Technological Inputs for Higher Ethanol Use in petrol and in diesel Engines

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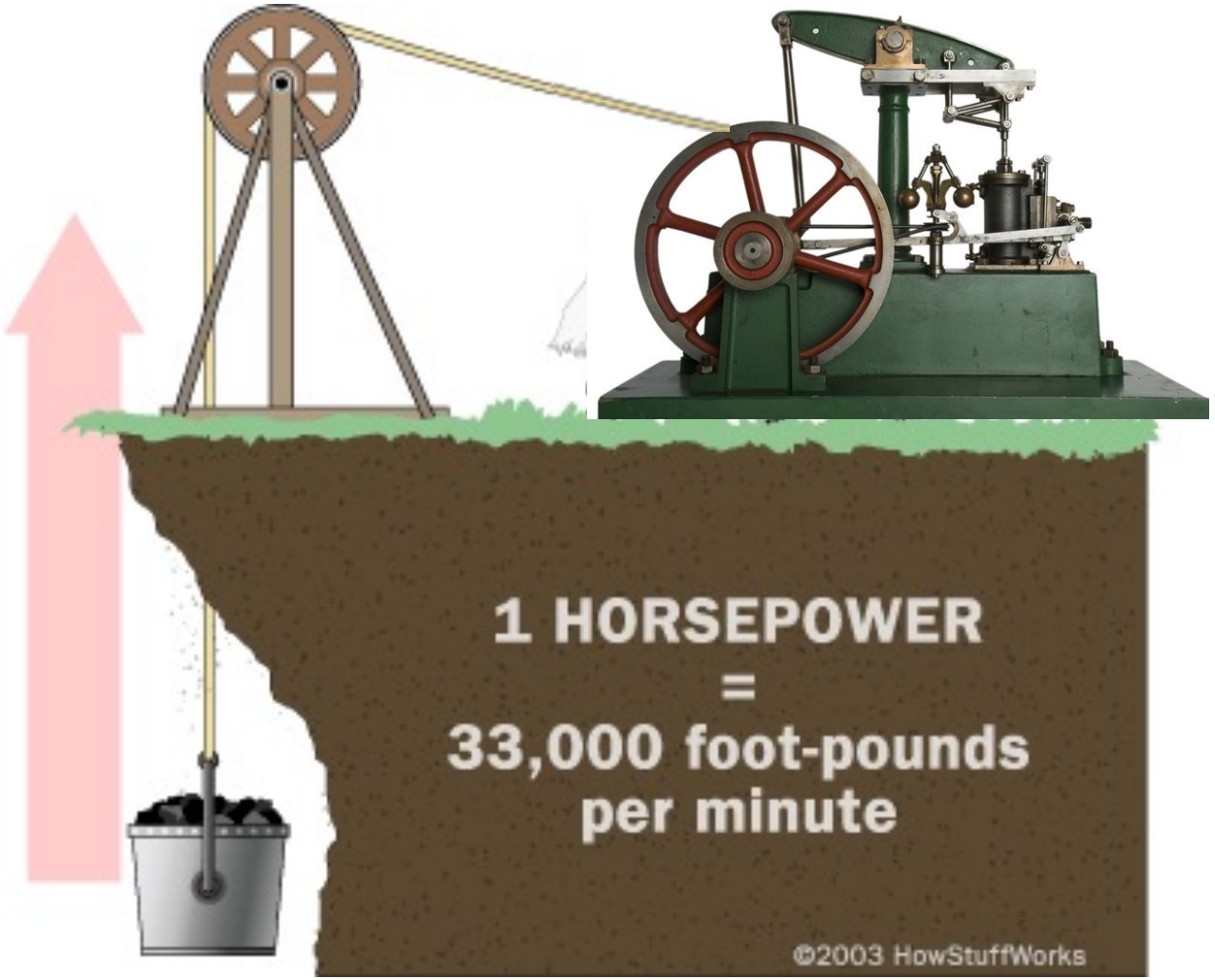
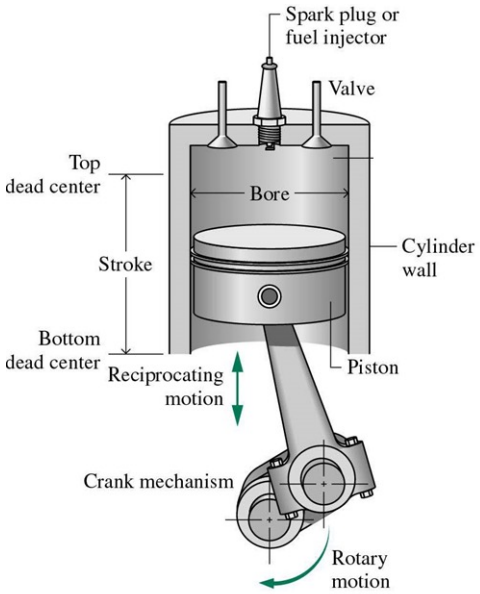
Selection of Right & Sustainable Diet for A Work Horse…..

