CEN/TC 19 2011 Conference

European EN590 Diesel Fuel Quality for Heavy and Light Duty Applications

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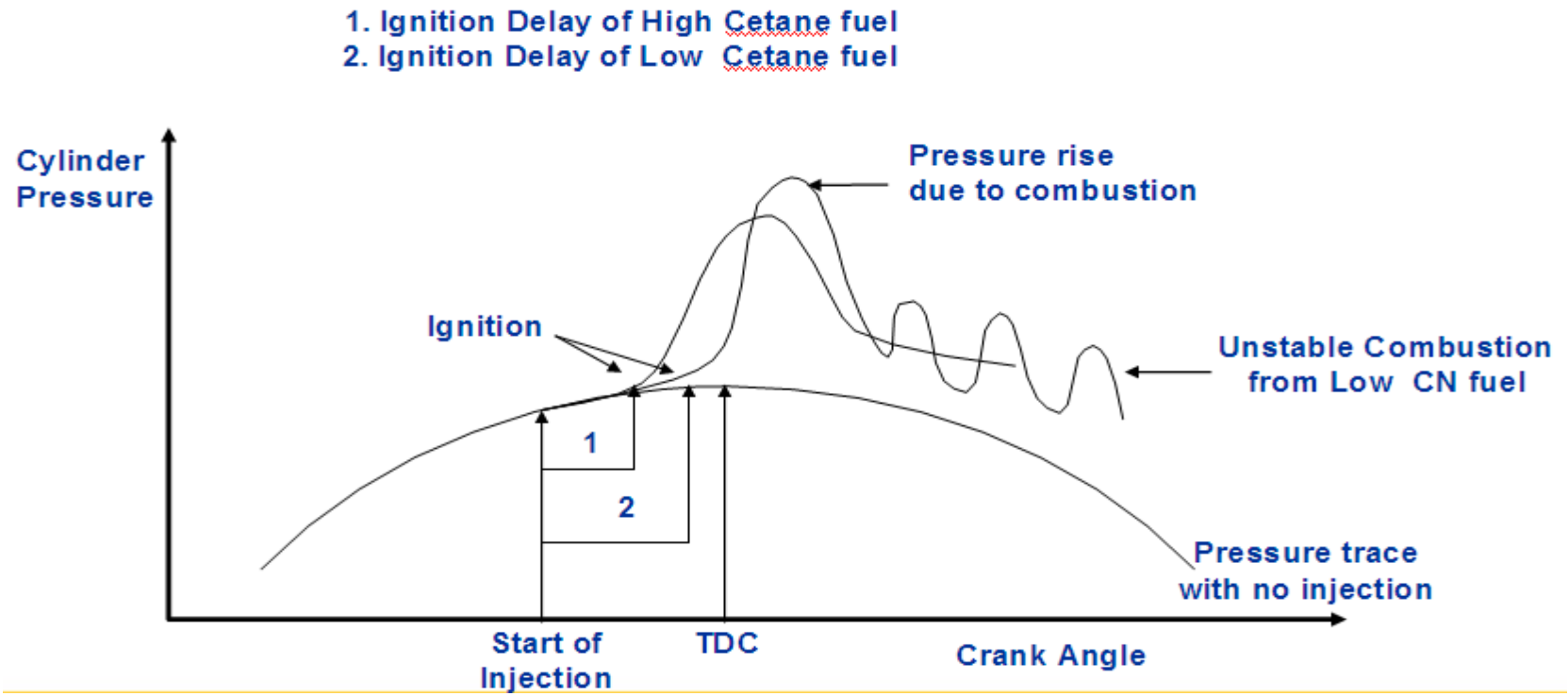
EN590 Diesel Specification

- Environmental aspects set by European Commission Fuel Quality Directive and respective amendments:
  - Diesel →Cetane, Density, Distillation, PAH's, Sulphur & FAME %
- Fit for use aspects covered by CEN specifications managed by TC19 working groups:
  - CEN specs include EC Directive environmental requirements
  - WG24 – Diesel EN590, FAME EN14214
  - WG's made up of experts from Auto, Fuel, Biofuel manufacturers and Test method experts
  - Draft specifications developed by WG's balloted at TC19 level with NSB's
- CEN specifications referenced in vehicle owners manuals and apply at point of sale to consumer:
  - Service station pump
  - Delivery into customer tanks

Cetane Number

- Cetane number Min 51,0:
  - Is a measure of the diesel fuels ignition quality (ignition delay) referenced to a chemically defined scale and affects
    - Cold startability
    - Exhaust emissions and combustion noise



Cetane Index

- Cetane Index (4 variable) Min 46,0:
  - Is a predictive calculation of cetane number based upon a distillation and density correlation with cetane number
    - T10, T50, T90 and Density
- Cetane index does not take account of ignition improver additives but provides an indication of the diesel fuels ‘Natural Cetane’
- The delta between cetane number and cetane index (51 – 46) is designed to limit the dose rate and boost provided by cetane improver additives

Density & Viscosity

- Density range of 820,0 to 845,0 kg/m^3 :
  - The diesel fuel injection is controlled volumetrically or by timing of solenoid valves
  - Variations in fuel density (and viscosity) result in variations in engine power
    - The European EPEFE program found that fuel density also influences injection timing of mechanically controlled injection equipment and hence engine emissions and fuel consumption
- To optimise engine performance and tailpipe emissions, both minimum and maximum density limits are defined in a narrow range
- Viscosity range 2,00 – 4,50 mm^2/s (EN3104):
  - Min viscosity limit controls fuel pump internal leakage and maintains correct fuel delivery
  - Max viscosity avoids excessive loads on fuel pumps

