

# E10 – Is there a problem?

Presentation by Colin Birkinshaw  
to the  
Irish Veteran and Vintage Car Club Meeting,  
West County Hotel,  
Dublin.

# E10 – the Presenter

- Colin Birkinshaw, PhD, MSc.
- Materials scientist with 50 years industrial and academic experience.
- Owner of two classic cars, a 1965 Alvis TE21 and a 1971 Triumph TR6.



# E10 – the Concerns

- Concerns around water, acidity and rubber damage.
  - Are these concerns justified?
  - How do we find out?
1. We can do the big experiment and use E10 for 5 to 10 years and see what happens.
    - Difficult to collect and collate the results.
    - Expensive if it works out badly.**
  2. We can see what the science says and proceed accordingly.
    - So what does the science say?

# E10 – the Science

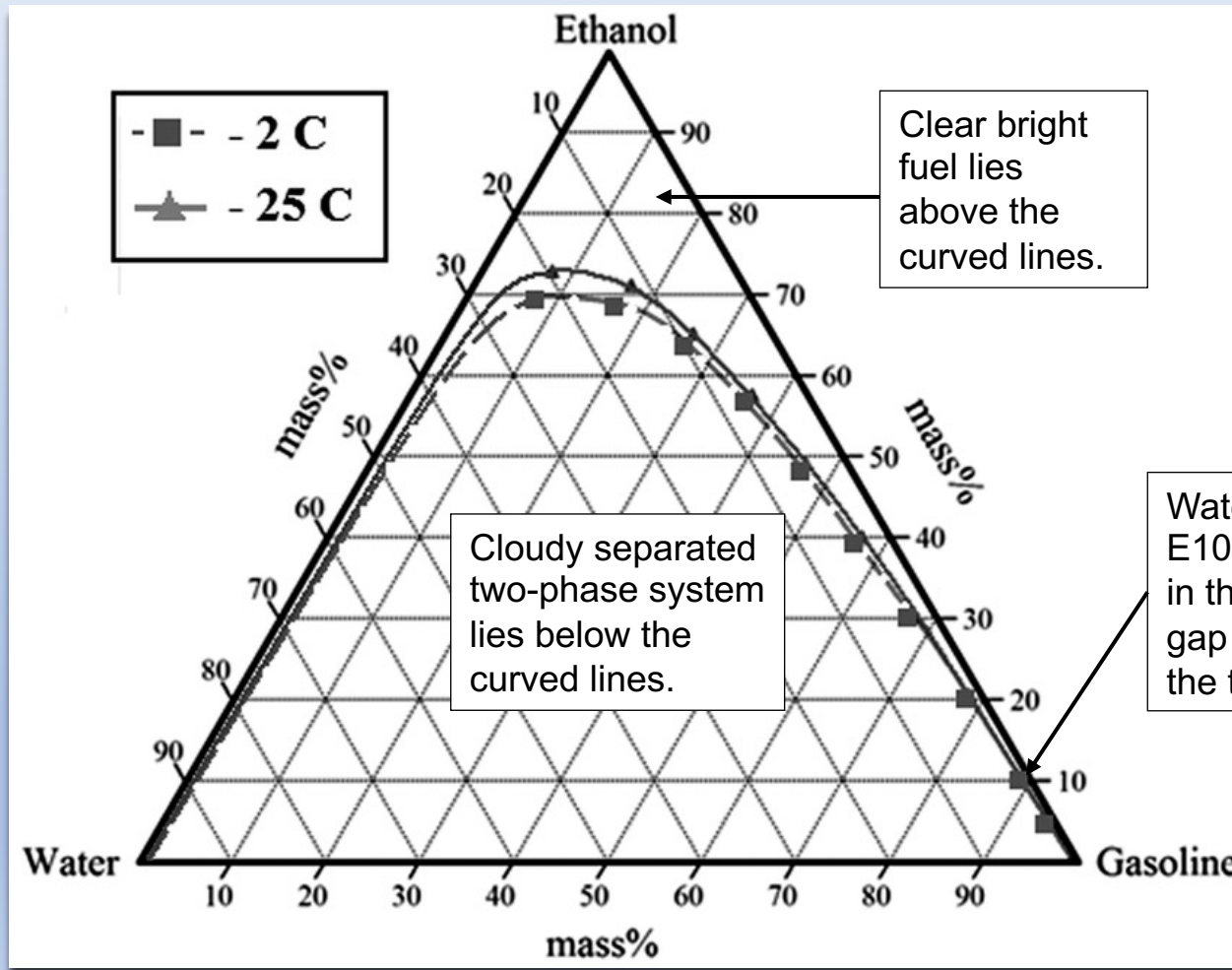
The science, in the form of published information, predicts three problems.

