# Ethanol in Petrol

# FBHVC AGM

October 15th 2011

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Steve McArragher

30 years + with Shell

1947 Rover 12

Matt Vincent

25 years with BP and Octel

1934 Frazer Nash

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# Presentation Overview

- Why is ethanol added to petrol?
- Effects of ethanol
  - Compatibility (Matt Vincent)
  - Corrosion
  - Driveability (Steve McArragher)
  - Combustion
- Solutions
- Summary

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# Ethanol in Petrol : Why?

- EU Directive : Renewable Fuels : $CO_2$ reduction
- Bio-Ethanol : renewable fuel source
- Currently used at up to 5% volume in petrol
- Expected to rise to 10% volume
- No labelling required at 5% volume level
- After 2013 no labelling up to 10% volume (maybe)

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# Effects of Ethanol in Petrol

- Ethanol is a bit of a mixed blessing:
  - Increases octane quality - potentially useful
  - Can adversely affect a range of materials - bad
  - Can lead to fuel system corrosion in storage - bad
  - Affects volatility of petrol blend - not helpful
  - Results in leaner fuel-air mixture - possibly not helpful

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# Ethanol : FBHVC Involvement, Activities

- Reacted to letters, communications, etc.
- Involved in DfT Stakeholder Meetings
  - presented Members complaints
  - questioned “nothing much to worry about” stance
  - established nature of concerns/threats to Members
- Supplied Qinetiq with information used in their influential ethanol report
  - led to some reconsideration of 10% ethanol by DfT
- Identified risk of corrosion : proposed solution
- Arranged additive tests : endorsement scheme

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# Ethanol in Petrol

## Compatibility Issues

# CONCAWE Compatibility Table

***Table 1*** Recommendations for Materials Considered for Use in Ethanol and Ethanol/Gasoline Blend Applications [3]

| Material | Recommended | Not Recommended |
|---|---|---|
| Metals | Carbon steel with post-weld heat treatment of carbon steel piping and internal lining of carbon steel tanks[2]<br>Stainless steel<br>Bronze<br>Aluminium | Zinc and galvanized materials<br>Brass<br>Copper<br>Lead/tin coated steel<br>Aluminium (may be an issue for E100) |
| Elastomers | Buna-N (hoses & gaskets)<br>Fluorel<br>Fluorosilicone<br>Neoprene (hoses & gaskets)<br>Polysulfide rubber<br>Viton | Buna-N (seals only)<br>Neoprene (seals only)<br>Urethane rubber<br>Acrylonitrile-butadiene hoses<br>Polybutene terephthalate |
| Polymers | Acetal<br>Polypropylene<br>Polyethylene<br>Teflon<br>Fibreglass-reinforced plastic | Polyurethane<br>Polymers containing alcohol groups (such as alcohol based pipe dope)<br>Nylon 66<br>Fibreglass-reinforced polyester and epoxy resins<br>Shellac |
| Others | Paper<br>Leather | Cork |

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# Compatibility

- Realities of compatibility problems:
  - elastomers and plastics may swell, shrink, leak
  - seals may not live up to their name
- Most common complaints: tank sealing failures
  - Consequential effects : leaks, blocked carburettors, fuel starvation, weak mixtures, engine damage
- Unfortunately there is no quick fix/additive solution
  - replace non-compatible materials with compatible
  - preventative measures: replace tank sealing materials : replace tank (extreme case)

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# Ethanol in Petrol

## Potential Corrosion Issues

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# Bio-Ethanol :Acidic Corrosion

- Ethanol in storage tends to degrade : pH falls
- pH ideally about 7 : low pH : acid, high pH : alkaline
- Special additive needed to protect against acid formation in storage (falling pH)
- Fuel-grade ethanol is usually treated at source
- No guarantee that this will happen
- Ideally an after market treatment should be used
- Add to the petrol during refuelling : protects fuel system

