The Need for Global Availability of High Quality Fuels

Presented by:
Sue Cischke, Senior Vice President
Ford Motor Company
Sustainability, Environment and Safety Engineering
AGENDA

• Fuel and Vehicle as a System
• Emission Regulatory Challenges
• Fuel Regulatory Needs
• Importance of High Fuel Quality
• Auto Industry Fuel Quality Needs
• OICA Recommendations
Fuel and Vehicle are a System

Emission Management Applied to Fuels and Vehicles

Emission Reduction
Base Engine Improvements
Catalyst Aftertreatment
Fuel Quality

Emission Prevention

Fuel Quality and Vehicle Hardware together Determine the Level of Emissions
The Path toward Zero Emissions...

Gasoline Vehicle Emissions Standards

- Hydrocarbons (g/km)
- Oxides of Nitrogen (g/km)

EURO I (1993)
Gasoline Vehicle Emissions Standards

- **EURO I (1993)**
- **EURO II (1996)**

The Path toward Zero Emissions...

Gasoline Vehicle Emissions Standards

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The Path toward Zero Emissions...

Gasoline Vehicle Emissions Standards

Hydrocarbons (g/km)

Oxides of Nitrogen (g/km)

EURO I (1993)

EURO II (1996)

EURO III (2000)
The Path toward Zero Emissions...

Gasoline Vehicle Emissions Standards

- Hydrocarbons (g/km)
- Oxides of Nitrogen (g/km)

EURO I (1993)
EURO II (1996)
EURO III (2000)
EURO IV (2005)

The Path toward Zero Emissions...
Vehicle Technology to meet the Emission Standards Requires Comparable Levels of Fuel Quality
The Progression toward Zero Emissions...

Emissions Standards alone do not achieve the benefits of Clean Air Quality – improved Fuels is Key
Sulphur Reductions have followed Legislation, Other Fuel Parameters Also Need Improvement
One approach...

- Established in 1998
  - Updates every two to three years

- Approved by Auto Manufacturers and Associations worldwide
  - ACEA/Alliance/EMA/JAMA
  - Brazil, Canada, Philippines, China, Indonesia, Korea, South Africa, Malaysia, Thailand, Vietnam

- Gasoline and Diesel Fuel Specifications
  - Four Levels of Fuel Quality with limits connected to emission requirements

- Fuel effects data support fuel quality needs:
  - impacts on engine performance
  - emission system functionality
  - component durability

Fuel quality specification matched to emission level
EC Emission Regs and CEN Fuel Specs

Another approach...

EC / UN-ECE (Emissions Regulation)
- EURO I / Stage I
- EURO II / Stage II
- EURO III / Stage III
- EURO IV / Stage IV
- EURO V / Stage V

EC (Fuel Regulation)
- EURO I
- EURO II
- EURO III
- EURO IV
- EURO V

CEN (Fuel Specification) (also similar to ASTM)
- CEN EN228 (Gasoline)
- CEN EN590 (Diesel)

FIT for PURPOSE

UN-ECE Emission Requirements have no direct link between Emissions and Fuel Quality

IMPROVING VEHICLE TECHNOLOGY and EMISSION CONTROL requires

IMPROVING FUEL QUALITY for the ENVIRONMENT

IMPROVING FUEL QUALITY for VEHICLE OPERATION & DURABILITY
Importance of High Fuel Quality

Research and Studies

• Auto / Oil Programs
  • EPEFE – European Programme on Emissions, Fuels, and Engine Technologies
  • AQIRP – US Auto/Oil Air Quality Improvement Research program
  • JCAP – Japan Clean Air Program
Importance of High Fuel Quality

AQIRP - Exhaust and Evaporative Emissions

Main Effects of Reducing RVP by 6.9 kPa

<table>
<thead>
<tr>
<th></th>
<th>Exhaust</th>
<th>Evap</th>
<th>Ozone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HC</td>
<td>CO</td>
<td></td>
</tr>
</tbody>
</table>

% Change in Mass Emissions

% Change in Light-Duty Vehicle Contribution to Peak Ozone

Note: Ozone data was modeled for three US cities based on the vehicle technology level and exhaust emission results.

RVP Control Reduces Exhaust and EVAP Emissions

RVP = Reid Vapor Pressure
NY = New York, New York
LA = Los Angeles, California
DFW = Dallas-Fort Worth, Texas
Importance of High Fuel Quality

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• Governments and Trade Associations conduct studies to evaluate the effect of fuels on emissions
Importance of High Fuel Quality

US-EPA Study: HC, NOx, and Benzene Exhaust Emissions

Changes to specific Fuel Properties results in Reductions in Tailpipe Exhaust Emissions

Fuel B compared to A
NMHC decreased ~26%
NOx decreased ~36%
Benzene decreased ~43%
Importance of High Fuel Quality

Less Benzene in Gasoline Resulted in Less Ambient Benzene Levels


Research and Studies

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- Governments and Trade Associations conduct studies to evaluate the effects of fuels on emissions