1. Water absorption and separation – ethanol readily absorbs water from the air.
2. Oxidation of ethanol to give acetaldehyde and acetic acid (vinegar).
3. Rubber and plastics damage.

# E10 – Water In

- Fuel tanks are open containers.
- Ethanol attracts water from the atmosphere into the fuel.
- Gasoline and ethanol are compatible in all proportions.
- Gasoline, ethanol and water are not compatible.
- With E10, when the water content exceeds 0.6% then water separation will occur.

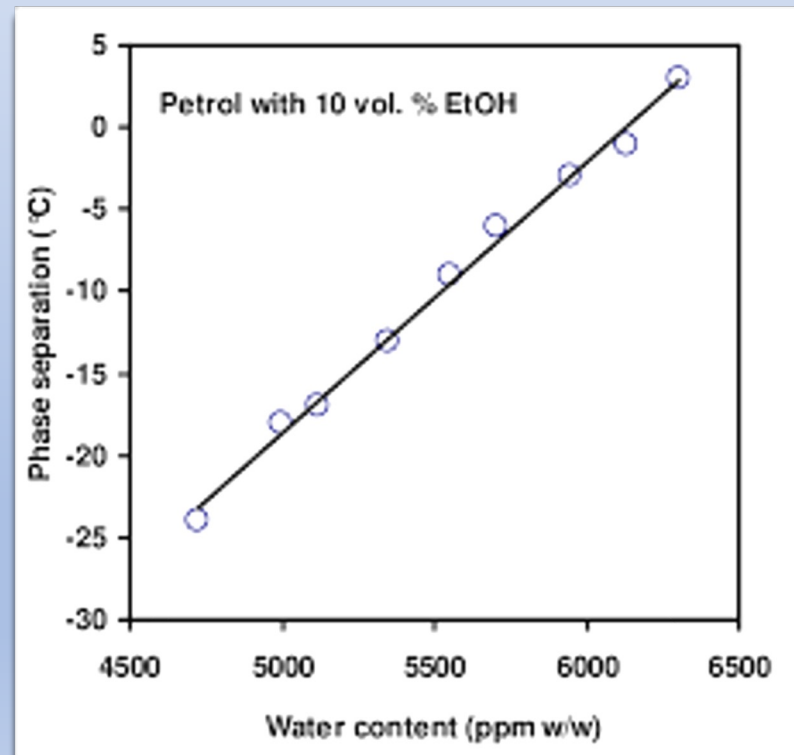
# E10 and Water



# E10 – Water Out

- At a water concentration of 0.5% to 0.7% (5000 to 7000ppm) in the fuel, the water separates out.

Haze point as a function of temperature. Lower temperature then less tolerance of water.



# E10 – Water precipitation

Water separates and collects in the bottom of the tank.

The separating water extracts some ethanol from the remaining fuel.

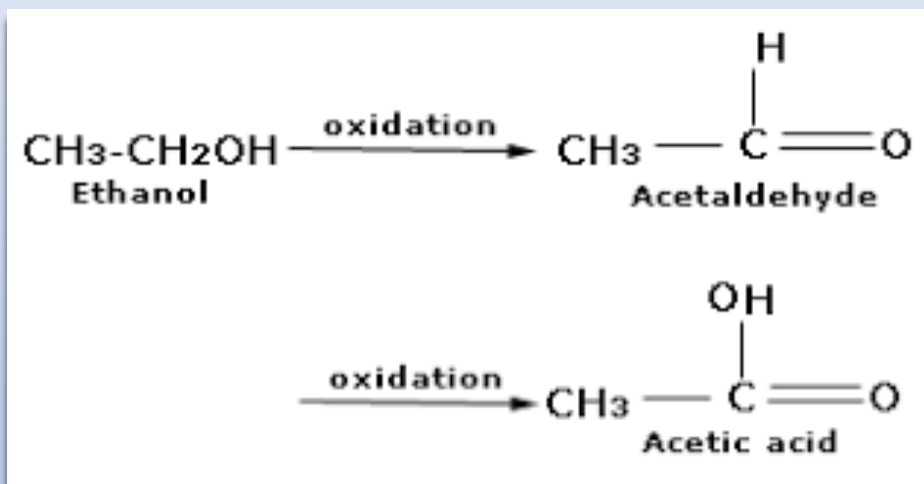
This can occur in the petrol station. Fuel could already have some water in it.

