Automotive Fuel Requirements – Current and Future

Dr. John Bennett
Ford Motor Company

Overview

- Fuel standards and their drivers
- Current issues
- Future requirements for conventional fuels
- Future fuels

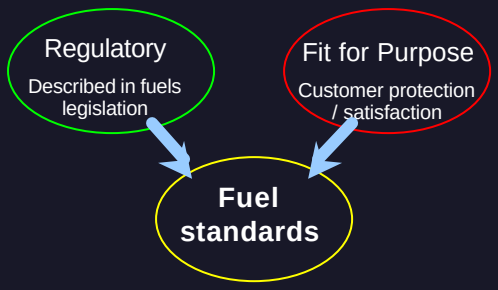
Vehicle design and fuel quality

- Vehicle design is driven by regulatory requirements and customer expectations
- These are becoming ever more stringent.
  - Reduced noise, emissions and fuel consumption
  - Increased responsiveness/power and durability
- Fuel is a key enabler to achieve low emissions and longevity
  - Legislation for fuels and emissions is linked.
- Advanced fuel systems contribute significantly to progress in these regards
- Vehicle design includes fuel performance / quality as a constraint.
- **Fuel quality is mainly defined by fuel standards**

Vehicle design and fuel quality

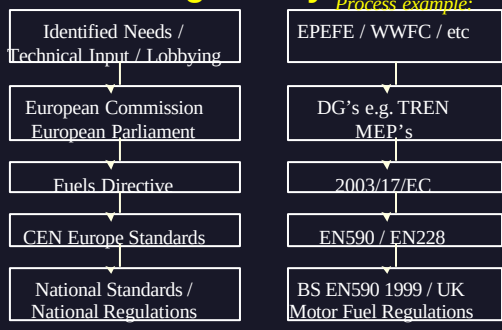
- Different fuel qualities will require different vehicles.
  - Restricts customer choice
  - Increases vehicle production costs
- The use of common fuel standards is a key objective
- Implementation of CEN standards preferred

Fuel Standards



Regulatory

Process example:



Fit for Purpose

- Input to CEN technical committees from Automotive and Oil industries for issues relating to ensuring satisfaction for our mutual customers
- Implementation of aspects of legislation (e.g. volatility)

CEN

- European fuel standards are published by CEN, the European Committee for Standardisation.
- CEN operates by consensus
- CEN has no direct legal powers
  - CEN standards only have force if referred to by national legislation

CEN Automotive Fuel Standards

- EN228 Unleaded petrol (currently 2004)
- EN590 Diesel (currently 2004)
  - Updated when required by amended regulations / vehicle requirements
  - Implemented into National Standards to cover climatic and/or other other local requirements
  - Other standards include EN589 (LPG) and EN14214 (biodiesel)

Current EU market fuel issues

- EN228 and EN590 do not prevent all potential fuel issues
  - 'Best practice' goes beyond specification
- Current issues include:
  - Diesel:
    - Water contamination
    - Particulate contamination
    - Deposits
  - Petrol
    - Silver corrosion
    - Deposits
  - Biofuel issues

Specific Fuel Issues in Turkey

- Turkey is making good efforts to introduce high quality fuels.
- High quality fuels must become the norm to support the use of modern automobiles
  - A vehicle cannot distinguish between good and bad fuels, but a bad fuel will increase emissions and reduce engine durability
- A scheme for monitoring of fuel quality is essential
- **Most fuel issues in Turkey relate to Diesel fuel**
- **One potential major problem for petrol**

Diesel Fuel Issues

- Sulphur
- Lubricity
- Contamination
  - Water
  - Particulate

Diesel - Sulphur

- Current fuel sulphur levels do not support Euro 3 emissions technology
  - ≈6,000 ppm compared to <350 ppm for Euro 3
  - Will deactivate exhaust gas aftertreatment systems and reduce engine / oil life due to acid formation.
- Some Euro 3 fuel already available, but needs to be more widespread
  - Understood will be addressed by legislation
    - Mandatory 10 ppm date aligned with EU

Diesel - Lubricity

- Most Diesel injection systems use the fuel to provide their own lubrication
- Some diesel fuel may lack sufficient lubricity
- Removal of sulphur (to make low sulphur diesel) often removes beneficial compounds
- Additives required to replenish lubricity

Diesel - Lubricity

- Modern Fuel Injection Systems require good lubricity, maximum 460 µm wear scar when tested by HFRR method (EN12156)
  - Worse lubricity could lead to rapid deterioration of the injection system or initiate wear, but not immediate failure.
- Will lead to reduced service life and increased emissions.

