

SOY BIODIESEL



SOY BIODIESEL



TWO



MILLION MILE

HAUL

B20 FIELD DOCUMENTATION PROGRAM



## Partners

Decker Truck Line, Inc. (DTL)



National Biodiesel Board (NBB)



Renewable Energy Group, Inc. (REG)



Iowa Soybean Association (ISA)



Caterpillar Engine Company (CAT)



Iowa Central Community College (ICCC)



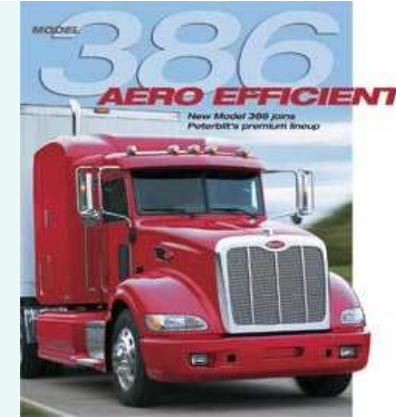
U.S. Dept. of Agriculture (USDA)

- Study design

- Many fleet studies done, but little publicly available information exists regarding long-term over-the-road use
- Much evidence for biodiesel as an engine lubricant (thus replacing lubricity lost due to removal of S)
- Will monitor fuel efficiency, maintenance costs, and engine oil life
- Will do engine tear-down for wear analysis
- 10 control units and 10 matched test units (new '06 and '07 models)
- Control uses 100% #2 diesel
- Test uses 20% blend of soy biodiesel with #2 petroleum diesel (B20)
- Test will run for two years, or approximately 3 million miles

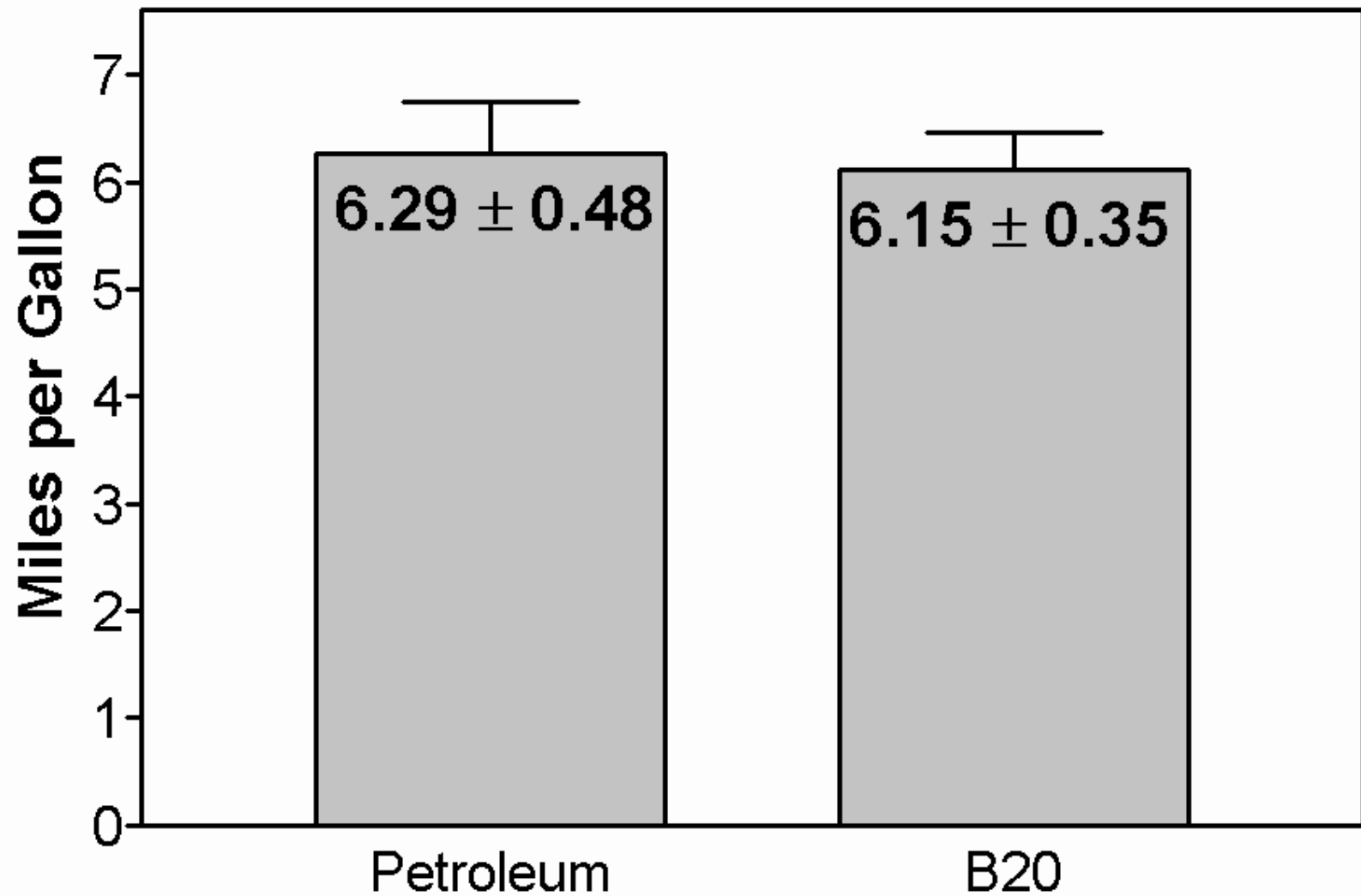


# Truck Specifications

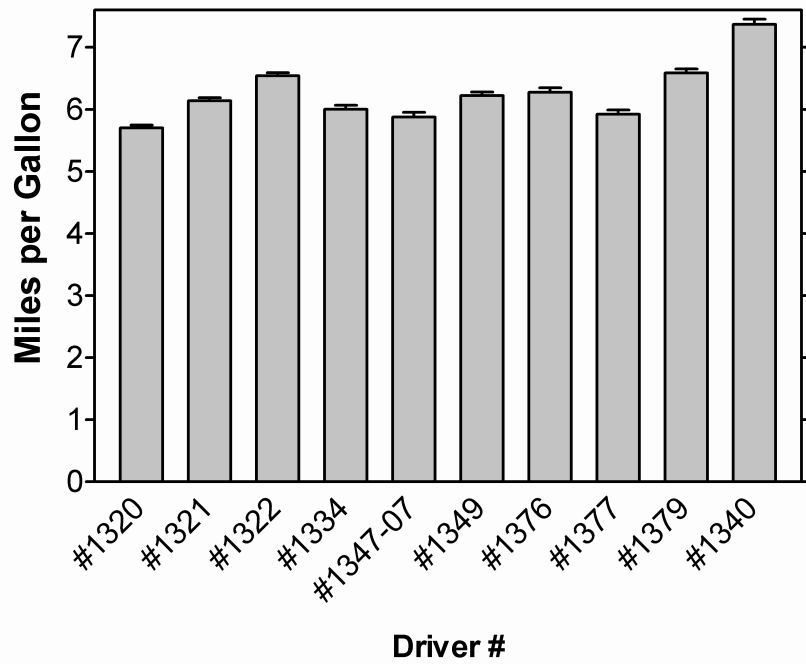


Control Truck	B20 Match	Model	'07 Eng.	Wheels	Sleeper	Destination
1320	1325	379	No	Duals	Yes	Minneapolis
1321	1323	379	No	Duals	Yes	Chicago
1322	1324	379	No	Duals	Yes	Chicago
1334	1335	379	No	Singles	Yes	Minneapolis
1340	1341	386	No	Duals	Yes	Chicago
1347	1348	379	Yes	Duals	Yes	Chicago
1349	1346	386	No	Duals	No	Minneapolis
1376	1336	379	No	Duals	Yes	Minneapolis
1377	1375	379	No	Duals	Yes	Minneapolis
1379	1378	379	No	Duals	Yes	Chicago