# Corrosion Inhibitor Testing

- Potential additive solution available
- Technology from USA where use is mandatory
- FBHVC proposes ‘Test and Endorsement’ policy
- Test protocol uses accelerated aging method
  - one week storage = one month in real world
  - 13 week storage = 12 months in real world
- Industry-recognised corrosion test every two weeks to monitor additive performance
- High performance level required for FBHVC endorsement

# Corrosion Testing

- NACE test protocol
- Polished steel probes
- Water and fuel : spinning probes
- Visual inspection to rate probes

- Base fuel : no additive
- E rating on NACE scale
- With additive,  A rating (clean-no rust) or B++ (six spots max) for FBHVC endorsement
- Standard maintained over 13 weeks (equiv. to 12 months)

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# Status Report

- Tests started in early July 2011
- Aim : complete by mid October : results for AGM
- But "…. best laid plans of mice and men….."
- Part-way through the 13 week test sequence
  - contamination in test bath found to have influenced results
  - tests abandoned : equipment stripped and cleaned
  - programme restarted late September : results end 2011
- However, enhanced confidence in data : additive performance assessment

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# Ethanol in Petrol

## Driveability and Combustion

Steve McArragher

# Volatility : Boiling Characteristics

- Pure substances : single component e.g. $H_2O$
- Single fixed boiling point : making tea with water at 100 $^oC$
- Petrol : 200 different molecules
- No single boiling temperature
- At any temperature between about 35 $^oC$ and about 195 $^oC$ boiling is observed in liquid petrol
- Ethanol in petrol affects volatility characteristics