Diesel - Contamination

- Two main contaminants:
  - Water
  - Particulate
- Both associated with bad housekeeping / inadequate quality systems in distribution / storage
- Both cause premature failure of Fuel Injection Equipment

Diesel Contamination – Water

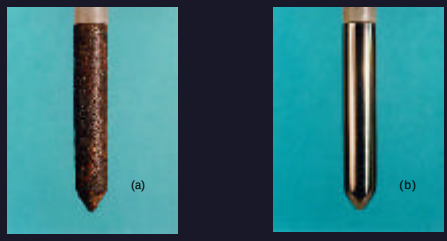
- Identified as issue by FIE manufacturers and OEMs
  - Micro-corrosion
  - Gross corrosion
  - Related to presence of free water in fuel
  - Free water linked to bad housekeeping / inadequate quality systems
- Reported in Document CEN TC19/WG24/N231

Diesel Contamination – Water

Figs.: Corrosion of high pressure distributor pumps (field returns): *a*. heavy corrosion at the roller ring with the consequence of sticking moving parts and no restart *b*. micro corrosion/hydrogen wear at the cam plate causing sudden breakdown.
(CEN TC19/WG24 Free Water Task Force)

Diesel Contamination – Water

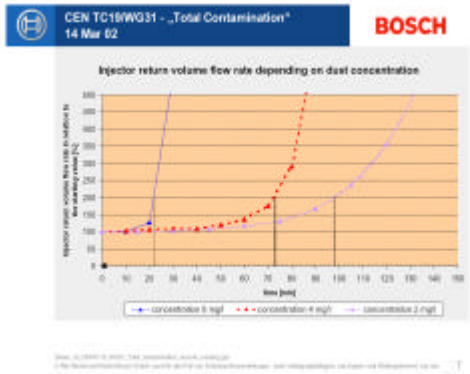
Gross corrosion can also be addressed by use of anti-corrosion fuel additives:



Diesel fuels showing (a) insufficient and (b) suitable anti-corrosion performance
Pictures courtesy of Renault. Test method ASTM D665

Diesel Contamination – Particulate

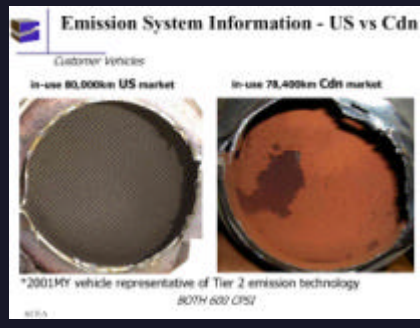
- Data shows relationship between component life and particulate contamination:
  - Size: bigger = >>worse
  - Number: more = worse
  - Hardness: harder = worse
  - Mass: more = worse
- High particulate contamination levels leads to premature failure and/ or filter blocking



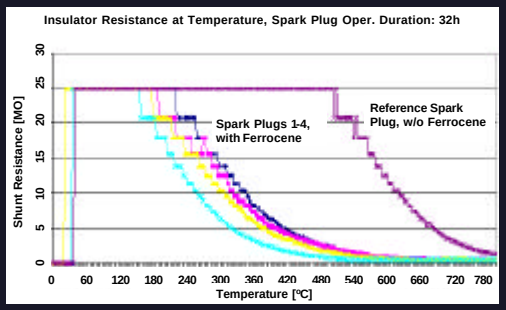
Petrol – Ash Forming Additives

- Lead
  - Effects well documented. Disappearing rapidly.
- MMT (manganese based) and Ferrocene (iron based) additives
  - Can be used as octane boosters
  - MMT leads to catalyst degradation / blocking (see next slide), exhaust oxygen sensor biasing and premature spark plug failure
  - Ferrocene causes premature spark plug failure, accelerated engine wear and catalyst erosion / blocking.

MMT -



Ferrocene – Spark Plug Resistance Loss



Future requirements for petrol and diesel

- Auto Industry requirements documented in **World Wide Fuel Charter**.
  - **Available from www.acea.be**

WWFC : The fuel categories

www.acea.be

Future requirements for petrol and diesel

- General trend to improved quality, but no significant changes due to need for 'backwards compatibility'
- Recent emergence of premium diesel fuel quality in some markets.
  - High cetane (up to 60+), high detergency, good lubricity and corrosion protection.