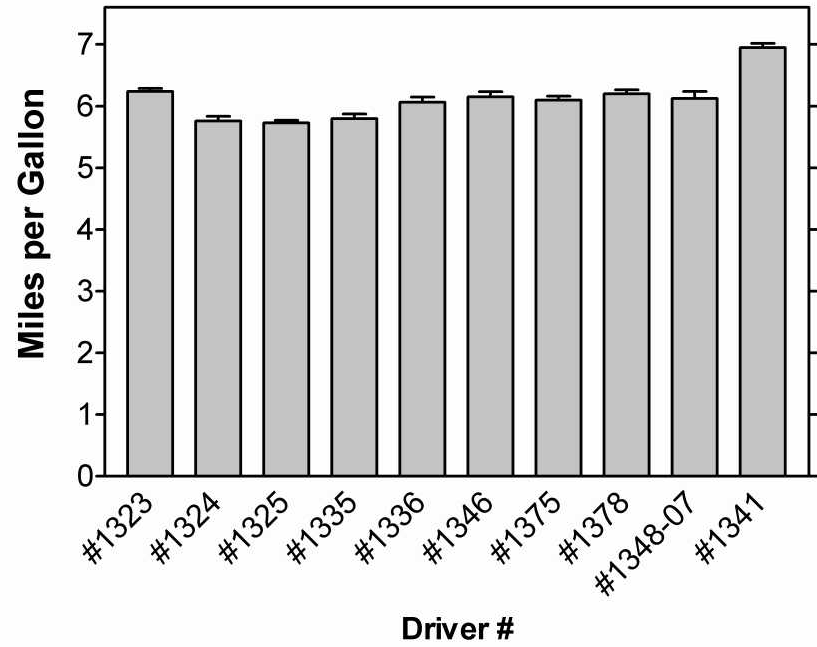
## Average Fuel Efficiency



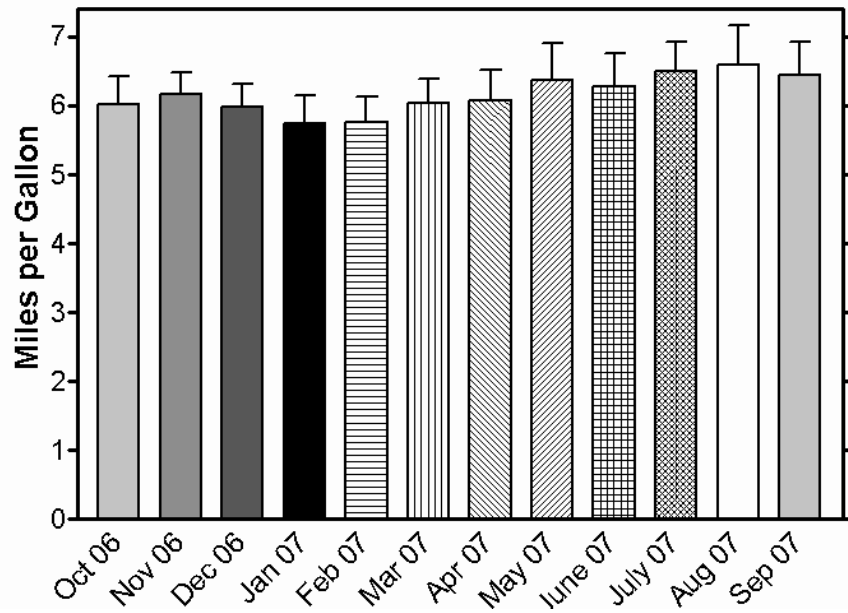
**Fuel Efficiency by Driver: Petroleum**



