS IN CUMMINS L-10 ENGINE TESTS



FUEL ECONOMY – BRAKE SPECIFIC FUEL CONSUMPTION



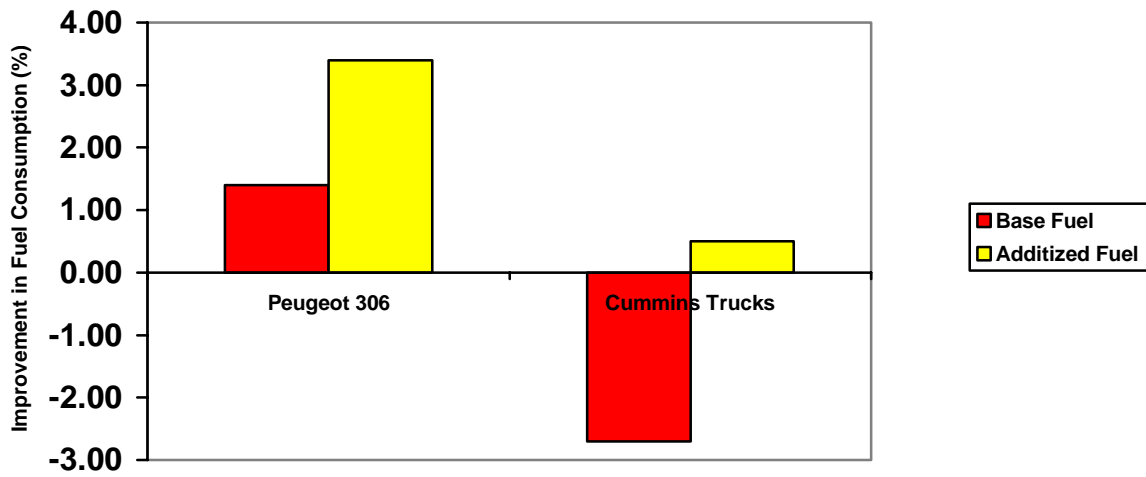
ADDITIVE TREATMENT RATE WAS 400 PPMV OF AFD-6550



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

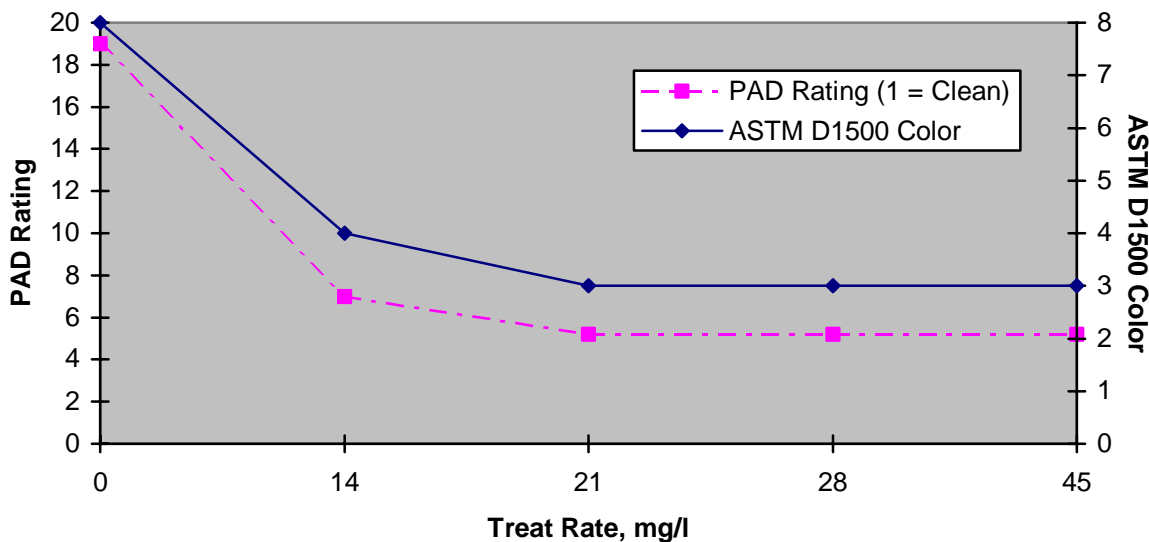
FUEL ECONOMY – PERCENTAGE FUEL CONSUMPTION CHANGES



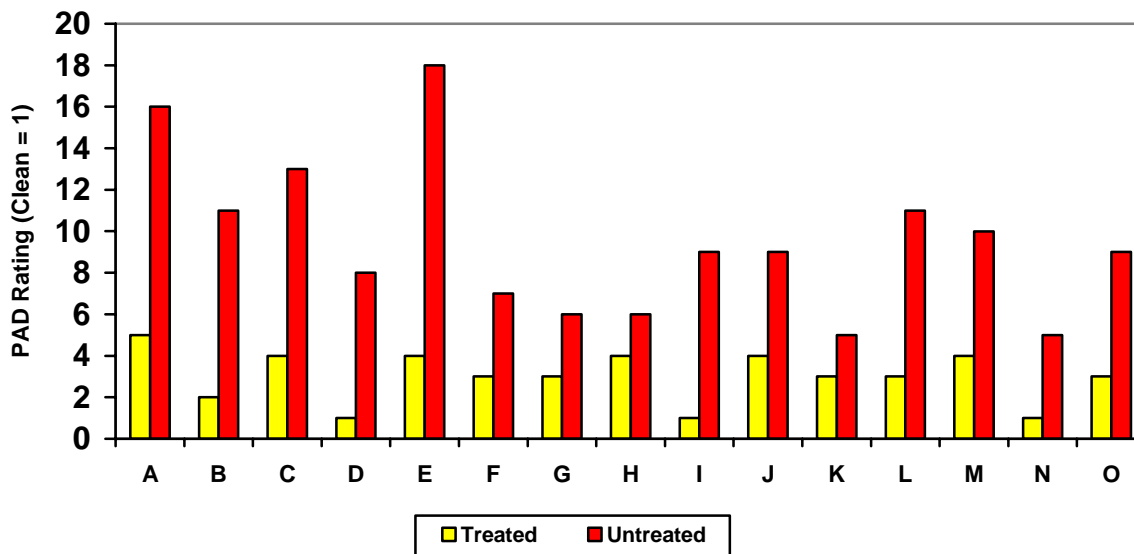
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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

FUEL STABILITY – F-21 HIGH TEMPERATURE TEST



FUEL STABILITY – D6864 THERMAL STABILITY



A – Dallas, TX; B – Atlanta, GA; C – Nashville, TN; D – Lowell, AR; E – Baton Rouge, LA; F – Springfield, MO; G – Columbia, MO; H – Harrison, AR; I – Jackson, MS; J – Memphis, TN; K – Tulsa, OK; L – Ft. Smith, AR; M – Chicago, IL; N – Wichita, KS; O – Oklahoma City, OK.



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PREMIUM DIESEL DETERGENT INHIBITOR CONCENTRATE

FUEL STABILITY – OXIDATION STABILITY

| Additive Treat Rate | Total Insolubles, mg/100 ml | Improvement, % |
|----------------------------|------------------------------------|-----------------------|
| Zero | 0.757 | - |
| Moderate | 0.599 | 21 |

FUEL STABILITY – CORROSION RESISTANCE

| Additive Treat Rate | NACE Scale Rating | Pass/Fail |
|----------------------------|--------------------------|------------------|
| Zero | E | Fail |
| Moderate | A | Pass |

