

Motor Fuels & Engine Technology

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Motor Fuels & Engine Technology

- Characteristics of Ethanol
- Ethanol Blends
- Vehicle Changes to Accommodate Ethanol
- Engine Changes to Accommodate Ethanol
- Engine Changes to Take Advantage of Ethanol
 - Flexfuel
 - Dedicated Ethanol Engines
- Summary



Ethanol vs. Gasoline

Engine & converter performance
Durability
Fuel economy & Cold start

- Ethanol is very different from gasoline
 - Ethanol's research octane number (RON) is higher than gasoline's
 - Ethanol's heat of vaporization more than double gasoline's
 - Cooler flame temperatures in the combustion chamber
 - Ethanol is a polar molecule. Gasoline is non-polar.
 - Ethanol conducts electricity. Gasoline does not.
 - Ethanol has less lubricity than gasoline
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- Ethanol has one third lower energy content than gasoline
 - Ethanol has a lower vapor pressure than gasoline



Ethanol Blending

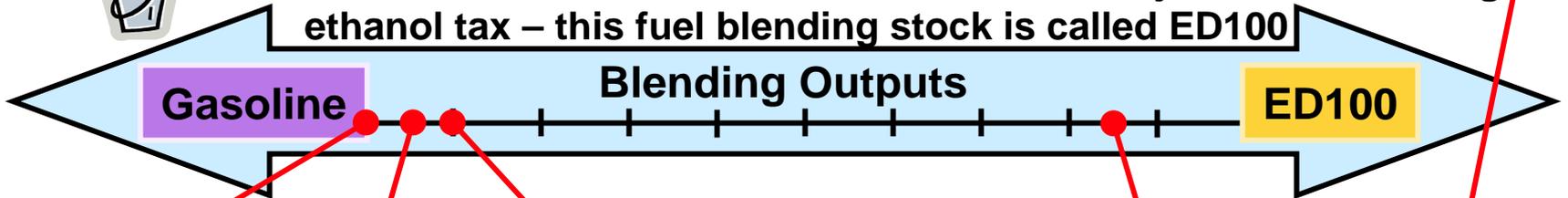
- Ethanol is usually blended with gasoline
 - The high blend octane of ethanol improves the octane of the blended fuel, particularly at low ethanol concentrations
 - Ethanol typically reduces vehicle emissions, particularly on older vehicles, improving air quality
 - Most vehicles and engines can tolerate 10% blends
- Ethanol blends higher than 10% displace more petroleum
 - Vehicles and engine that are not designed for blends higher than 10% can be damaged
- Some gasoline is required for cold start to avoid an auxiliary fuel system
 - This limits the maximum that can be blended into gasoline to 75-85%



Ethanol Blending Options



- From the still, ethanol (as used for fuel in Brazil) includes about 5% water
- The water is removed in a molecular sieve to produce anhydrous ethanol, the base ethanol fuel for gasoline blending
- 5% gasoline is then added to the anhydrous ethanol to produce denatured ethanol, which is toxic and not subject to the beverage ethanol tax – this fuel blending stock is called ED100



Gasoline (E0) 0% Ethanol	CA RFG (E5.7) 5.4% Ethanol	Fed RFG (E10) 9.5% Ethanol
		
Gasolines: Straight & Low % EtOH Blends		

E85 81% Ethanol	Brazil E100 95% Ethanol
	
Alternative Fuels	



Vehicle Changes to Accommodate Ethanol

- E10 requires changes to sealing materials and the elimination of some alloys sensitive to Ethanol
- E20 requires additional changes to both sealing materials and electrical components.
- E85 requires increased flow from the fuel pump to accommodate the increased fuel flow requirements due to the lower energy content of ethanol
- E100 requires an additional fuel tank to hold gasoline for cold starts.



Engine Changes to Accommodate Ethanol

- E10 and E20 require progressive changes to sealing and metallic materials
- E85 requires higher flow injectors and some additional changes to the injector materials
- E85 requires harder engine valve seat and valves
 - The reduced lubricity of ethanol makes the harder valve seats and valves necessary
- For E85 a fuel composition sensor or a software algorithm is necessary to determine fuel composition
- For E85 many changes and additions are required to the engine control software and calibrations
- E100 requires additional fuel lines and controlled valve to allow automatic switching between the gasoline and ethanol tanks.
 - The low vapor pressure of ethanol makes the cold starting on gasoline necessary and the auxiliary fuel system is required to deliver the gasoline



Vehicle Modifications



Carburetor

The material of the carburetor body or carburetor cover cannot be aluminum or exposed zinc; if it is, must be substituted, protect with surface treatment or anodize;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected;

The material of buoy, nozzle, metering jet, floating axle, seals, gaskets and o-rings must be appropriated.