Poly Aromatic Hydrocarbons (PAH)

- Poly Aromatic Hydrocarbon (PAH) Max 8,0% (m/m):
  - Limit set to help reduce exhaust particulate PAH
  - Severe reduction of PAH can lead to very low total aromatic levels:
    - Reduced fuel solvency
      - Important for cold flow wax and additive solubility
      - FAME blending
- Important that total aromatic hydrocarbon levels are kept reasonably constant
  - Large variations >15% can cause seal swell or shrinkage and cracking

Sulphur & Lubricity

- Sulphur max 10 mg/kg:
  - Reduce sulphate particulate emissions
  - Enable exhaust after-treatment systems:
    - De-NOx Catalyst
    - Particulate traps
- Lubricity Max 460 microns WSD:
  - To ensure fuel injection equipment durability is maintained
  - Hydro-processing to reduce sulphur removes natural polar molecules that provide good surface lubricity characteristics
    - Sulphur content provides an indication of lubricity however severity of hydro-processing is a better predictor

Flash Point & Carbon Residue

- Flash point >55℃ :
  - Minimise risk of flammable mixtures in vehicle and storage tanks
  - To meet European transport regulations
- Carbon residue after fuel pyrolyisis Max 0,3% (m/m):
  - Measures the coke forming tendency of the fuel
    - Has been related to combustion chamber deposits
  - Cetane improver additives will increase carbon residue
    - Where cetane improver additives are used, the limit refers to the fuel before additisation

Ash Content

- Ash Content Max 0,01% (m/m):
  - Fuel and lubricant derived ash can contribute to
    - Injector nozzle coking
    - Diesel Particulate Filter (DPF) plugging
  - Ash-forming metals can be present in fuel additives, lubricant additives or as a by-product of the refining process:
    - e.g. Sodium and Calcium from salt driers
- Metallic ash materials are incombustible:
  - They can become trapped within the DPF
  - Leading to a premature build-up of backpressure and vehicle operability problems
- Ash content is a balance between fuel manufacturing feasibility and DPF endurance

Water and Total Contamination

- Water content Max 200 mg/kg
  - Dissolved water precipitates as fuel cools and excessive levels can lead to
    - Fuel injection equipment corrosion
    - Filter blocking (ice crystals)
    - Micro Biological Growth
- Total Contamination Max 24 mg/kg:
  - Excessive diesel fuel contamination can cause premature clogging of fuel filters and wear leading to:
    - Reduced fuel injection equipment endurance & malfunction
    - Engine failure & increased exhaust emissions
  - Modern high pressure fuel injection equipment have small component clearances 2 - 5 µm

Copper strip Corrosion

- Copper Strip Corrosion – visual rating Class 1:
  - Certain sulphur compounds can cause corrosion of copper components in fuel systems:
    - The reactivity depends on the type of sulphur compounds present and is not necessarily related to the total sulphur level
  - The specification also protects against other corrosive materials that may be present in diesel fuel as a result of refinery processing unit upsets or fuel contamination

FAME Content

- FAME content 7% max:
  - Limit set to control engine lubricant oil dilution with diesel fuel that can lead to increased engine wear and deposits
    - FAME is high boiling point component 320 - 340℃
    - Under cold start conditions high boiling fractions of the diesel and FAME can condense on cylinder liners and be swept into the engine sump by the piston rings
- Modern diesel DPF regeneration strategies employ post combustion fuel injection where additional fuel is injected into the cylinder to provide a source of energy to burn-off the trapped carbon deposits, this can cause additional lube oil fuel dilution

Oxidation Stability

- Oxidation stability max 25g/m^3 *(EN12205):*
- Limit set to prevent the formation of excessive levels of sediment during storage under normal storage conditions
- Oxidation stability min 20hrs *(EN15751)*:
  - Limit set to control volatile acid formation due to FAME oxidation
- New test methods are under consideration by WG24 and associated TF's and the Joint Working Group:
  - PetroOxy *(prEN16091)*
  - Delta Acid Number *(2010 Method)*

Distillation

- Distillation
  - <65% recovered at 250℃
  - Min 85% recovered at 350℃
- Controlled for the following reasons:
  - European Customs requirements (CN codes)
  - Back end volatility to control particulate and smoke emissions
    - Max 95% recovered at 360℃
    - Also affects engine lube oil fuel dilution

Cold Flow

- Cold Filter Plugging Point (CFPP):
  - Specifications are set to ensure vehicle operability is maintained year round and diesel waxing is controlled
  - Options are given to allow for seasonal grades to be set nationally based upon local climatic conditions
    - The options are for temperate climates six CFPP grades and for arctic or severe winter climates five different classes which also include Cloud Point
- The addition of FAME can deteriorate cold flow performance and precautions are required to ensure that cold flow additives are compatible with the finished fuel blend
- A revised FAME standard with increased cold flow requirements is under development by the FAME TF

Summary

- Environmental aspects set by European Commission
- Fit for use aspects covered by CEN specifications:
  - Cannot cover all failure modes
- Also need to consider how the fuel is produced:
  - Refinery processes
  - Blending
  - Performance and process additives
  - Management of Change practices, key to avoiding Product Quality incidents

→Thank you for your attention