- Models for emission inventory estimate the impact of fuel quality improvements on a region’s air quality

Studies over the past Three Decades directly link Fuel Quality to Emissions
Auto Industry Fuel Quality Needs

**Gasoline Fuel Quality Needs:**
- Eliminate Metal Additives (No Pb, Mn, Fe)
- Eliminate Silicon
- Improve Octane
- Reduce Sulphur
- Control Vapour Pressure
- Control Volatility
- Reduce Benzene
- Improve Detergency
- Control Aromatics and Olefins

**Bio-based Fuels Market is Growing**
- Evaluate Vehicle Compatibility
- Develop and Adopt Fuel Specifications
  - Use Performance Tests as a Basis
  - Protect Existing Vehicles
  - Support Biofuel Market Growth

**Diesel Fuel Quality Needs:**
- Improve Cetane Number and Index
- Control Density, Viscosity, Distillation
- Improve Lubricity
- Reduce Sulphur
- Control Ash
- Improve Cold Flow
- Include Detergency
- Eliminate ethanol in diesel

There is a Broad Base of Fuel Quality Needs to Match Emissions Requirements
### Example Fuel Specification

**Table 1 - Requirements and test methods for premium grade unleaded petrol**

*requirements in bold refer to the modified European Directive 98/70/EC [1]*

<table>
<thead>
<tr>
<th>Property</th>
<th>Units</th>
<th>Min.</th>
<th>Limits</th>
<th>Max.</th>
<th>Test Method a (See 2. Normative references)</th>
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<tbody>
<tr>
<td>Research octane number, RON</td>
<td>95,0</td>
<td>95,0</td>
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<td>--</td>
<td>EN ISO 5164 b</td>
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<tr>
<td>Motor octane number, MON</td>
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<td>85,0</td>
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<td>--</td>
<td>EN ISO 5163 b</td>
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<tr>
<td>Lead content</td>
<td>mg/l</td>
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<td>5</td>
<td></td>
<td>EN 237</td>
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<tr>
<td>Density (at 15 °C)</td>
<td>kg/m³</td>
<td>720</td>
<td>775</td>
<td></td>
<td>EN ISO 3675</td>
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<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>EN ISO 12185</td>
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<tr>
<td>Sulfur content c</td>
<td>mg/kg</td>
<td>--</td>
<td>150 (until 31-12-2004) or 50,0</td>
<td>10,0</td>
<td>EN ISO 20846</td>
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<td></td>
<td></td>
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<td>EN ISO 20847</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EN ISO 20884</td>
</tr>
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<td>Oxidation stability</td>
<td>minutes</td>
<td>360</td>
<td></td>
<td>--</td>
<td>EN ISO 7536</td>
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<tr>
<td>Existent gum content (solvent washed)</td>
<td>mg/100 ml</td>
<td>--</td>
<td>5</td>
<td></td>
<td>EN ISO 6246</td>
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</tbody>
</table>

**Fuel Specifications Need to be tied to Emissions**
Avoid Separating Fuels from Emissions

Real-Life Scenario #1
New Emission Standards Introduced - Low Sulfur Diesel – Decreased Lubricity (worsened) – Fuel System Concerns

Solution: Use Diesel Lubricity Additives

Real-Life Scenario #2
Tier 2 Emission Standards – Introduced Advanced Emission Control – Manganese in Gasoline – Deposits Plugging Catalysts

Solution: Provide Manganese-Free Gasoline

Real-Life Scenario #3
Biofuel – Inadequate Stability – Biofuel Blend Degrades – Performance based Stability Specifications Required

Solution: Develop Adequate Fuel Specifications

Both Heavy Duty and Light Duty Require Fuel Specifications to be tied to Emissions
UN-ECE Needs Fuel Regulations

Current EU Process

EU Emissions Regulations ↔ EU Fuel Regulations → “Fit For Purpose” requirements

CEN Fuel Standards

Fuel Quality Drivers:
1. Air Quality and Environment
2. Operability and Long-term Mechanical Durability

European Process Recognizes a Vehicle’s Need for High Quality Fuel and Provides Operability and Long-Term Mechanical Durability
Summary

- More stringent Emission Regulations require the use of more advanced emission control technologies which drives the need for improved fuel quality.

- Fuel quality must be compatible with vehicle technology.

- Data clearly shows the link between fuel quality and vehicle emissions.

- Need exists to treat the fuel and vehicle as a system.

- Market Fuel Quality needs to be part of the UN-ECE Regulations.
Recognition of the need to link market fuel quality to vehicle emission requirements is critical to the Environment and Auto Industry.
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Action within WP29:
- Determine the Best Process to move forward
- Identify Experts to develop fuel specifications
- Evaluate the most effective mechanism for implementation
- Decide which is most expeditious to implement
- Launch most efficient process for timely implementation
We Must All Work Together!

CLEANER FUELS + CLEANER VEHICLES = CLEANER AIR