Engine

The engine compression ratio can be higher;

Camshaft with new cam profile and new phase are possible;

New surface material of valves (intake and exhaust) and valve seats.

Fuel Tank

If the vehicle fuel tank is metallic, the internal surface of tank must be protected (coated);

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

Higher fuel tank capacity, due to the higher fuel consumption.

Cold Start System for E100

Auxiliary gasoline assisted start system, with temperature sensor, gasoline reservoir, extra fuel injector and fuel pump;

The vehicle battery must have higher capacity.

Ignition System

New calibration of advance control;

Colder heat rating spark plugs.

Electronic Fuel Injection

Substitution of fuel injector material by stainless steel;

New fuel injector design to improve the "fuel spray";

New calibration of air-fuel ratio control and new Lambda Sensor working range;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

Fuel Pump

The internal surface of pump body and winding must be protected and the connectors sealed;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

The pump flow must be increased.

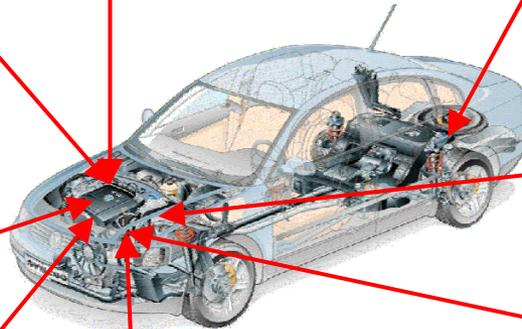
Fuel Pressure Regulator

The internal surface of the fuel pressure device must be protected;

Any component in polyamide 6.6 (Nylon) that has contact with the fuel must be substituted by other material or protected.

The fuel pressure must be increased.

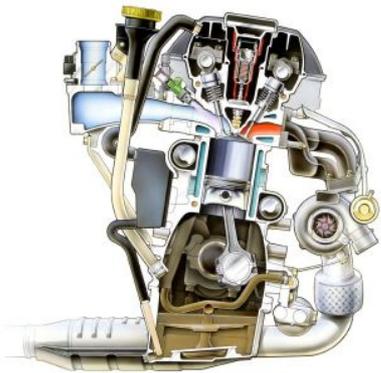
Chart from Henry Joseph – Manager, Engine and Emission Department Volkswagen do Brasil



Engine Changes Optimized for Ethanol

FlexFuel Engines

- Spark timing can usually be advanced for better torque and efficiency
- If an engine is turbo-charged the boost can be increased for large increases in power and small increases in efficiency



- This process is limited by the strength of the engine and transmission
 - To take full advantage of the potential increase in turbo boost significant structural and fuel flow improvements may be required
- Direct injection can use the charge cooling effect to increase power

Engine Changes for Ethanol Only

Dedicated ethanol engines

- Compression ratios can be increases for more power and efficiency
- The engine can be downsized and boosted for maximum efficiency improvement
- Both of these approaches result in reduced gasoline performance
 - Universal, competitively-priced, ethanol availability is required
- Fuel economy can be increased, but can not entirely compensate for Ethanol's lower energy content