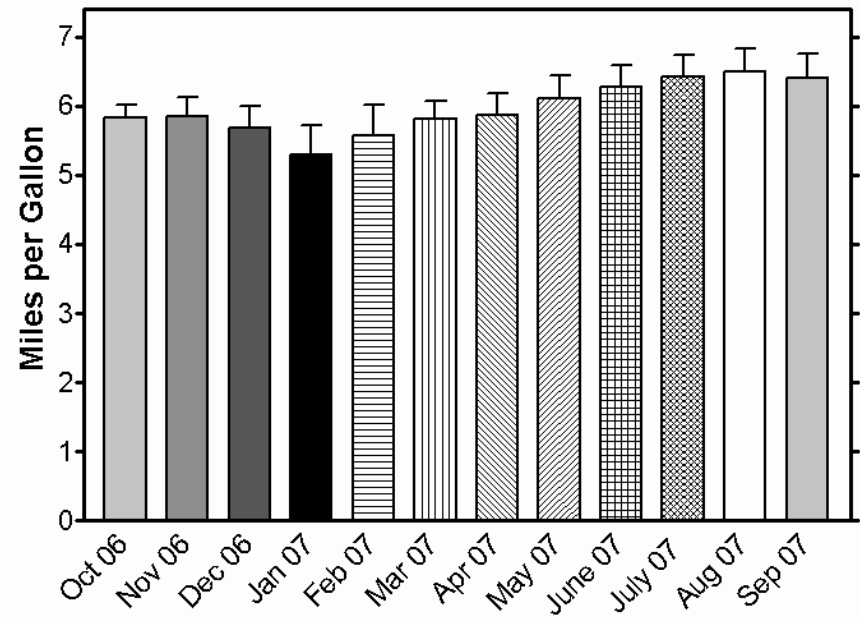
**Fuel Efficiency by Driver: B20**



**Monthly Fuel Efficiency: Petroleum**

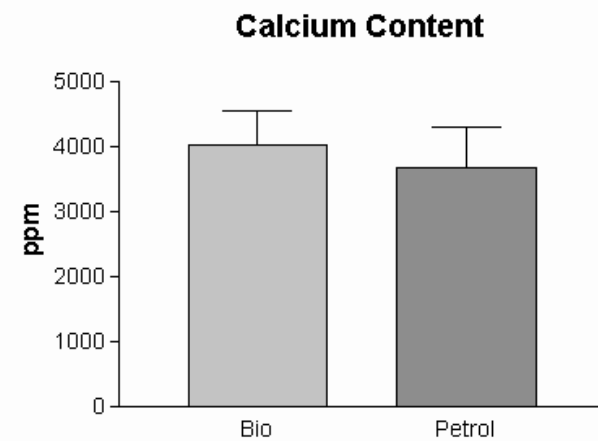
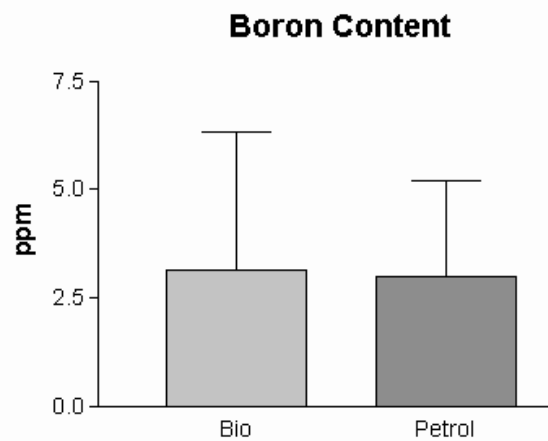
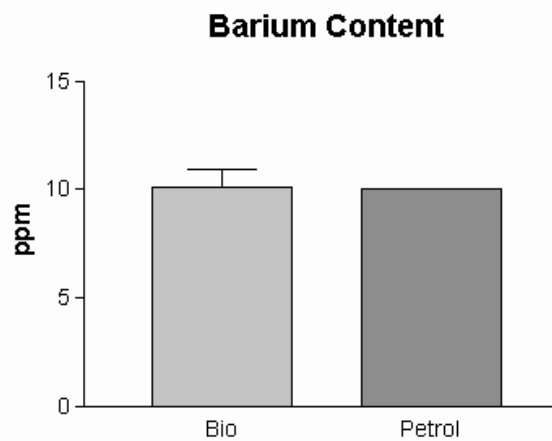
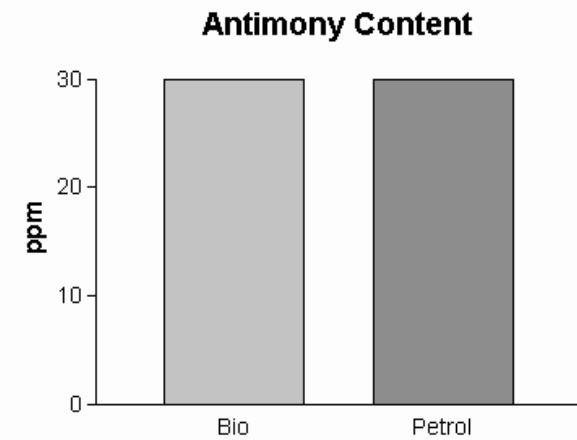
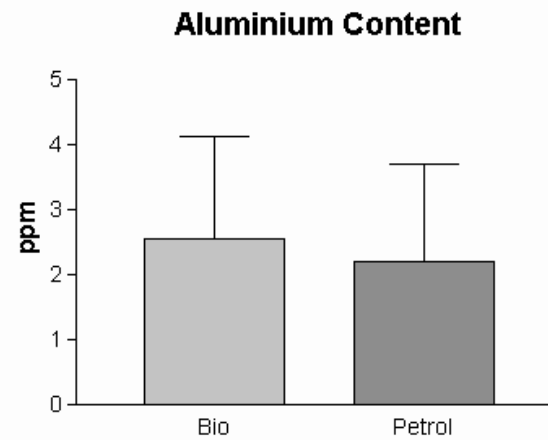
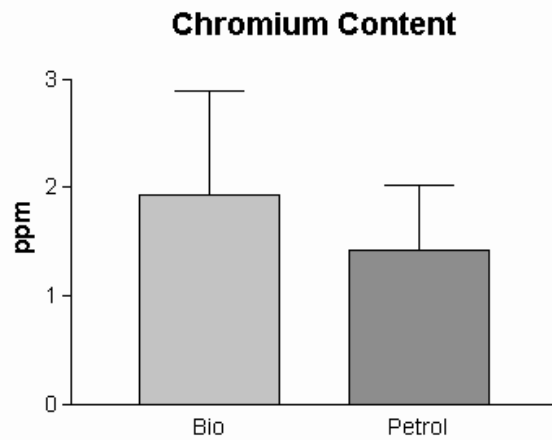


**Monthly Fuel Efficiency: B20**

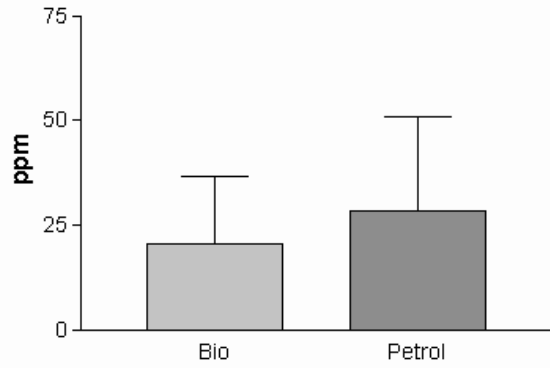


# Engine Oil Analysis

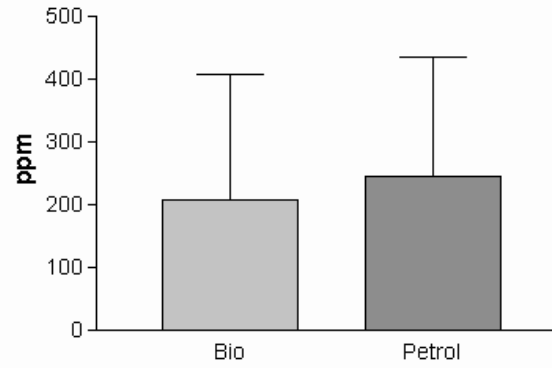
## Metals content by ICP (Shell Oil lab)