# Petrol Volatility Curve

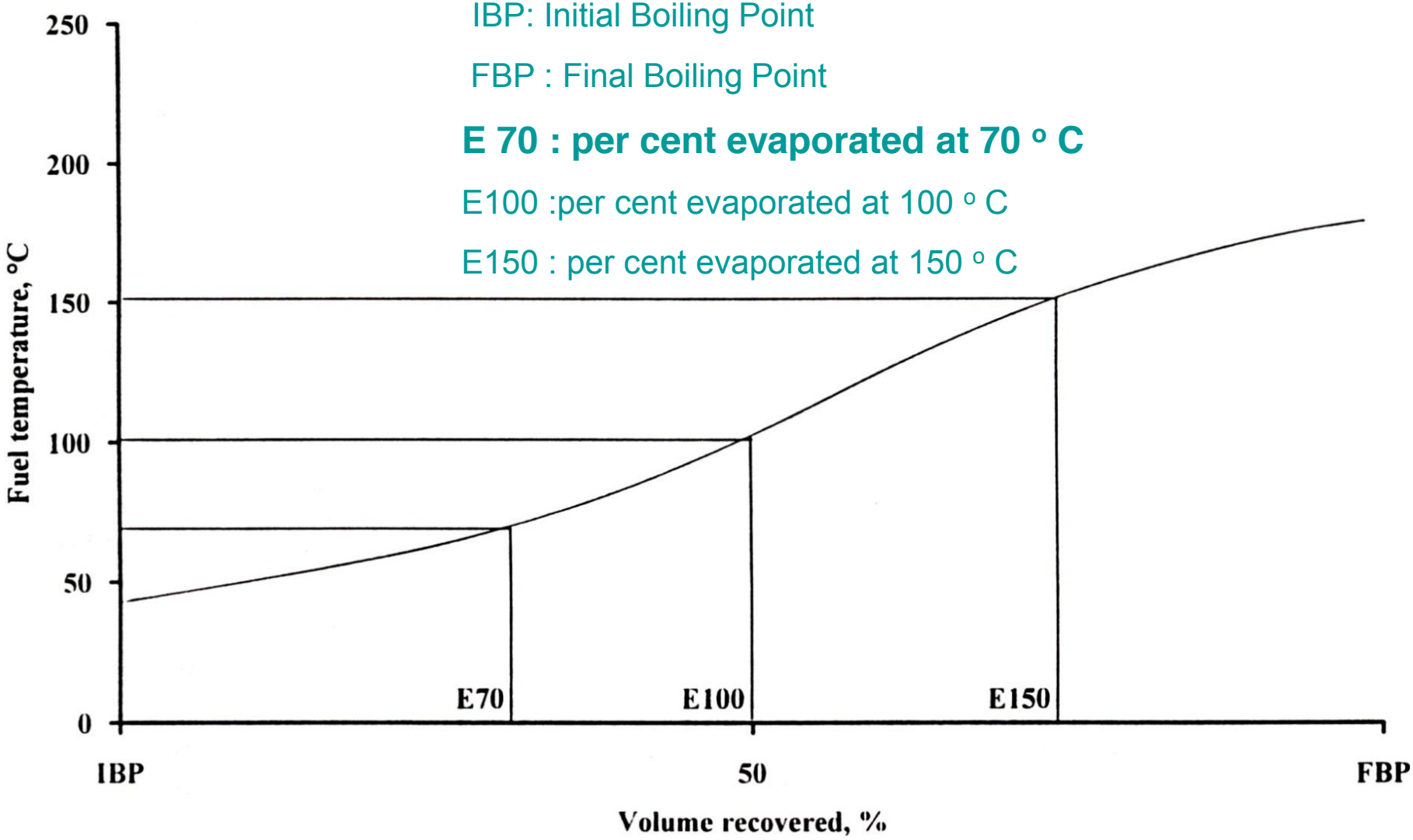
IBP: Initial Boiling Point

FBP : Final Boiling Point

**E 70 : per cent evaporated at 70 º C**

E100 :per cent evaporated at 100 º C

E150 : per cent evaporated at 150 º C



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# Steve McArragher

## Driveability and Combustion

# Summary: After Ethanol

- Materials compatibility
  - Replace problem materials with compatible products
  - FBHVC newsletter (No 5  2010) lists materials
- Corrosion:
  - Ideally an after market treatment should be used
  - Add during refuelling : protects fuel system
- Combustion/Driveability effects:
  - Mixture leaning from ethanol (1.8-3.6%) : adjust fuelling if possible or
  - Air/fuel ratio changes may cause driveability problems and increase exhaust temperature
  - Adopt measures to restrict heat transfer to carburettors
  - Baffles, pipe routing, thermal blocks and breaks

