

E85 and Flex-Fuel Technology

By

Blaine M. Heisner

SIUC Department of Automotive Technology

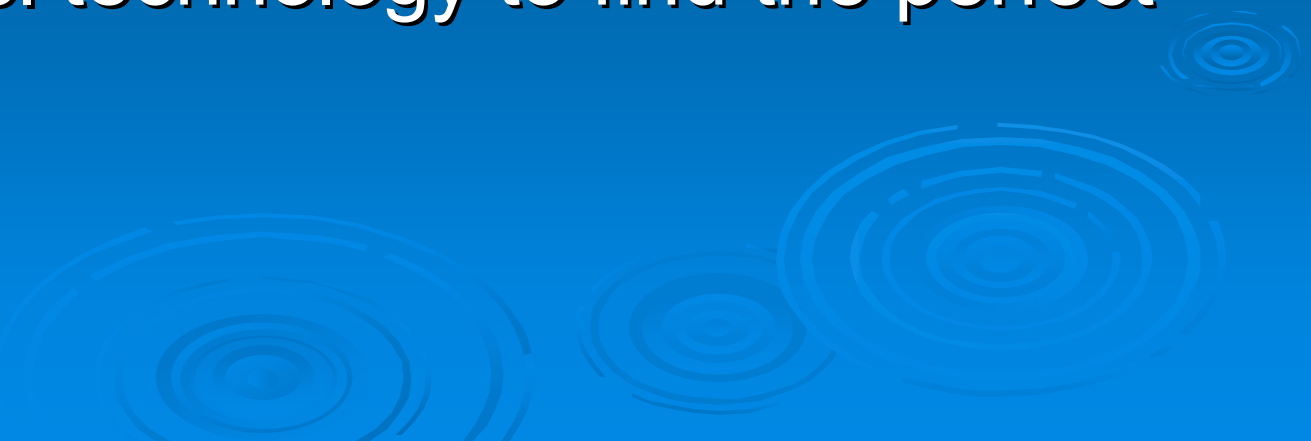
bheisner@siu.edu



What is an Alternative Fuel?

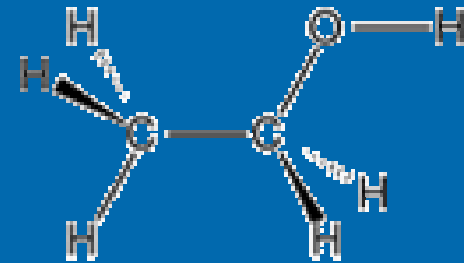
- As defined by Energy Policy Act of 1992 (EPAAct)
 - Substantially non-petroleum
 - Substantial energy security benefits
 - Substantial environmental benefits
- Methanol/ethanol/alcohol blends (85%)
- Natural gas/Propane
- Coal derived liquid fuels
- Hydrogen
- Electricity
- Biodiesel
- Biological source fuels
- P-series fuels

Why do we need them?

- Reduce our nation's dependence on imported petroleum
 - Reduce exhaust emissions and environmental pollutants
 - Controlling costs in certain applications
 - Expand fuel technology to find the perfect fuel
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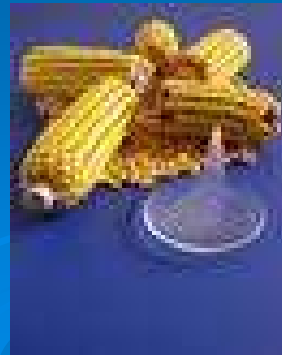
Ethanol

- Ethyl alcohol, grain alcohol
- liquid product produced from the fermentation of plant sugars/starches
- can be produced from almost any organic feedstock
- Flammable/colorless/strong odor



Ethanol Properties

- Heavier than gasoline
- Less dense than water
- Mixes with water
- Has less heat energy than gasoline
- Less volatile than gasoline
- Corrosive



Ethanol Production

➤ Glucose

- Expensive due to food value
- Sugar rich=sugar beets/sugar cane
- Starches=corn/potatoes

➤ Cellulose

- Cheap feedstock due to no/little food value
- Extract cellulose from plant material
- Convert cellulose to glucose
 - Acids or enzymes
- More expensive due to extra processes

➤ Energy returned on energy invested

- Corn=1.34/1
- Sugar Cane=8/1



Ethanol in Fuel

- Largest use is in fuels
- Must be void of water (anhydrous)
- High octane
- Lower emissions
 - 40% less CO
 - 10% less NO_x
 - 20% less PM
 - No net CO₂





