Tier 4 Final Workshop

Presented by AIS Training Center
Joe Thompson
Tier 4 Final Workshop

• Regulations
• Tier 4 Interim recap
  – Parts and Functions
• Tier 4 Final
  – Parts and Functions
Diesel engines emit nitrogen oxides, particulate matter and air toxins which contribute to serious public health problems according to the U.S. EPA.
Progression of Regulations
Part of the science

Combustion Temperatures Have **OPPOSITE** Effect on PM and NOx

**Particulate Matter**

- High combustion temps increase NOx and low temps increase PM
- Reducing both toxics simultaneously is difficult. Multiple technologies are required.
Tier 3 Test Points

- Idle Speed
- Peak Torque Speed
- Rated Speed

Modes:
- Mode 1
- Mode 2
- Mode 3
- Mode 4
- Mode 5
- Mode 6
- Mode 7
- Mode 8

Engine Torque vs. Engine Speed
Tier 4 Test Points
Tier 4 Interim Recap

- Variable Geometry Turbochargers (VGT)
- Open or Closed Crankcase Ventilation (OCV or CCV)
- High Pressure Common Rail (HPCR) fuel systems
- Exhaust Gas Recirculation (EGR)
- Air Throttle Valve
- Diesel Oxygen Catalysts (DOC)
- Diesel Particulate Filters (DPF)
Open or Closed Crankcase Ventilation (OCV or CCV)
High Pressure Common Rail (HPCR) fuel systems
Exhaust Gas Recirculation (EGR)

- From exhaust manifold
- To mixing box
- EGR gas flow
- Fin & Tube EGR Cooler: Large heat exchange capability
- Hydraulic Servo EGR Valve: Highly stable control evolved from Tier3 hydraulic actuator
Air Throttle Valve
Diesel Particulate Filter (DPF)

- DOC = Diesel Oxidation Catalyst
- PF = Particulate Filter

**DOC:**
- Diesel Oxidation Catalyst
- Catalysts are coated on a ceramic substrate

**PF:**
- Particulate Filter
- Catalysts are coated on a ceramic substrate
Diesel Oxygen Catalyst (DOC)

- Cylindrical Shaped
- Ceramic
- Coated with Precious Metals
- Chemical Reaction

400 cells per square inch
Diesel Particulate Filters (DPF)

- Ash included in lube oil is accumulated in DPF
- Periodic ash cleaning required
Regeneration

- **Purpose** – to remove soot from the filter to prevent plugging
- **Accomplished by** – Oxidizing the soot to convert it into a gas
- **Oxidizing** is done by inducing high heat
Types of Regeneration

• Passive
  – Happens with the heat generated by the operation of the engine

• Active
  – Happens when fuel is injected into the exhaust stream to create a chemical reaction to increase the amount of heat
  – There is no flame
Types of Active Regeneration 1/2

• Automatic
  – Notifies the operator that it is happening
  – Under most conditions, do not disable
  – Will stop automatically (15-30 minutes)

• Parked / Manual Stationary
  – Machine cannot be used
  – Operator must initiate
  – Will stop automatically (40-60 minutes)
  – Happens more often when Automatic is disabled
Types of Active Regeneration 2/2

• Service
  – Machine cannot be used
  – Technician must initiate
  – Will stop automatically (45+ minutes)
  – Happens when Automatic is disabled too often or when service work needs to be performed
DPF Servicing
Tier 4 Final

- Mostly same parts as Tier 4 Interim, depending on horsepower
- Some engines do not use a DPF
- Almost all engines use Selective Catalytic Reduction (SCR)
The SCR System

- The system can be classified into two major assemblies
  - Exhaust aftertreatment system
  - DEF delivery system
Aftertreatment System

DEF

Nitrogen Water

NOx Sensor (upstream)

Engine exhaust gas

Mixer

NOx Sensor (downstream)

SCR Catalyst

NOx

Ammonia
The Chemical Reaction
Diesel Exhaust Fluid (DEF)

- Adblue is a brand
- Freeze Point = -11°C (12°F)
- Not affected by freezing and thawing
- Recommended storing between -11°C and 30°C (12°F and 86°F)
What is the shelf life of DEF?

Technically Speaking -

![Diagram showing the pH levels of various substances and their comparison with DEF and aged DEF.]