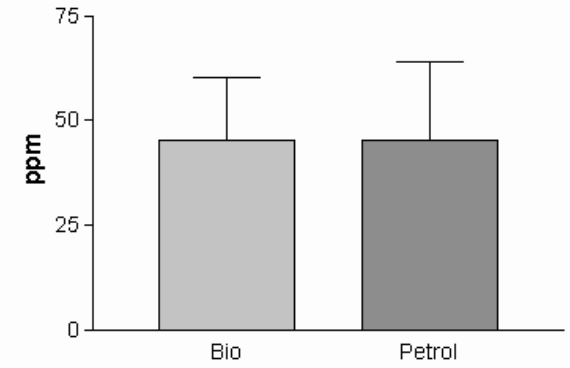
**Silicon Content**



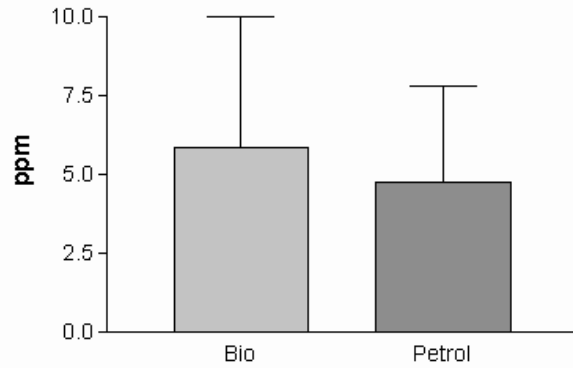
**Copper Content**



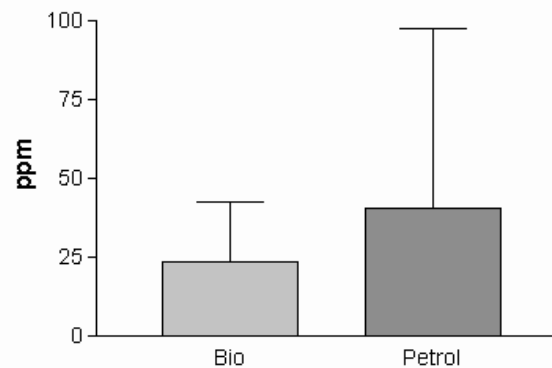
**Iron Content**



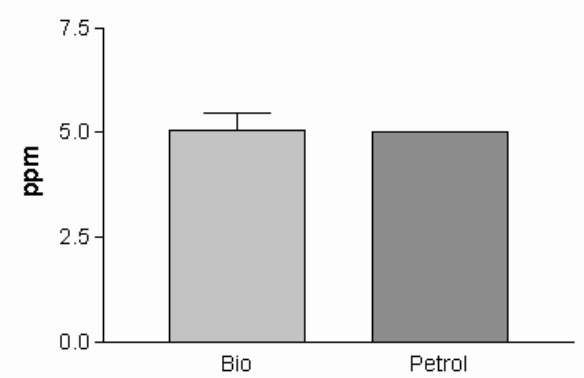
**Lead Content**



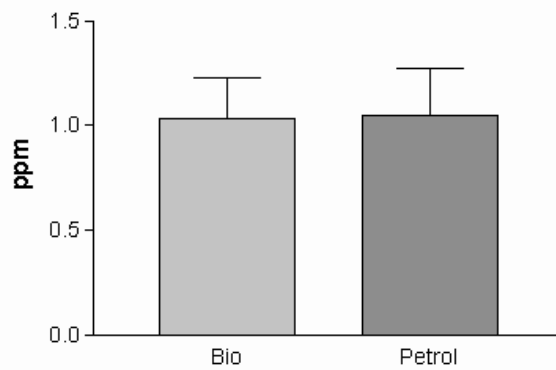
**Magnesium Content**



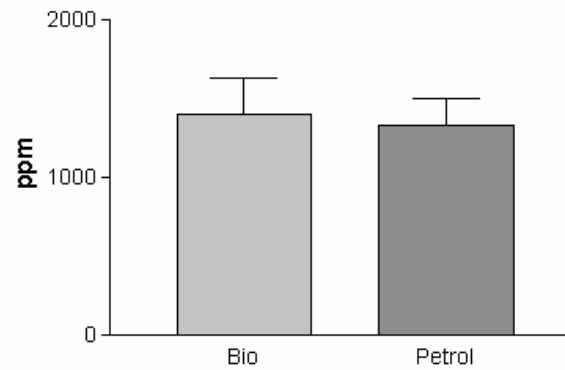
**Molybdenum Content**



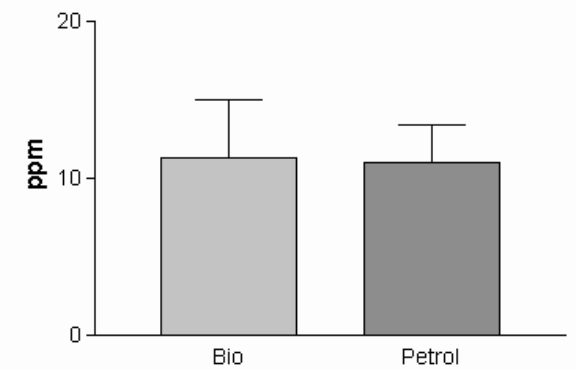
**Nickel Content**



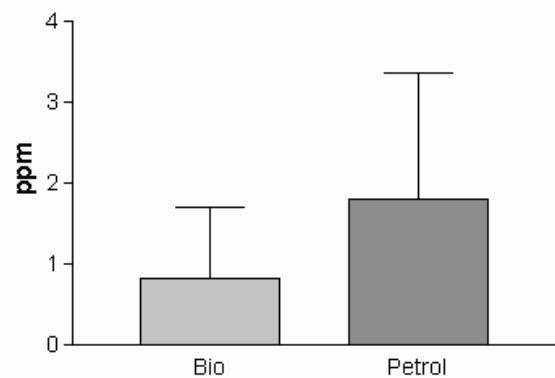
**Phosphorus Content**



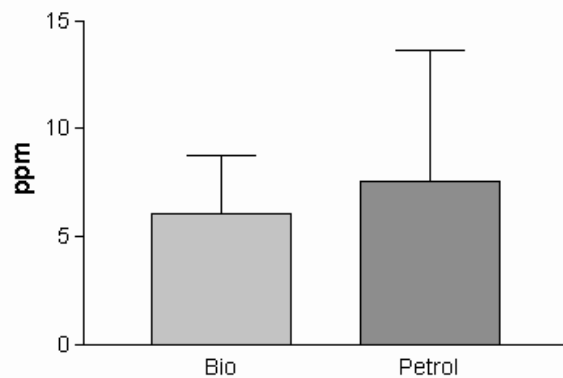
**Potassium Content**



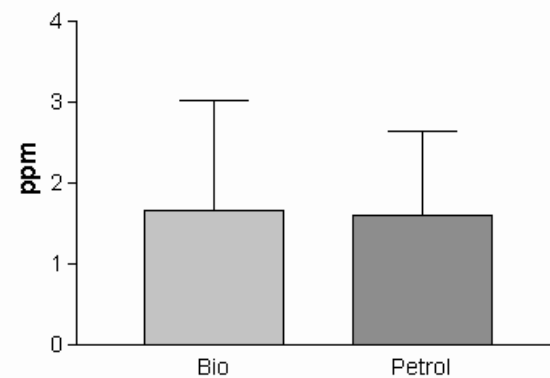