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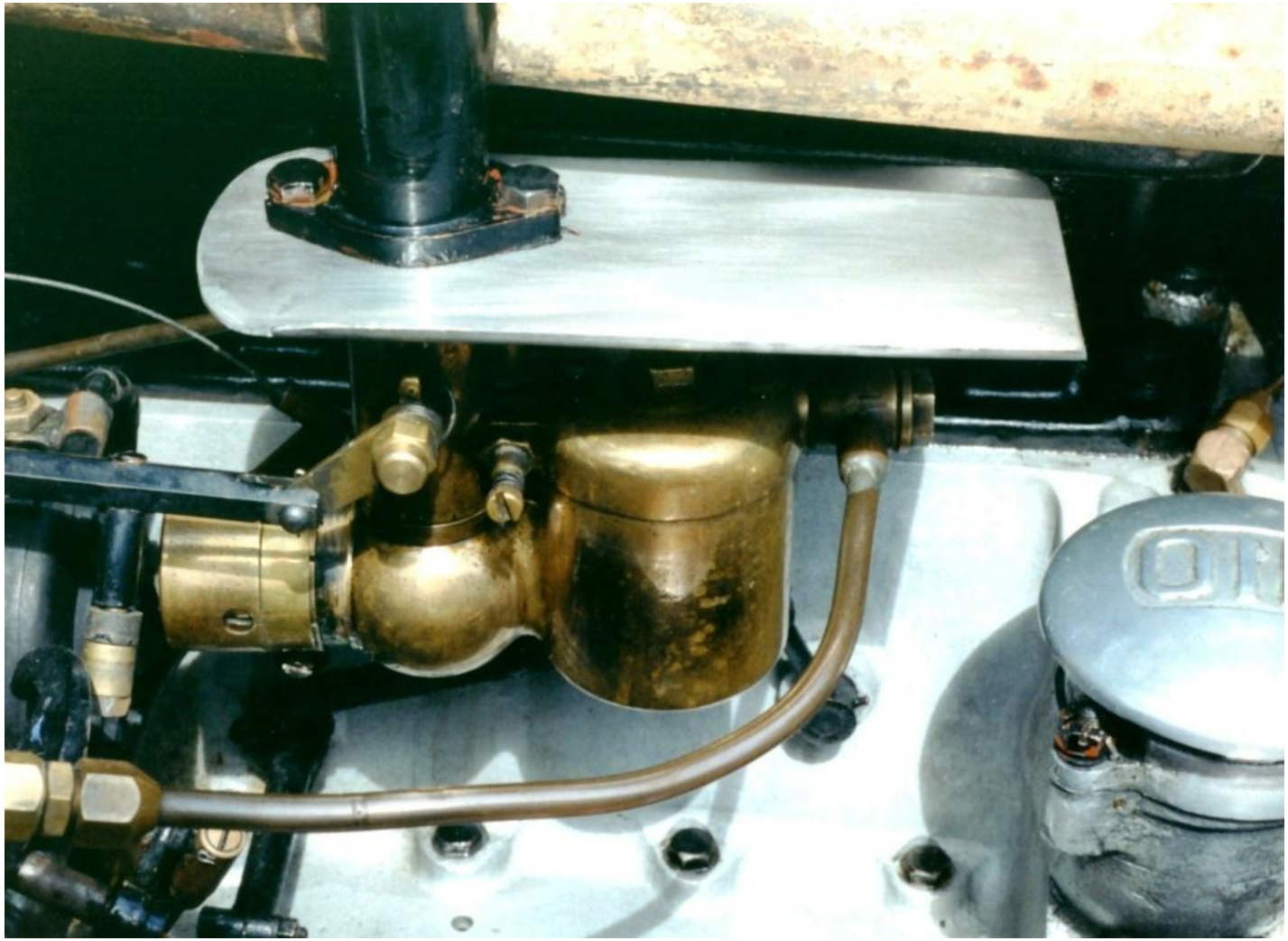
# Solutions to Combustion/ Driveability Problems

JCMA McArragher Associates

- Need to reduce (exhaust) heat flow to liquid fuel
- Fuel line routing away from heat sources
- Pump location away from heat source
- Carburettor shielding from exhaust heat
- Often simple modifications  are effective
- Changes need not alter vehicle character
- Baffles and heat shields can be fitted sympathetically

