

Differences in Gasoline and Ethanol Engines for Automobiles

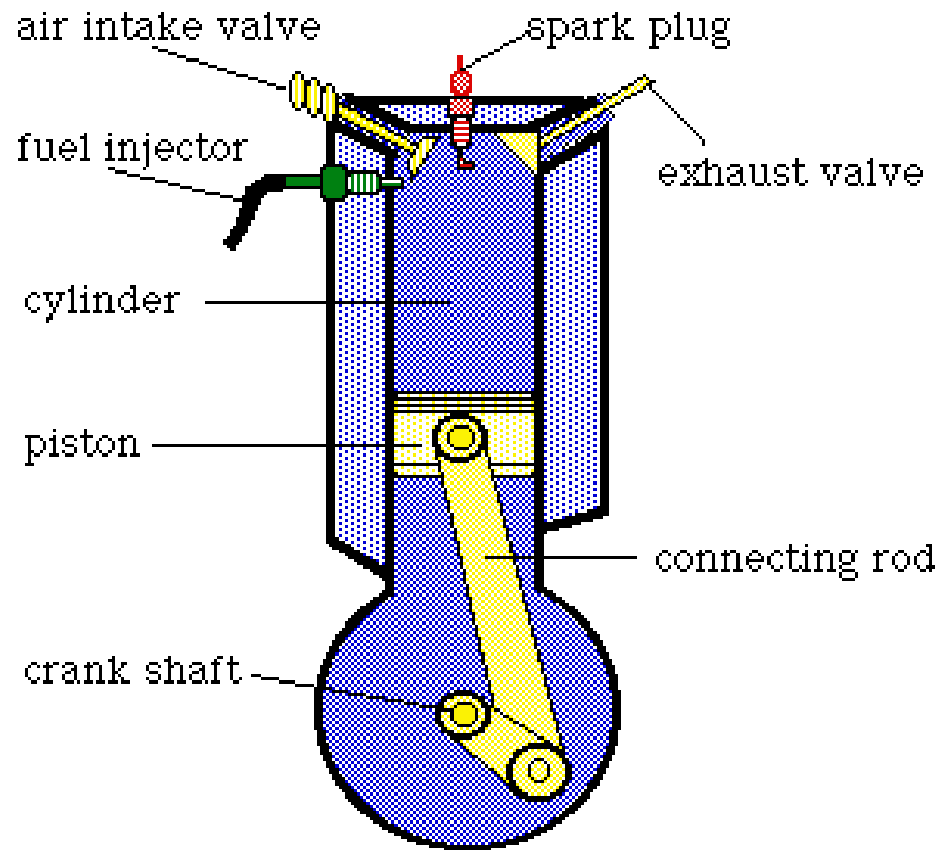
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June 6, 2012

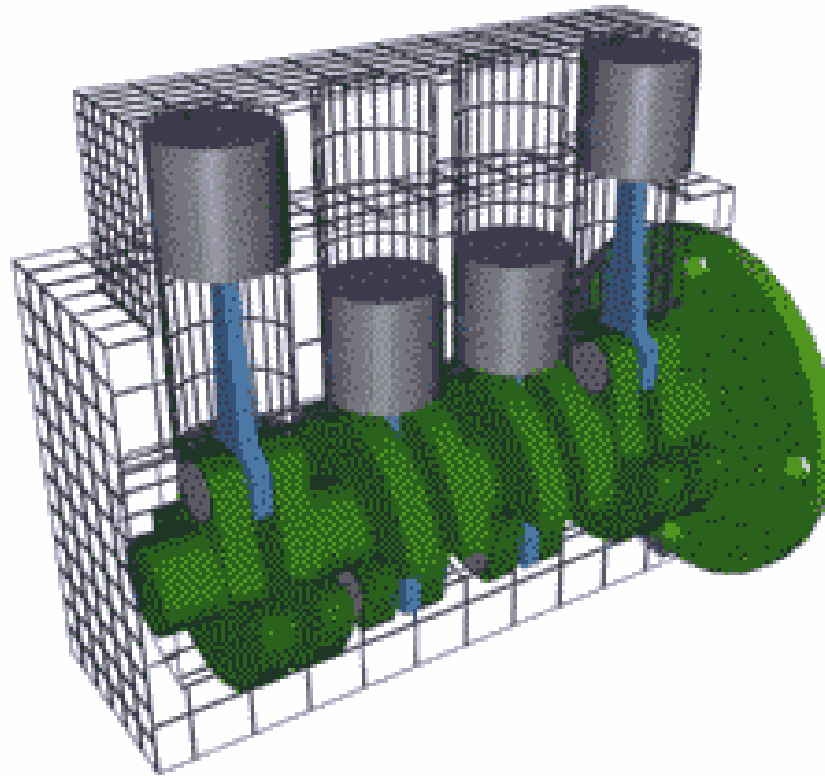
Outline

- **How does an ICE work?**
- **Fuel comparison**
- **Gasoline**
- **Ethanol**
- **Flex-Fuel**
- **Future Designs**
- **My opinion on the use of biofuels...**

Internal Combustion Engine



Internal Combustion Engine, cont.



4 cylinder engine, inline configuration,
<http://auto.howstuffworks.com/engine2.htm>

Octane Number & Knocking

- Octane number measures how much compression a fuel can take before detonating.
- Higher compression engines generally have higher performance (87 vs. 89 or 91)
- Knocking, or engine knock, occurs when the fuel self-ignites before the piston is in the optimal position.