**Silver Content**



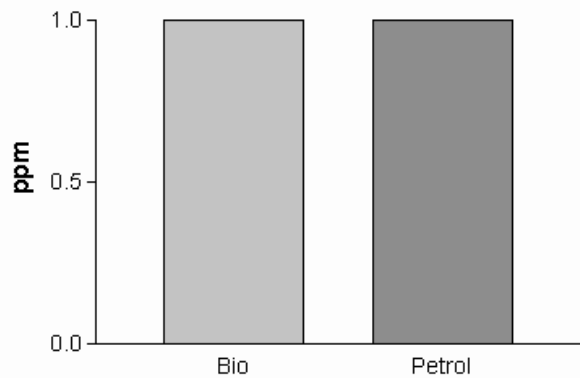
**Sodium Content**



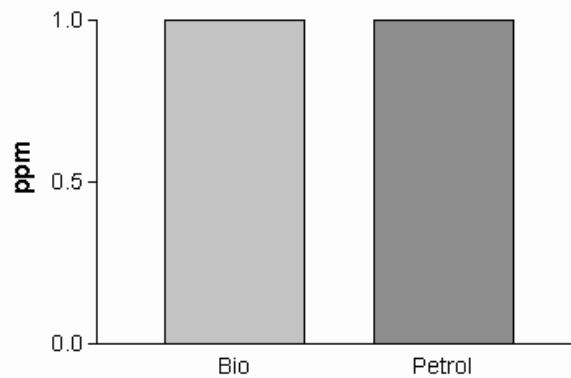
**Tin Content**



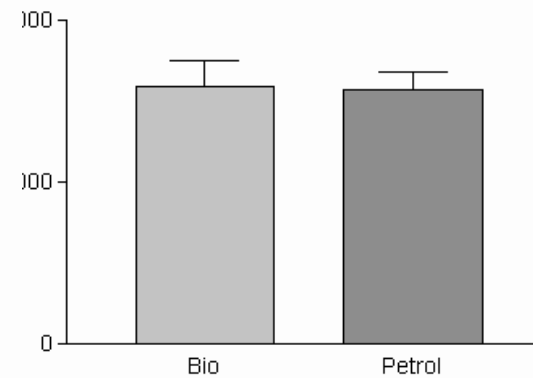
**Titanium Content**



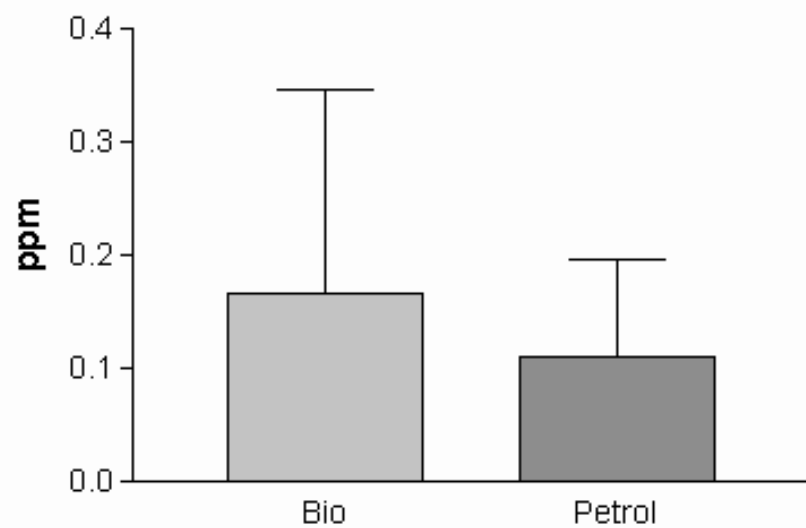
**Vanadium Content**



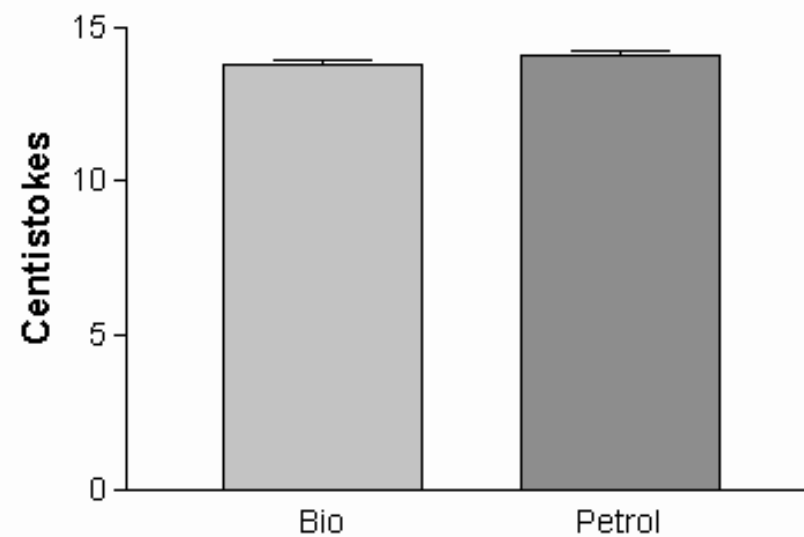
**Zinc Content**



### Fuel Soot



### Viscosity @ 100°C



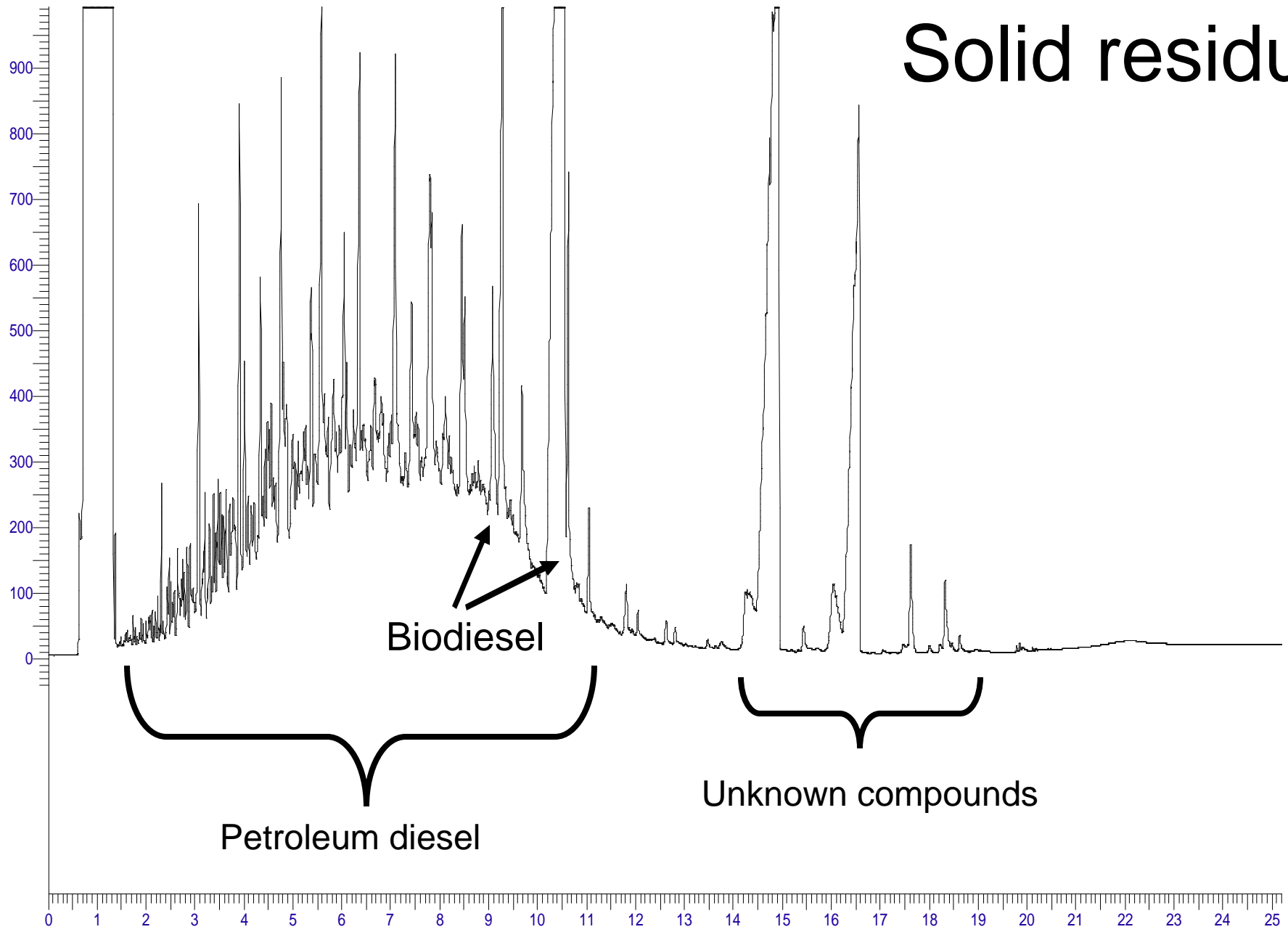
# Maintenance Records

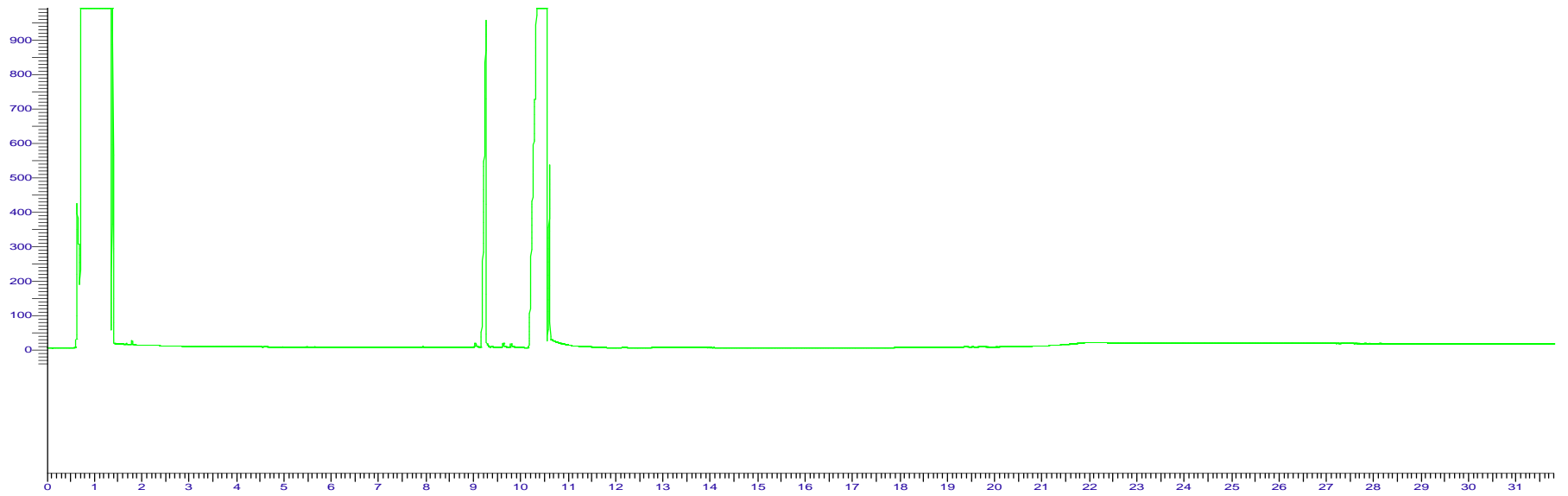
- Fuel-related issues
  - B-level service interval (oil change, oil filter, fuel filter)
    - Scheduled for 18,000 mile intervals