A serious problem in vehicles not used regularly.



# E10 – Acidity

- Ethanol reacts with air to give acetic acid.

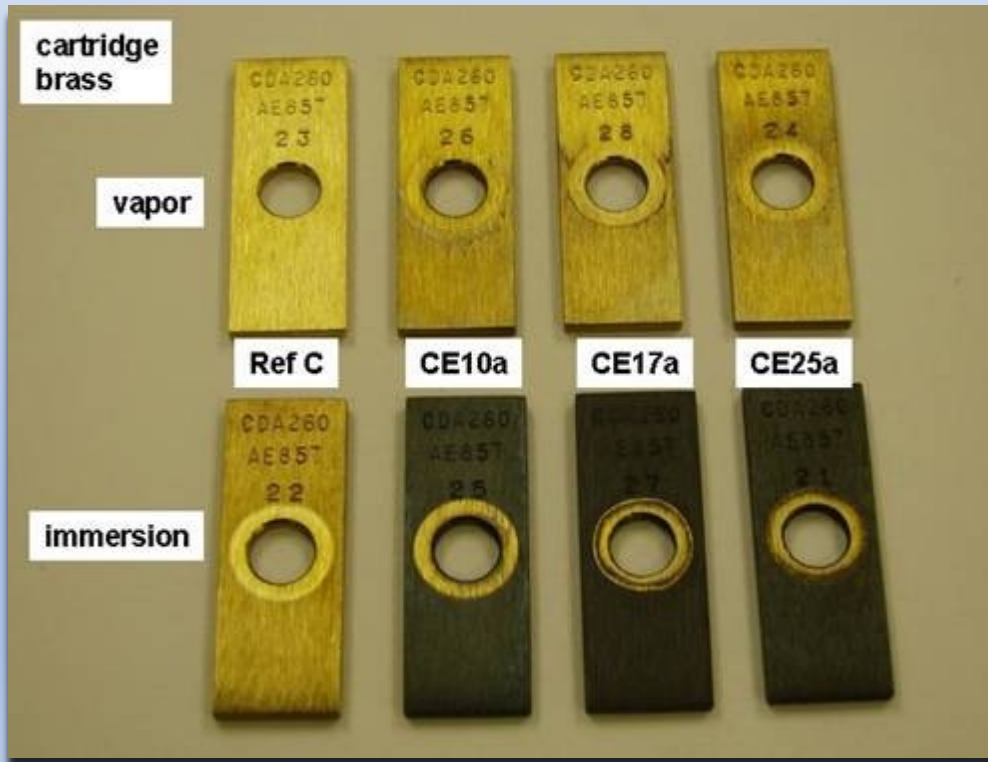


- Acetic acid will dissolve in any separated water to give vinegar, a powerful corrosive.



# E10 – Surface corrosion 1

Cartridge brass after 28 days exposure to ethanol containing fuels.



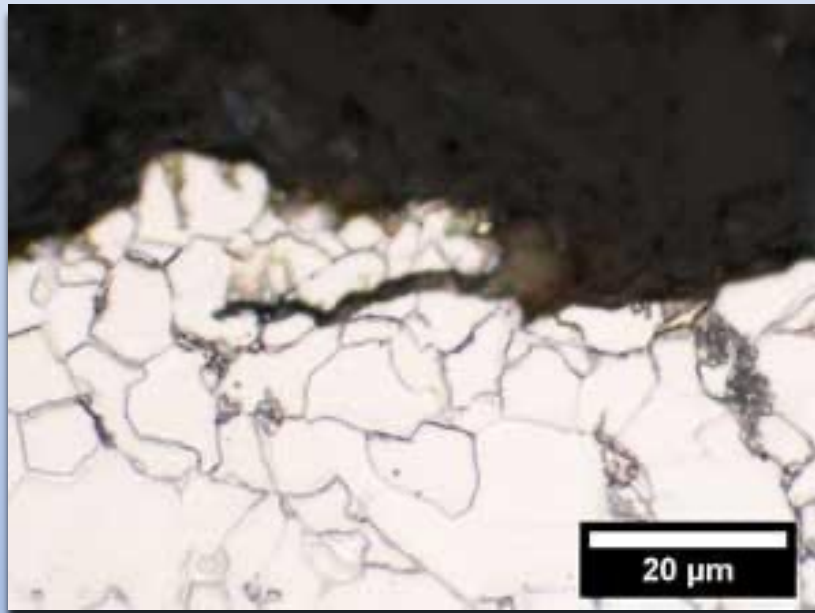
# E10 – Surface corrosion 2

Galvanized steel after 28 days exposure to ethanol containing fuels.