Future requirements for petrol and diesel – specifics

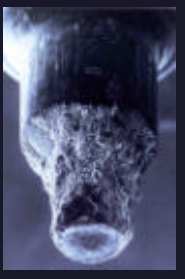
- Improved 'fit for purpose' limits
  - Better water limit definition
  - Reduced particulate limits
- Banning of ash forming additives from petrol
  - catalyst protection
- Mandatory detergency for both petrol and diesel
  - maintain air, fuel and combustion system cleanliness
- Control of ash in diesel
  - improved Diesel Particulate Filter life

Detergency – Diesel Nozzle

bp ultimate

Clean

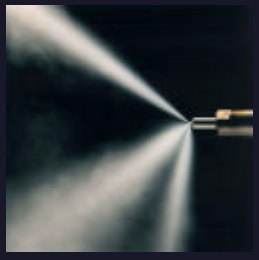
Dirty



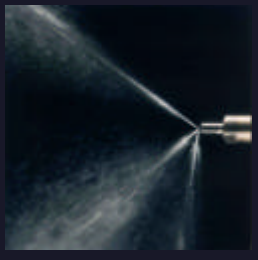
Diesel Spray Pattern

bp ultimate

Clean

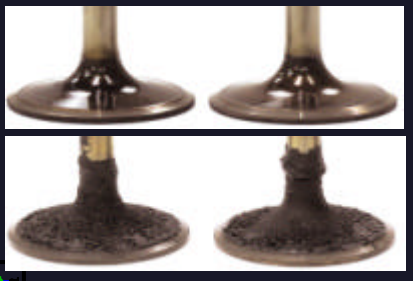


Dirty



Gasoline Intake Valves

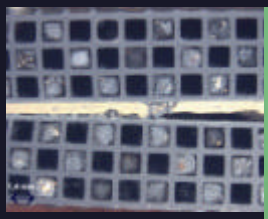
bp ultimate

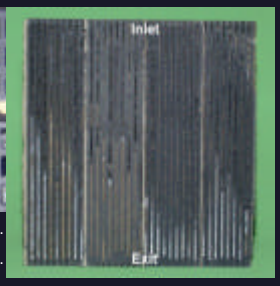


Clean

Dirty

Ash – effects on DPF filter





Above: Vertical slice near filter end.

Right: Horizontal slice.

Future - increased use of bio / alternative fuels

- Increasing use of bio fuels / alternative fuels
  - Legislation being enacted to promote this, including EU 5.75% content of fuel (energy) to be bio origin by 2010
- Niche products or as fuel extenders
  - Use as fuel extenders preferred to avoid complexity and confusion
  - Niche approach may be appropriate to address specific local/regional requirements
- Limited availability compared to fossil fuels

Future - increased use of bio / alternative fuels

- Biofuels
  - Biodiesel. EU currently limited to 5%
  - Ethanol. EU currently limited to 5%
  - Other concentrations are being proposed, but higher concentrations require modified vehicles
  - Ethanol (E85) compatible vehicles (FFV – Flexible Fuel Vehicle) becoming more available.

Focus Flex Fuel Vehicle (FFV)

Can use from 0 – 85% Ethanol / Petrol mixtures

Increased use of bio fuels / alternative fuels

- GTL Diesel
  - Derived from natural gas (usually stranded)
  - High cetane blend component
- Gaseous fuels likely to remain niche
  - Limited to mainly urban fleets
- Hydrogen has significant difficulties to overcome
  - Energy source to produce hydrogen still tbd.
- HCCI engines
  - Fuel still to be defined

Future fuels

- No single answer to '…which fuel ? ….'
  - "There are no clear winners for the next 30 years on fuels and powertrains"

G. Schmidt, Head of Research, Ford

Conclusions

- Overall
  - Petrol and diesel will remain the main automotive fuel source in the short and medium term
    - Bio/renewable fuels will support but not replace fossil
  - Alignment of global fuel qualities will continue
  - Improvement in 'fit for purpose' necessary to ensure long term vehicle and emissions durability

Conclusions

- Turkey
  - Significant progress being made in improving and enabling introduction of higher quality fuels
  - Significant concerns about diesel quality
    - Regulations being addressed
    - Best practice / good housekeeping must be promoted
  - Monitoring of fuel quality required

Thank you for your attention