GM US Flexfuel Club



GMC Savana



GMC Sierra



Chevy Impala



Chevy Silverado



**GMC Yukon &
Yukon XL**



Chevy Monte Carlo



Chevy Uplander



**Chevy Avalanche ,
Suburban & Tahoe**



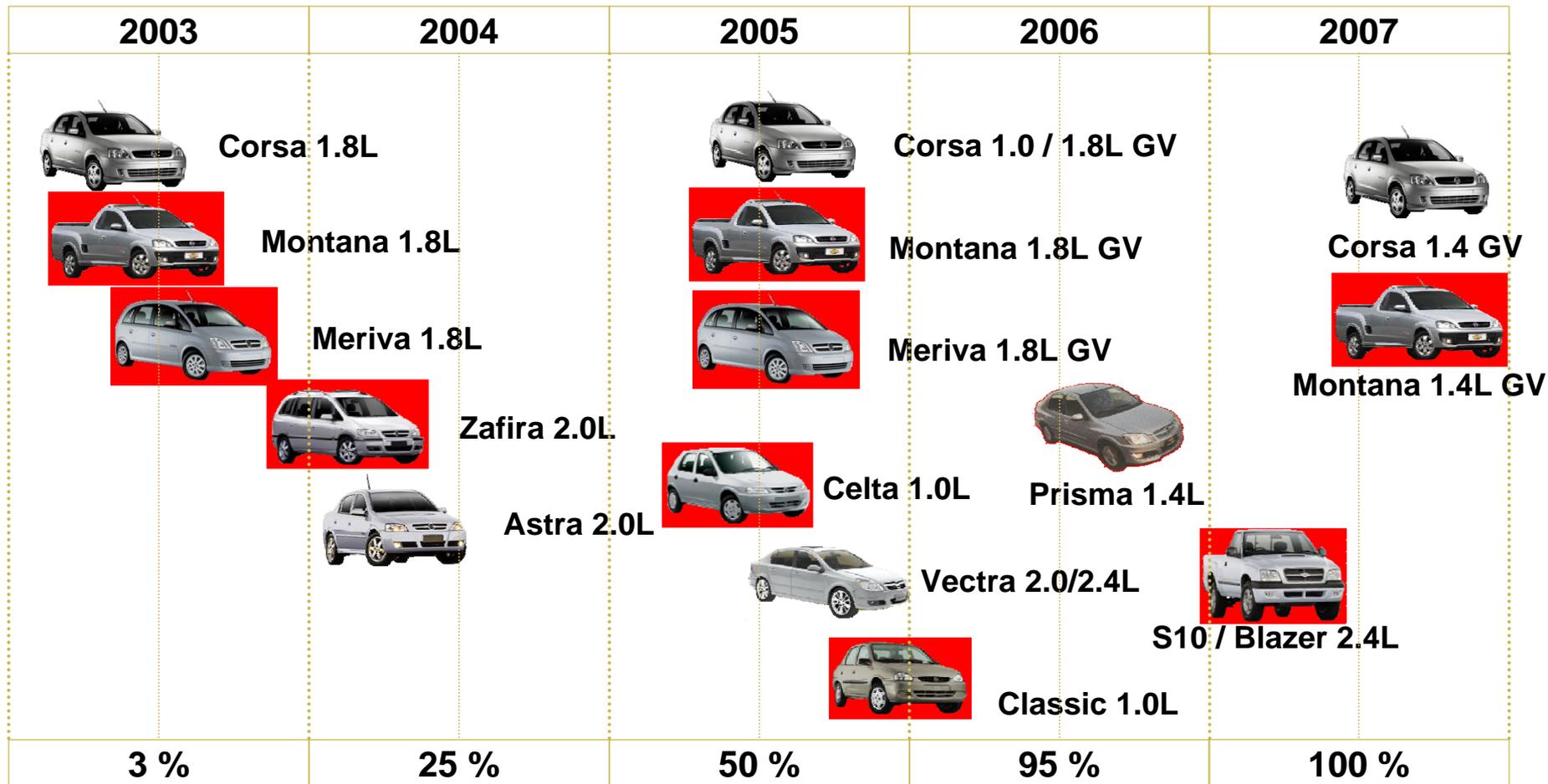
BioPower Roll-Out in Sweden/Europe

- MY05 – Saab 9-5 Fam III 2.0t featuring +30 hp and +40 Nm launched May 2005 for Swedish market
- MY07 – Saab 9-5 Fam III 2.3t 185 hp will be offered as BioPower 210 hp (Euro 4 and EOBD) for Europe
- MY07 – Saab 9-3 L850T 2.0t 175 hp will be offered as BioPower 200 hp (Euro 4 and EOBD) for Europe
- MY08 – Saab 9-3 L850T 1.8t 150 hp offered as BioPower 175 hp (Euro 4 and EOBD) for Europe
- MY08 – Cadillac BLS L850T 2.0t 175 hp will be offered as FlexPower 200 hp (Euro 4 and EOBD) for Europe



GMB FlexPower Portfolio

Passenger Vehicles - Brazilian Market



Summary

- Ethanol is very different from gasoline
 - It requires its own specifications to protect engines and vehicles
 - Using ethanol in engines and vehicles that are not designed for it can damage them
 - The damage is slow to appear
 - Small engines and off-road vehicles can be especially vulnerable
- High ethanol blends can displace much more ethanol when used in vehicles designed for them
- Dedicated ethanol vehicles offer significant efficiency gains but require universal availability
- Technology is mature and is being used strategically to address energy security and climate change issues around the world