# E10 – Stress cracking

Micrograph of crack in X52 (pipe) steel after the sample was subjected to mechanical forces for several days in an ethanol solution containing acid-producing bacteria.



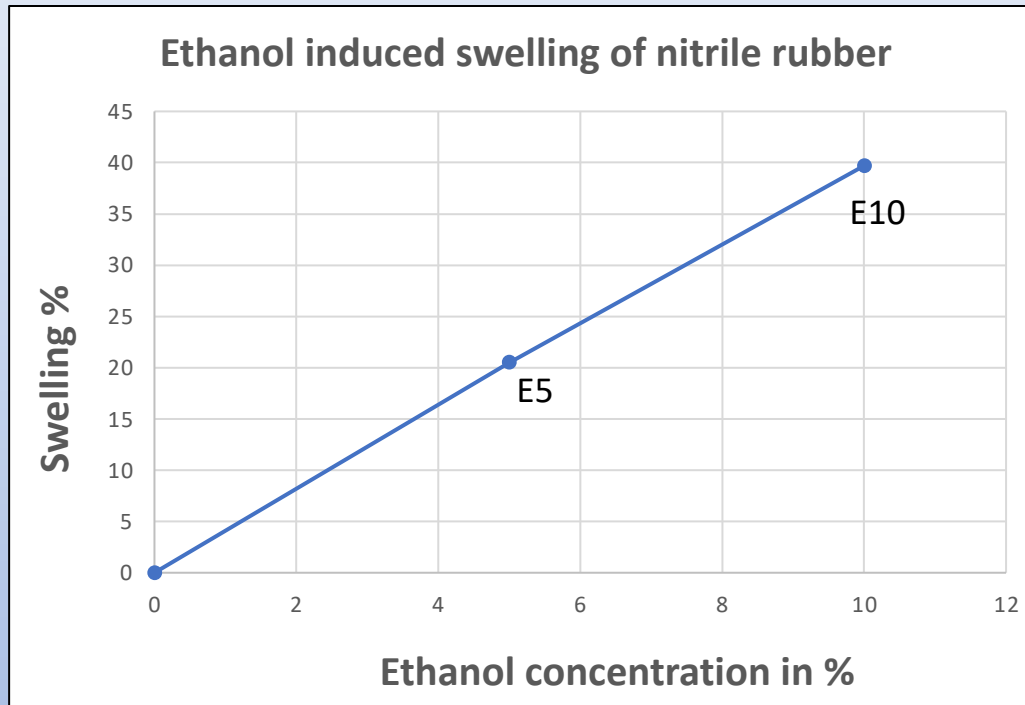
Ethanol induced corrosion is a real problem.

# E10 – Rubbers

- Nitrile rubber was extensively used in older fuel systems because it has good resistance to gasoline.
- Nitrile rubber has poor resistance to ethanol.
- Seals and pipes will soften and will ultimately fail.