- Mixture of 85% ethanol/15% gasoline
- Designed for Flex-Fuel vehicles
- 105 octane rating
- Well suited for racing applications
- Possible cold-start concerns

one gallon: A COMPARISON

REGULAR OLE OIL-BASED GAS: 124,800 BTU

CORN OIL (E85): 80,000 BTU

1.56 gallons of E85
takes you as far as
1 gallon of gas

Other Ethanol Blends

- E10
 - 10% ethanol/90% gasoline
 - Very common in US
 - 1990-newer vehicles are compatible
- E70=winter blend E85
- E95=Diesel engines



Ethanol Argument

➤ Benefits

- Domestically produced
- Renewable
- Biodegradable
- Lower emissions

➤ Detriments

- Less heat energy
- More expensive to produce
- Limited availability






For more information, visit
[livegreen
goyellow
.com](http://livegreen.goyellow.com)

Flex-Fuel Technology

Flex-Fuel Technology Basics

- What does “Flex-Fuel” mean?
- Are Flex-Fuel vehicles available?
- How flexible are FF vehicles?
- What is different about FF vehicles?


Flex-Fuel Vehicle Modifications

- anti-corrosion protection
 - increase fuel system capacity
 - fuel conductivity consideration
 - verify alcohol percentage
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Anti-Corrosion Protection

- alcohol's corrosive nature
 - methanol worse than ethanol
- aluminum & magnesium lines/tanks
 - stainless steel not affected
- deteriorates rubber components
 - use of Teflon seals, o-rings, etc...
- formic acid production
 - nitride coatings/FFV oils

Fuel System Capacity

- alcohol's lower heat energy per unit
 - larger fuel tank capacity
 - sender modifications
 - larger fuel line diameters
 - increased flow fuel injectors
 - higher fuel pressures?
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Conductivity Concerns

- alcohol is electrically conductive
 - gasoline is “dielectric”
 - fuel pump design is considered
 - fuel sender design is considered
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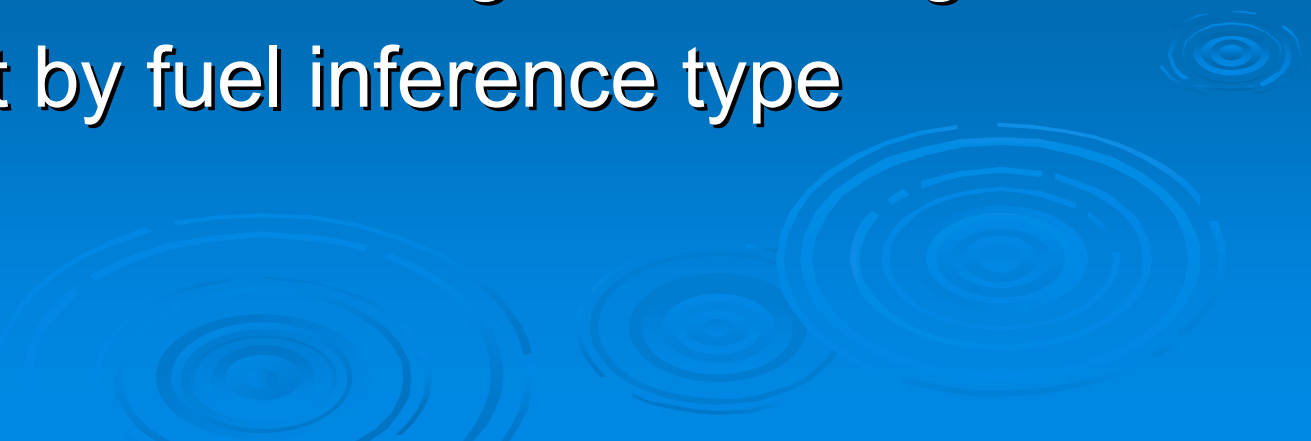
Alcohol % Identification

- Flex-Fuel vehicle need to verify %
 - designed to operate 0%-85%
- two main methods of verifying %
 - Flex-Fuel sensors
 - inference strategy

Flex-Fuel Sensors

- first method of learning alcohol %
 - mounted in the fuel line
 - can measure fuel conductivity, fuel temperature, dielectric constant
 - direct input to the PCM
 - sends signal continuously
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Flex-Fuel Sensors

- normally use power, ground, and signal output circuits
 - typically output a square wave signal in hertz (cycles per second)
 - PCM uses tables stored in memory to adjust fuel control and ignition timing
 - phased out by fuel inference type strategies
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Flex-Fuel Sensor



- 0% ethanol=51 hz
- 25% ethanol=67 hz
- 50% ethanol=89 hz
- 85% ethanol=115 hz
- Shorted sensor=
170 hz