    - Control group: once every 17,500 miles
    - B20 group: once every 15,100 miles
  - Additional fuel filters
    - Control: 3 unscheduled fuel filter replacements
    - B20: 27 unscheduled fuel filter replacements
      - Majority during cold weather months
      - Changing blending procedures reduced extra replacements by 4-fold

# Plugged Filters

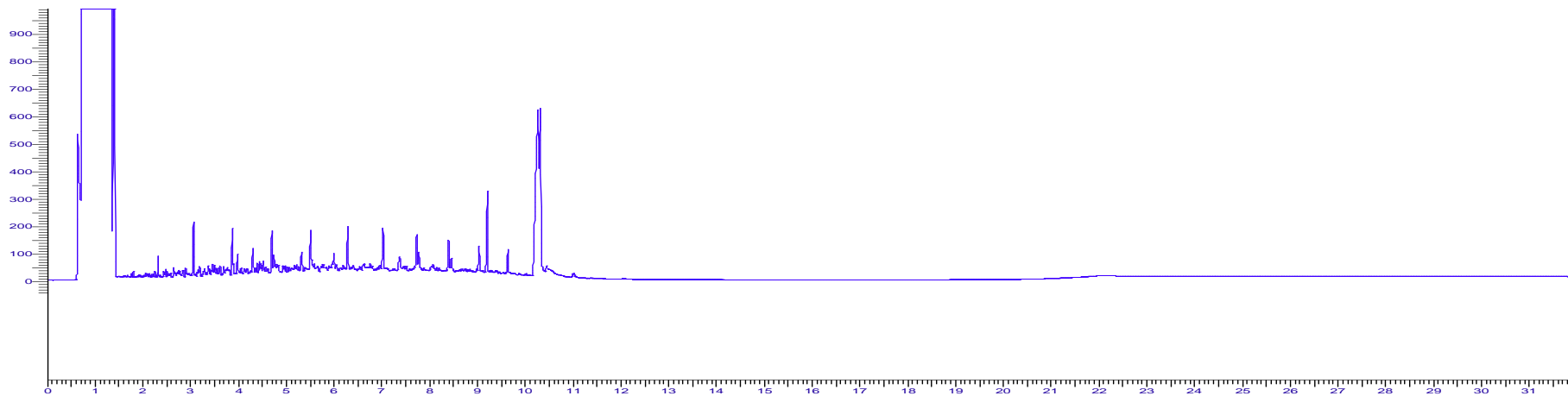
- Experienced several plugged fuel filters in winter of 06 - 07
- Several possible causes:
  - Reached plug point
  - Off-quality fuel
  - Trace compounds in feedstock
  - Water in tank
  - Improper blending
  - Unexpected interactions with new ULSD