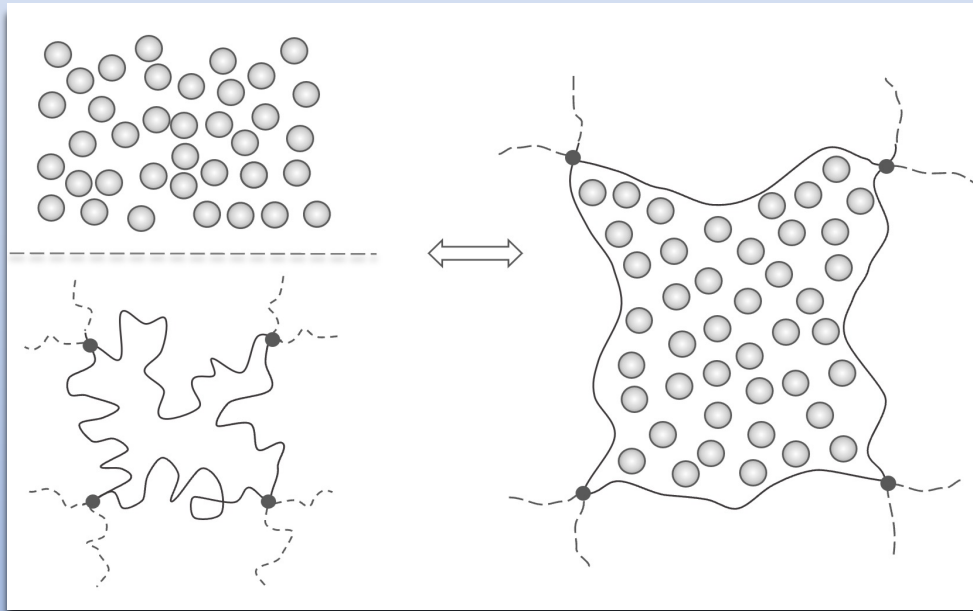
# E10 – Concentration Effects



A static application may tolerate up to 30% swelling, but a dynamic application less than 20%.

# E10 –Rubber swelling mechanism

If the rubber molecular chain and the small solvent molecule attract each other, then swelling will occur as the solvent penetrates the rubber network and expands it.



Swelling and softening are real problems leading to failures.

# E10 – A fuel system 1930 - 1980

Petrol tank, steel



Piping, zinc coated steel and nitrile rubber



Petrol pump, aluminium, brass, and nitrile rubber



Delivery piping, copper and nitrile rubber



**Failure is possible in every component of the system. It will not be possible to retain originality.**

Carburettor, aluminium, brass and solder





# E10 – Are additives the answer?

Makers of additives have to give a Safety Data Sheet (SDS) which lists components and approximate amounts, so we know what is in them.

Large variation in composition of E10 “protectors” but typically they may contain –

- Dispersants, non-ionic and anionic surfactants.
- Antioxidants or neutralising bases.
- Assorted hydrocarbons similar to gasoline.

# E10 – Oxidation Reduction?

The only area where additives may have something to offer. Manufacturers seem to have adopted one of four approaches.

1. Do nothing.
2. Use a chain breaking anti-oxidant such as a hindered phenol, as used in ordinary gasoline.
3. Use a chemical base to try to neutralise any acid formed.
4. Use an amine as a passivator.

Could not find published evidence that routes 2,3 and 4 actually work with ethanol fuels.

# E10 – Additives Not the Answer!

- Water absorption and separation cannot be stopped. A small amount of dispersant or surfactant is not going to deal with precipitated water/acid.
- Seal degradation cannot be stopped.
- Oxidation may be delayed but not stopped.
- Will additive manufacturers guarantee their products?



# E10 – Timescale?

- If problems are real how quickly will they develop?
- Corrosion and pipe swelling are slow processes.
- No two vehicles and vehicle usages are the same.
- Impossible to predict, but it will be months to years and **problems will not show until damage is done.**
- Some vehicles may remain unaffected.

# E10 – Where are we now?

- E10 is here with no alternative.
- Have we been asleep at the wheel?



- Where do we go next?

# E10 - the only answer

- In the North there are almost 100 stations offering non or low-ethanol petrol.
- Look at <https://www.aovc.co.uk/articles/e5-petrol-availability-in-northern-ireland>
- The nearest one to here is in Warrenpoint.

**We need the same facility here!**

# E - 10 Are the problems real? – Yes!

- Thanks for your attention and good luck with your motoring.

- Questions?

- Comments?

- Suggestions?



# Dodgy Stuff?

- Anything on YouTube where people put things in jam-jars, add petrol and see what happens. Dubious science.
- Adding two stroke oil to each fill. Waste of time.
- Washing fuel to remove ethanol. Scientifically sound but requires care and is dangerous. The resulting laundered fuel will have a reduced RON.
- Aiming to always end up with a full tank or an empty tank. There is a sort of logic to this in that it reduces the fuel surface area and minimises absorption but would have to be done scrupulously to achieve anything. Probably impossible to achieve in real life.
- Use Avgas? A leaded high-octane petrol, no ethanol, but difficult to get. At Weston airport €2.89 litre inclusive of VAT, but what about duty ?



# Ethanol for Fuel – A Dubious Business

Issues are energy balance and environmental effects.

- Ethanol from corn/grains – no scientific agreement on energy balance. Pushes up all food prices. Should food be used as fuel? Amplifies the effect of Ukraine war on food prices?
- Ethanol from sugar cane – positive energy balance but an ecological disaster. Bio-diversity is destroyed and breaking new ground results in massive CO<sub>2</sub> surge. 10 to 20-year CO<sub>2</sub> payback time.

**The use of bio-fuels is a short-term wrong-turn on the path to cleaner transport.**