Gasoline vs. Ethanol

Property	Gasoline	100% Ethanol
Energy Density	35 MJ/L	24 MJ/L
Octane Number	87 - 91	~110
Heat of vaporization	349 kJ/kg	846 kJ/kg

Gasoline Engines

- Able to run on 10% Ethanol with no alteration
- Operates on an 8-10:1 compression ratio¹
- Better fuel economy than ethanol

¹<http://www.howstuffworks.com/diesel1.htm>

Ethanol Engines

- Extra cost is relatively insignificant; manufacturer generally absorbs cost
- Ethanol has higher octane number (~110) and higher heat of vaporization than gasoline
- Burns cooler in the engine
- Can operate on a 14.5-16:1 compression ratio²
- Ethanol may corrode inner workings of regular gasoline engines, so different metals and alloys can be used or additives can be added to ethanol to prevent corrosion

²<http://www.turbofast.com.au/racefuel2.html>

Flex-Fuel Engines

- Capable of utilizing any blend of gasoline and ethanol
- Slightly less efficient than gasoline engines
- Electronic sensors adjust fuel injection and spark timing automatically to fuel blend
- Brazil: engines initially contained small gas reservoir for cold weather starting; since 2009, new technology eliminated need for secondary tank

Future Engine Designs

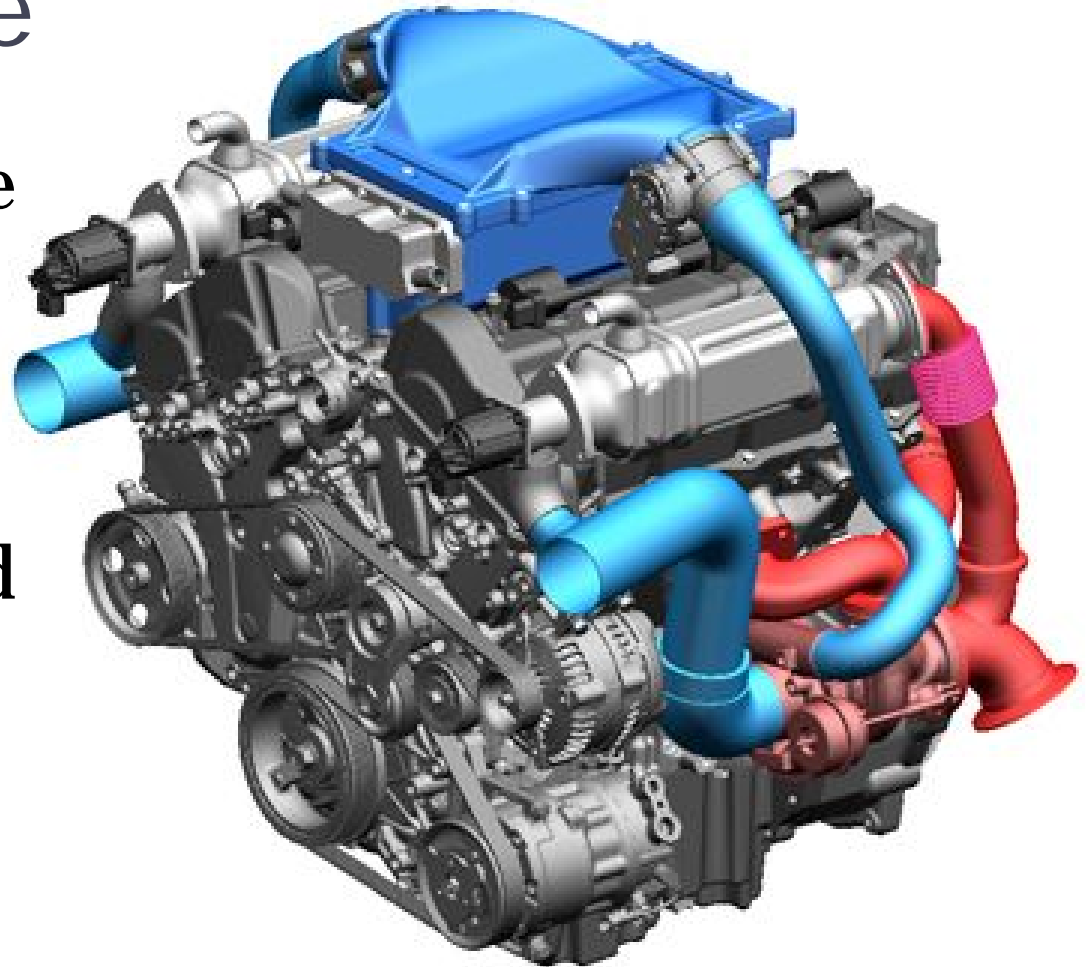
EBDI (Ethanol Boosted Direct Injection) engine by Ricardo, Inc.

- Goal: to match the performance of a 6.6L turbo-diesel engine in power while bettering it in fuel efficiency
- Optimized for both ethanol and gasoline
- Proposed benefits: 17% gain in fuel economy, 1.5x the torque of a diesel engine, 300-400 lbs lighter

http://www.ricardo.com/Global/IA/What-We-Do/Technical-Consulting/Research_and_Technology/EBDI%20case%20study%201.pdf

EBDI Prototype

- 3.2-liter V6 engine
- For use in heavy trucks to replace diesel engine
- Prototype released in 2009
- Still in progress?



The Biofuel Question

Yes, biofuels are worth investing in

- CO₂ outputs are generally much better with biofuels (considering life-cycle analysis)
- We can run biofuels on existing (and improving) technologies as other solutions such as fuel cells and batteries are developed

Questions?