# Heat Shield - I



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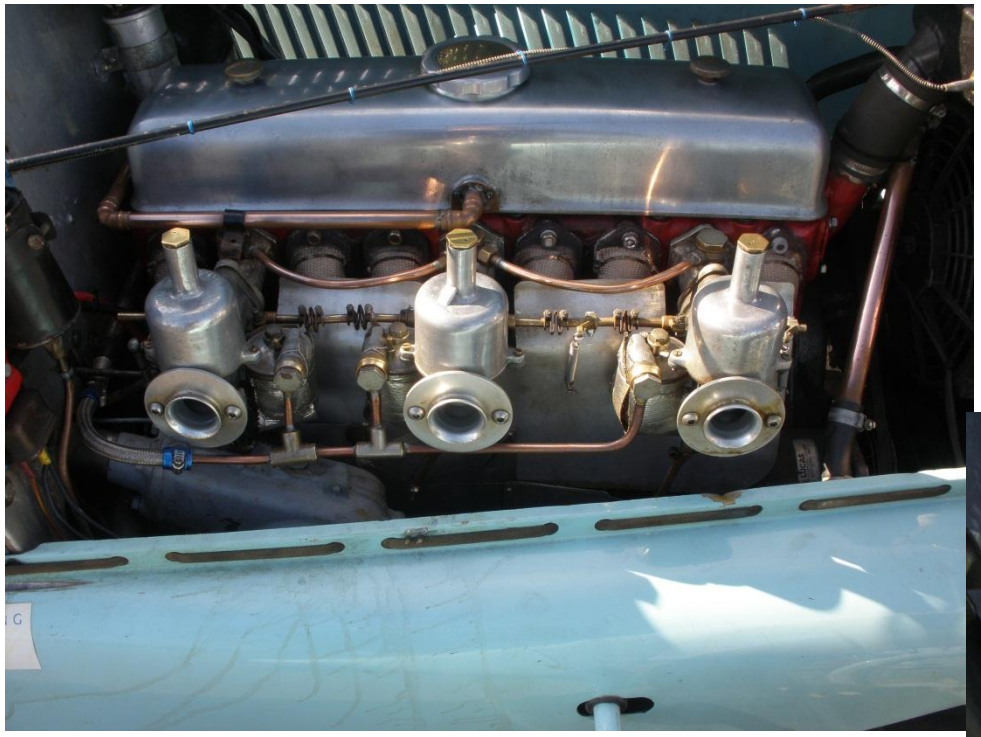
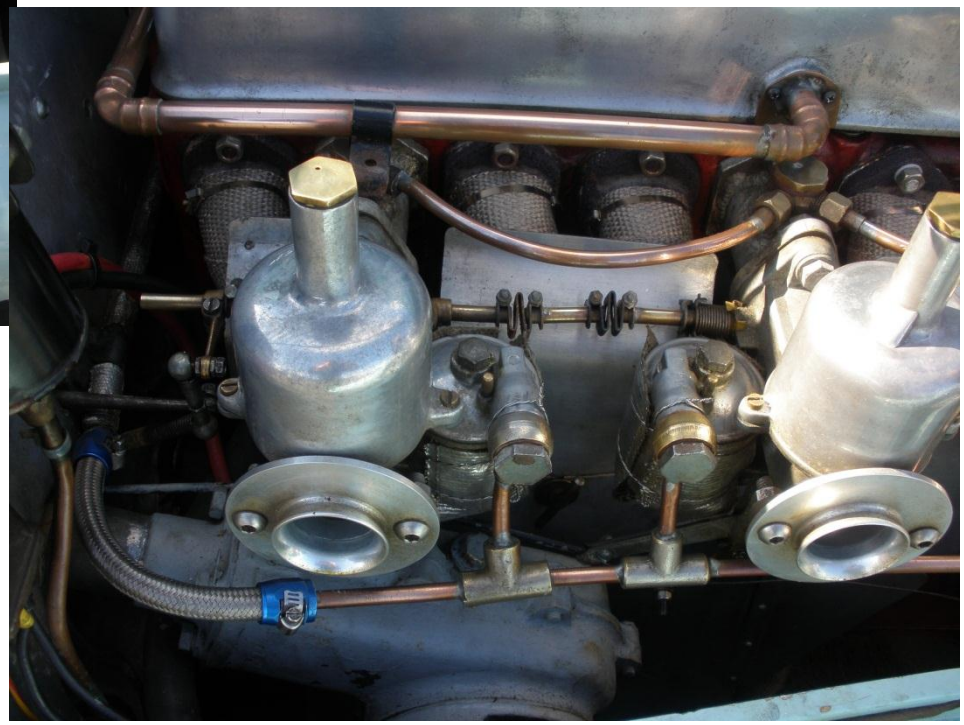
# Heat Shield - II

JCS MA McArragher Associates





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# Presentation to FBHVC AGM

Thank you for your attention