# Solid residue



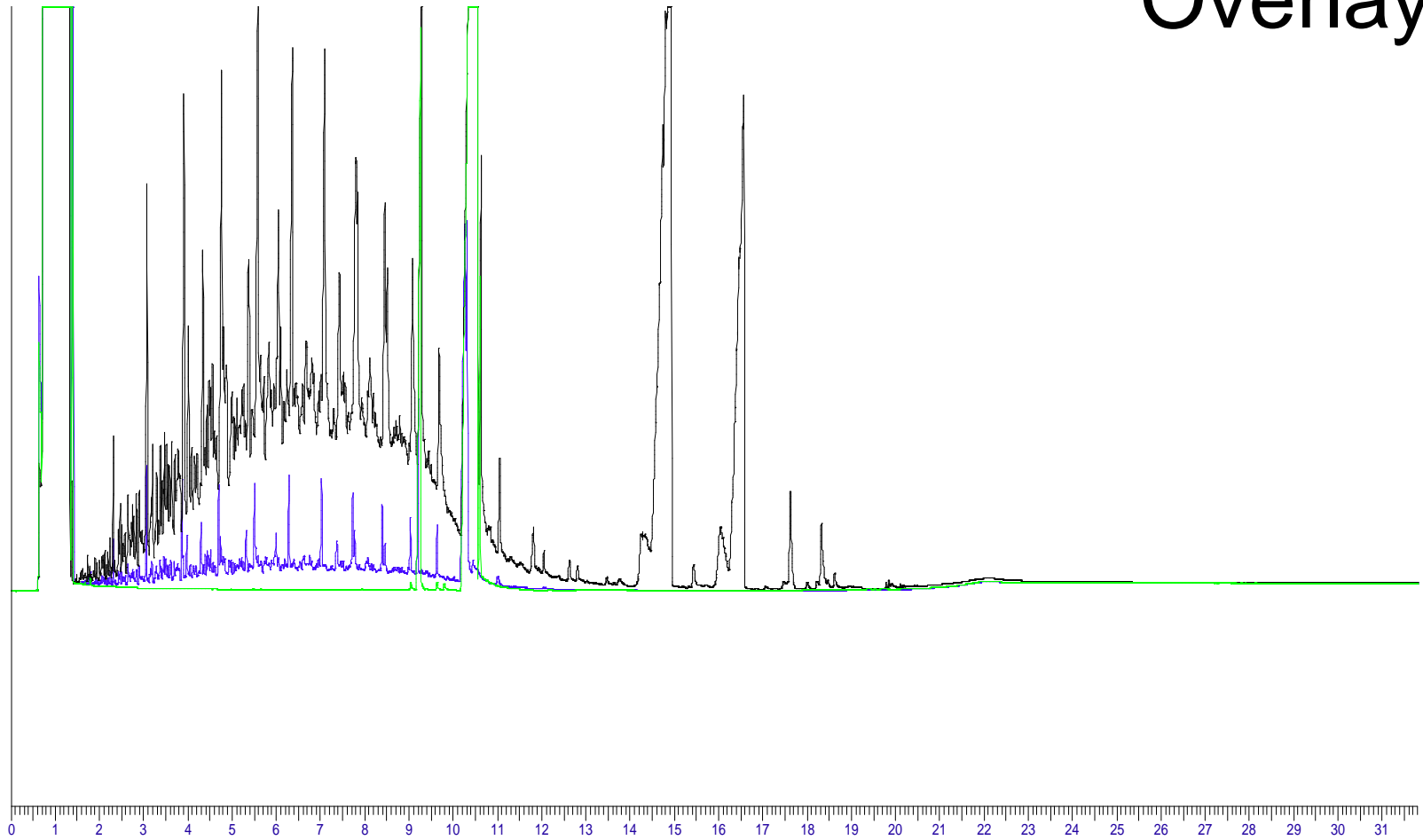


B100 before blending



B20 blend

# Overlay



# Cold Flow Properties

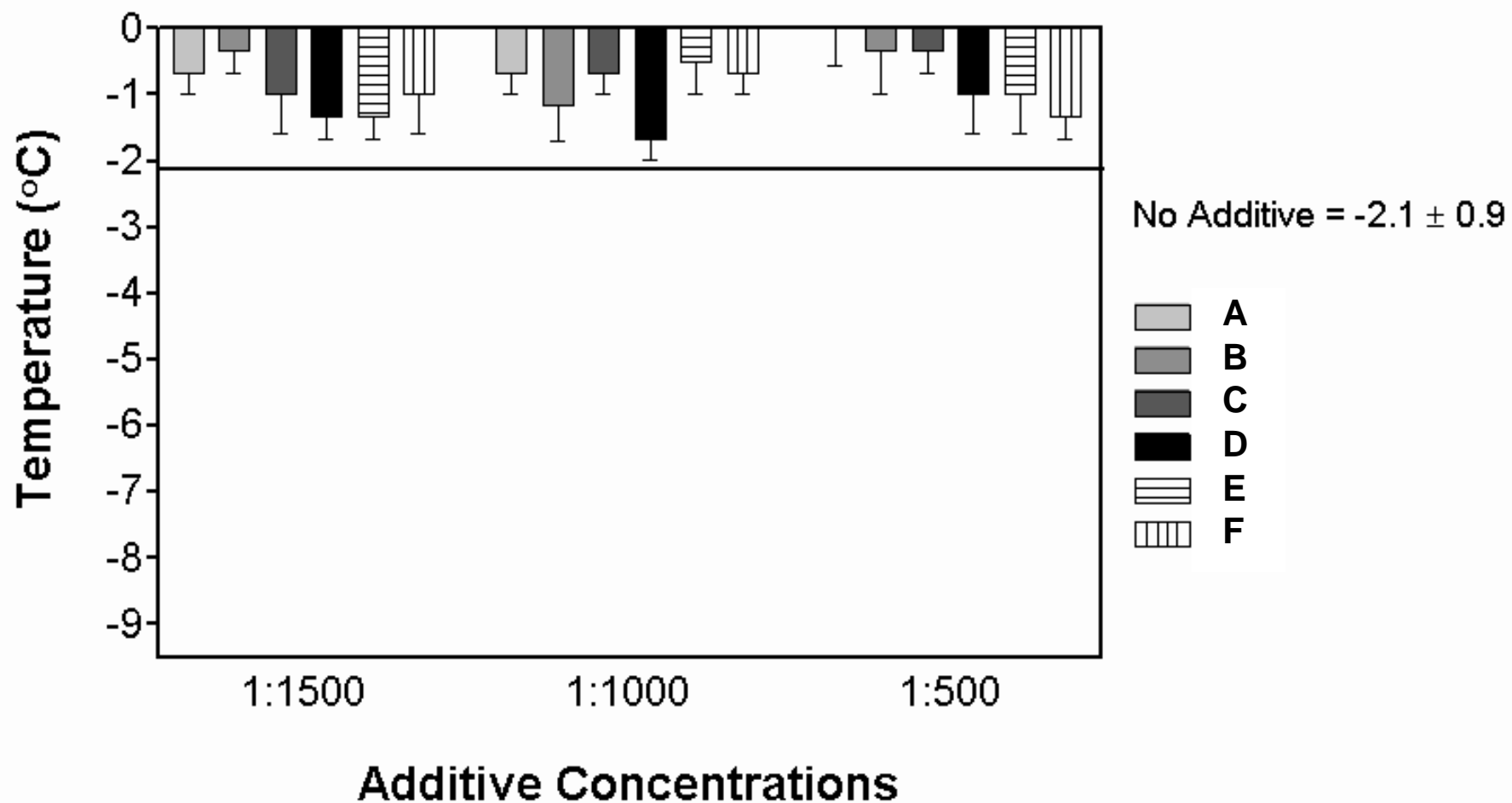
- Cold weather performance always an issue, but biodiesel has noticeably worse performance characteristics
  - New '07 ULSD has reduced performance over LSD
  - Removal of sulfur also removes many short chain and aromatic hydrocarbons
  - This magnifies the problems already associated with biodiesel
- Indicators of cold weather performance
  - Cloud point- temperature at which wax crystals begin to appear
  - Plug point- temperature at which wax crystals are large enough to plug the fuel filter
  - Pour point- solid mass
- Strategies to minimize cold weather effects on biodiesel
  - Decrease blend ratio (increase #2 diesel)
  - Blend with #1 or kerosene
  - Use commercial additives
  - Transesterify with branched alcohols