FF Sensor Pros/Cons

➤ Pros

- proven technology
- read continuously
- fuel system faults do not affect

➤ Cons

- water read as alcohol
- extra cost
- extra parts to fail

Inference Strategy

- currently preferred method for alcohol %
- use oxygen sensor information to “infer” the alcohol concentration of the fuel
- Ford= “deductive refueling logic”
GM= “Virtual Flex-Fuel Sensor”
- learns only after KAM reset or fuel level change
- FLI increase by at least 10% or KAM reset

PCM Inference Mode

- disables canister purge/normal fuel adaptive learning
- meters fuel based upon previous %
- monitors ECT, MAF, BOO, Gear, HEGOs
- alters injector on-time to obtain 0% fuel error

PCM Inference Mode

- delays locking in value
 - fuel in tank has reached engine
- locks in FF% once HEGOs switch normally
- canister purge/normal fuel adaptive learning are reinitialized after inference
- typically complete within 7 miles

Inference Strategy Pros/Cons

➤ Pros

- uses existing components
 - less cost
 - less parts to fail

➤ Cons

- infers alcohol % only after refuel
- fuel system faults can alter inferred value
- calibration revisions to fine tune strategy

Flex-Fuel Specific Faults

- PCM sees higher than correct alcohol %
 - PCM commands higher injector on-time
 - A/F ratio richer than optimal
 - HEGOs read a rich mixture
 - PCM will decrease injector on-time
 - fuel trims will show -% (rich condition)
 - may set rich codes (P0172/P0175)

Flex-Fuel Specific Faults

- PCM sees lower than correct alcohol %
 - PCM commands lower injector on-time
 - A/F ratio leaner than optimal
 - HEGOs read a lean mixture
 - PCM will increase injector on-time
 - fuel trims will show +% (lean condition)
 - may set lean codes (P0171/P0174)

Flex-Fuel Fault Diagnosis

- problem could be Flex-Fuel related
 - check FF PID first
 - compare PID reading to fuel sample
 - clear KAM and relearn alcohol %
 - substitute/change to known value fuel
- problem could be unrelated
 - fuel pressure
 - vacuum leaks
 - MAF voltage

Alcohol in Non-Flex Fuel Vehicles



E85 Fuel

- Designed for Flex-Fuel vehicles
- Lower heat energy than gasoline
- Corrosive to certain materials
- Can void manufacturer warranties of non Flex-Fuel vehicles

Manufacturer Statements (General Motors)

- Only vehicles designated for use with E85 should use E85 blended fuel.
- Use of fuel containing greater than 10% ethanol in non-E85 designated vehicles can cause driveability issues, service engine soon indicators as well as increased fuel system corrosion.
- Repairs that result from the use of improper fuel, such as the use of gasoline containing more than 10% Ethanol in a non-FlexFuel certified vehicle, are not covered under the terms of the New Vehicle Warranty.

Straight E85 or ethanol is not smart

➤ Fuel injected vehicles

- May run properly due to adaptive learning
- Will set MIL and set lean codes
- May lean out dangerously at WOT


➤ Carbureted vehicles

- Will not run properly
- Will be lean at all times

Blending Ethanol

- Blending ethanol can obtain ethanol benefits without undesirable effects
- Vehicles built after 1990 were designed for E10
- Ethanol can increase octane and lower emissions
- Maximum ethanol % can be tested on various vehicle designs

Blending for Fuel Injection

- Start with low ethanol % and increase until undesirable traits are present
 - Check HEGOs at WOT
 - Calculate % by volume
 - Sample fuel at rail to verify %
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Alcohol Conversions

- Corrosion protection
 - Teflon, polyethylene, stainless steel
- Fuel system
 - Sufficient fuel flow
 - Initial filter replacements
 - Enrichment method
- Engine modifications
 - Ignition timing, compression
- Cold start enrichment

Aftermarket Conversions

- Aftermarket alcohol conversion kits are widely available online
 - Reprograms (E85 Solutions)
 - Standalone CPUs (FLEXTEK)
- Conversions do not void warranty
 - Magnuson-Moss Act
- May require recertification to be resold

Blending for Carburetors

- Much less ethanol can be used in unmodified carbureted vehicle
- Older vehicle designs not set up for alcohols
- If ethanol use is desired for carbureted vehicle, rejetting should be performed.

Carburetor Conversions

- Larger power valve if available
- Increase accelerator pump flow
 - Drill orifice 10%-25%
 - Adjust arm travel or pump cams
- Use alcohol rated seals, gaskets, float
- Manual chokes are desired

Optimizing for Alcohol

- increased ignition timing
 - higher compression ratio
 - superchargers/turbochargers
 - electric fuel pump
 - tune, tune, tune
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