- DEF
- Ammonia Solution
- Milk of Magnesia
- Sea Water
- Urine
- Tomato Juice
- Orange Juice

- Aged DEF
- Ammonia Solution
- Milk of Magnesia
- Sea Water
- Urine
- Tomato Juice
- Orange Juice
How should DEF be stored?
In Sealed Containers!

- Open containers allow:
  - Contamination
  - Water Evaporation
  - Ammonia Release

To avoid Downtime:
- Keep containers sealed!
Where should I store DEF?

Wherever it is convenient to your operation!

- By the fuel barrel
- By the oil
- In the shop
- In the field
- At the job site
- Other
Does direct sunlight harm DEF?
What do I do if I park my vehicle for an extended amount of time?

- A rule of thumb is handle DEF how you handle the other vehicle fluids.

  Fuel
  Oil
  Coolant
Summary

• Store in sealed containers.

• Shelf life is not a major concern.

• Think about DEF similar to the other maintenance fluids you use today.

• Purchase amounts that can be used in a reasonable amount of time.

• Store where it is convenient to your operation.
DEF Tank

- Stores the DEF
- Contains:
  - Heater (Electric or Coolant)
  - Level Sensor
  - Temperature Sensor
  - Quality Sensor
  - Suction tube
- Size varies by application
Pump Module

• Pressurizes the system to 70-130 PSI
• Evacuates the DEF from the lines after engine shuts off to prevent line freezing
• Contains a filter that is a service item
DEF Nozzle

- Injects the DEF into the exhaust stream at the diffuser
- Coolant lines for heat or cooling as required
- Need not operate at very cold temperatures for a while (>70 minutes)
Catalyst and AOC
Catalyst, AOC and Sensors

SCR Outlet Temperature Sensor

SCR Inlet Temperature Sensor

AOC

SCR

SCR Outlet Temperature Sensor

SCR Inlet Temperature Sensor
What can you, the end user do?

Monitoring the Fuel – The Fuel Chain

- Refinery
- Transport
- Bulk Storage
- Delivery
- Tank Storage
- Transport to Application
- Application Fueling
What can you, the end user do?

1. If any empty space is left in the tank, dew condensation water formed by temperature changes between night and day may get mixed in with the fuel.
2. To prevent the formation of any condensation, fill up the tank with fuel after daily operation is completed.
3. Drain the water and sediment from the tank before starting daily operation and about 10 minutes after refueling.
4. Be sure not to damage or lose the strainer during fueling.
5. Be sure to put the fuel tank cap tightly not to come away.
What can you, the end user do?

Maintaining & Improving Fuel Quality - Storage

- Keep Tanks Full
- Use Drain Valve on Bottom Tank to Remove Impurities
- Allow New Fuel 24 hours to Settle
- Completely Drain Tank & Rinse with Fresh Diesel – Annually
- Minimize Direct Sunlight or Heat
- Store in Containers Not Made of Copper, Lead, Zinc, Tin, Brass or Bronze
What can you, the end user do?

Maintaining & Improving Fuel Quality - Filtration

- Storage Filtration
  - Well Serviced Filter Between Pump & Nozzle
  - Particulate Filters
How small is..........

A MICRON?

Human Hair Comparison

1 MICRON
17 ~ 23 microns

RAGWEED

1 MICRON
10 microns

DUST MITE FECES

POLLEN
30 ~ 50 microns

HUMAN HAIR
50 ~ 70 microns

DUST MITE CARCASS
250 microns

POLLEN
30 ~ 50 microns

RAGWEED
17 ~ 23 microns
Prefilling the Pre-filter
FUEL-PROTECT Diesel Fuel Conditioner

- Boosts Cetane number for faster, smoother, fuel efficient starting
- Aggressive Detergents and dispersants clean and keep clean injectors – helps prevent injector erosion, prevents emissions deterioration due to deposits, and cleans entire fuel system
- Lubricity Improver for added protection and reduced fuel injection and pump wear when using Ultra Low Sulfur Diesel (ULSD) fuel
- Moisture Control improves water tolerance and helps minimize microbial growth
- Maintains fuel pump warranty
- Minimizes smoking
- Compatible with all diesel fuels
- Summer and Winter Formulas – Winter Formula lowers Cold Filter Plugging Point (CFPP) and Pour Point improving cold weather fuel flow
End of

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