# Plug Point Studies

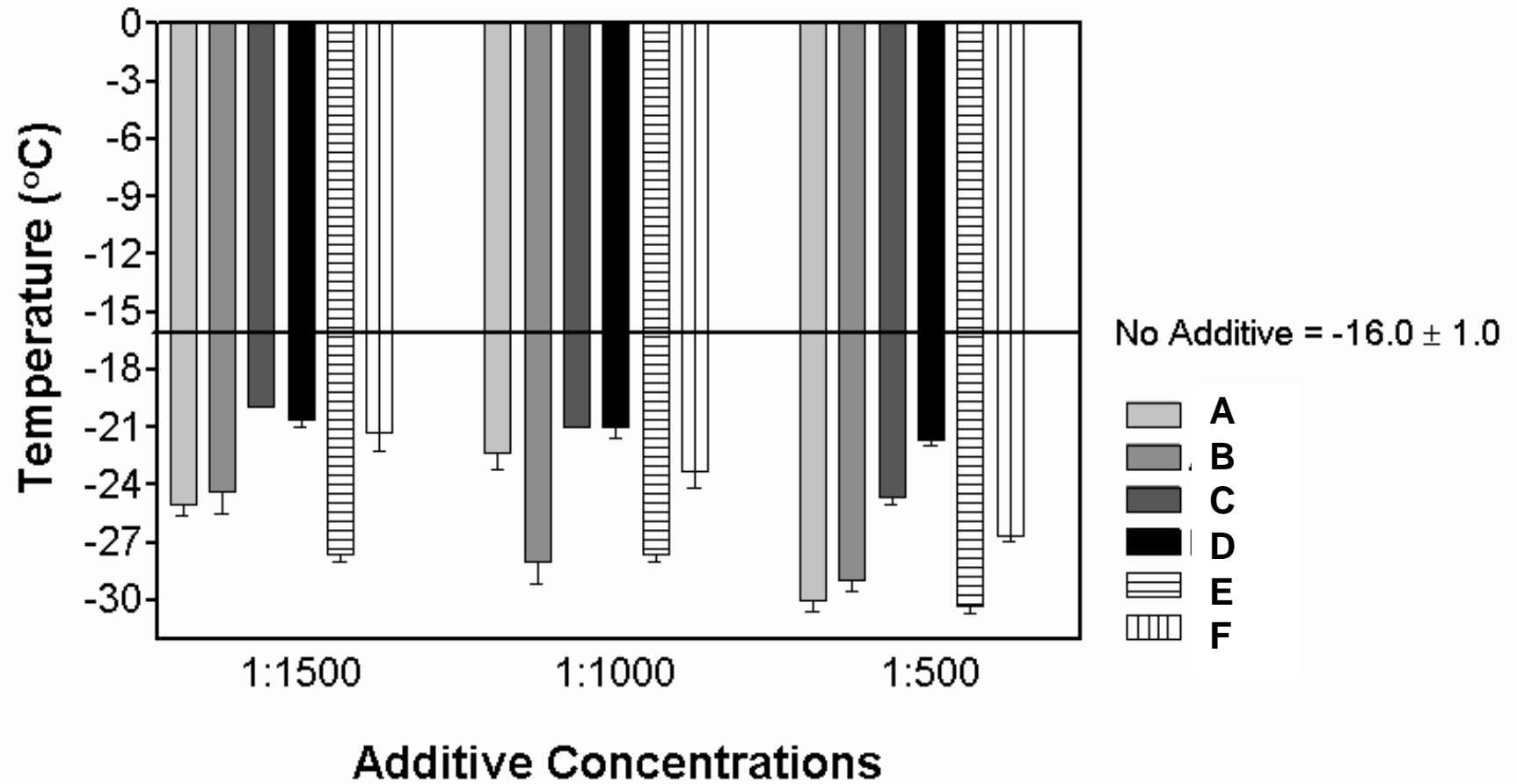
- CFPP, ASTM D 6371
  - 45 mL of sample chilled in bath
  - At every 1 degree C drop in temp, 20 mL of sample is pulled through a mesh screen under 2 kPa pressure
  - Test fails when 20 mL is not pulled through within 60 s



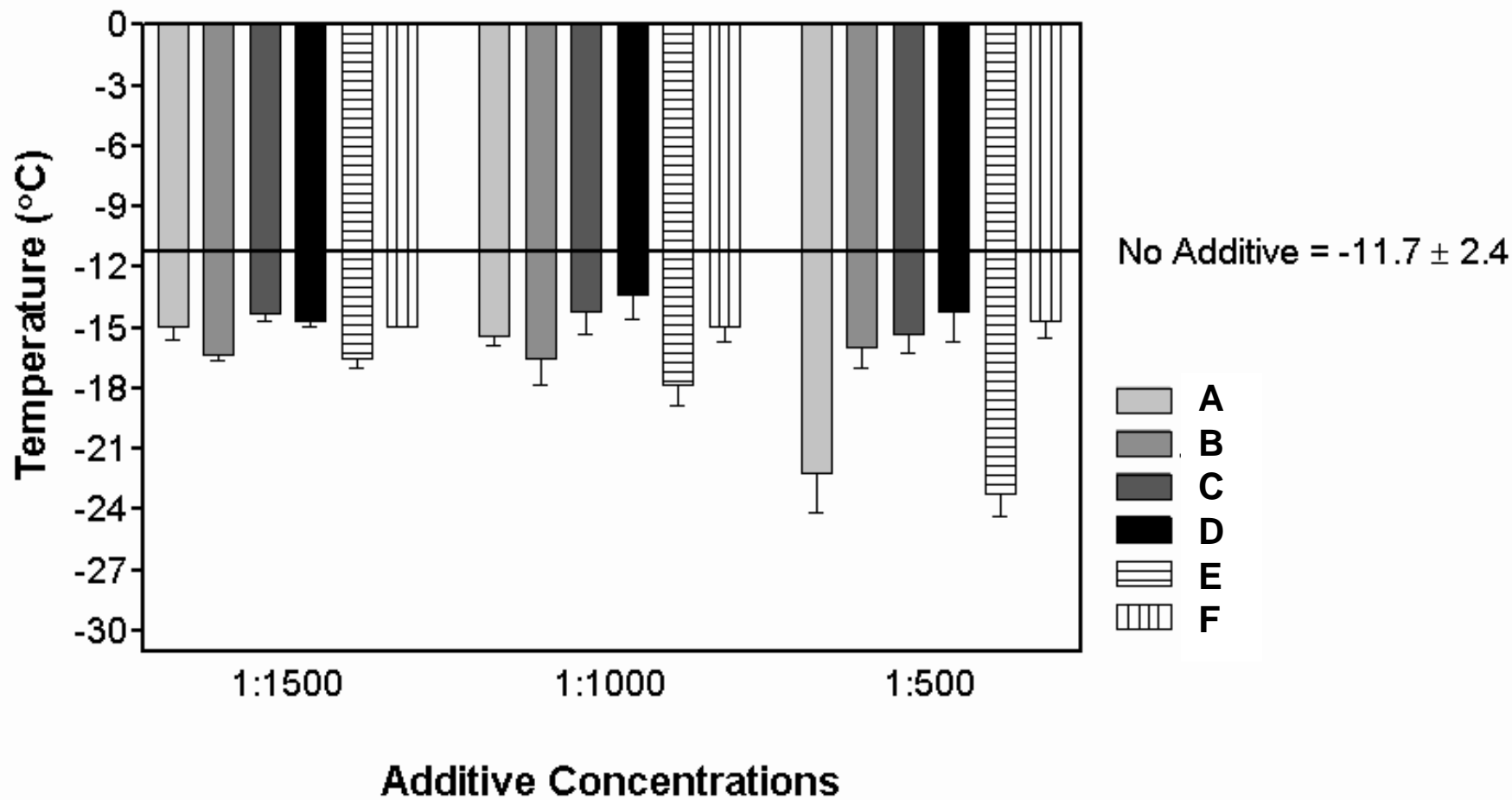
## B100 Cold Filter Plug Point Temperatures



## B0 Cold Filter Plug Point Temperatures



## B20 Cold Filter Plug Point Temperatures



**THANK YOU**