James Watts Creation of An Artificial Horse for Road Transport



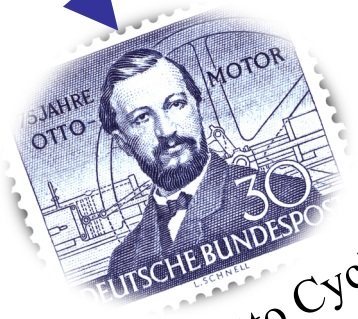
Internal Combustion Engines



CARNOT Gas Engine THEORY
1824

Brayton Cycle
1872

Diesel Cycle
1893



Otto Cycle
1876

A Race for Correct Diet !?!?

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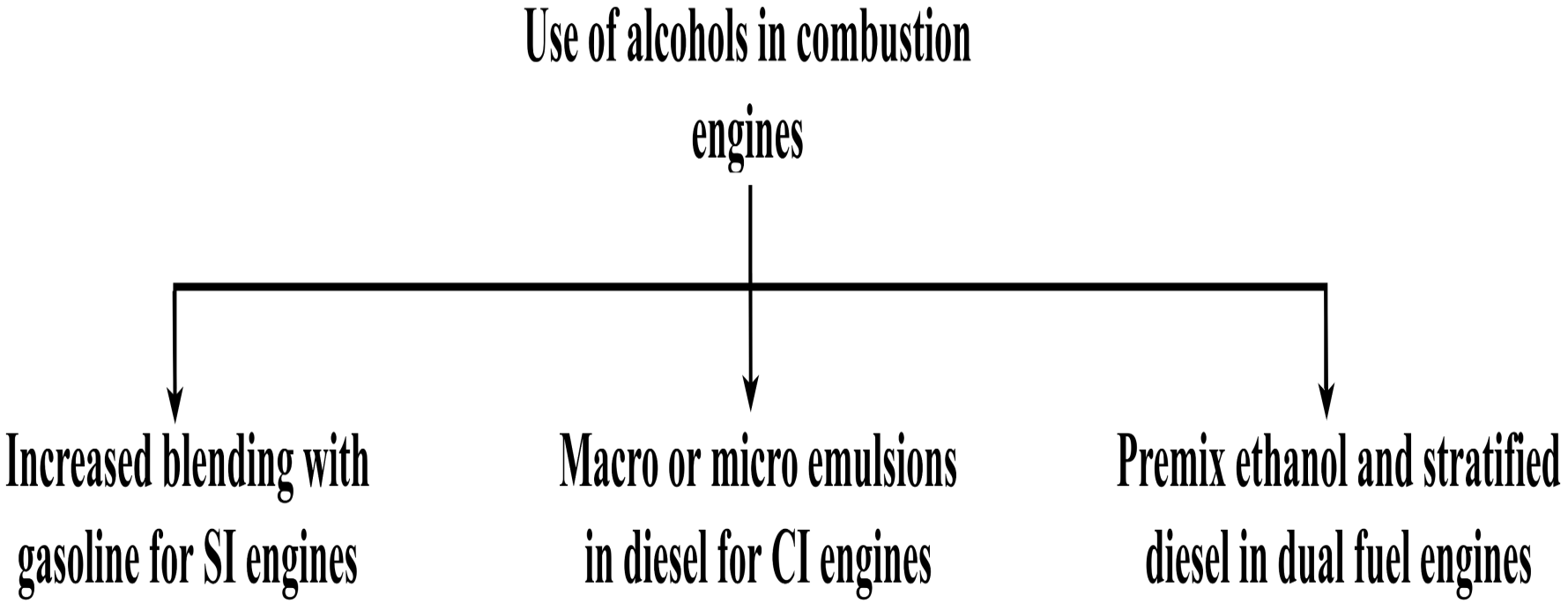
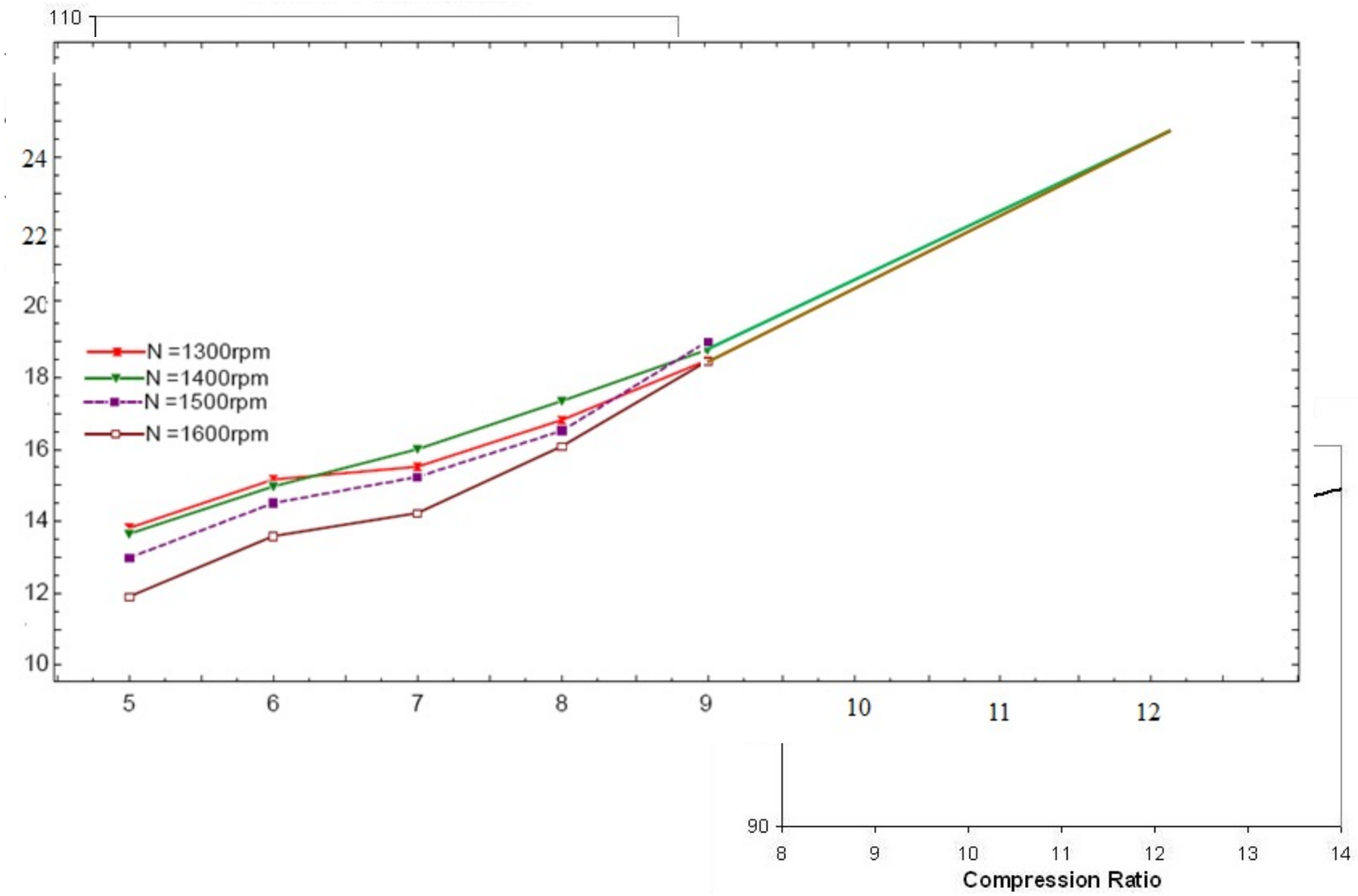
- ✓ Strict emission regulations
- ✓ Efficient utilization of energy resources.
- ✓ Hydro carbon emissions due to SI Engines using Petrol.
- ✓ The conventional diffusion combustion using liquid fuels can not meet upcoming stringent emission norms (Higher Smoke and NOx emissions)
- ✓ Banning of Diesel engines across various Cities world-wide regardless of their high efficiency and power out put (e.g. Delhi, Chandigarh).
- ✓ Emerging topic worldwide to keep the Highly efficient CI Engine-vehicles rolling on the roads

Alcohols in combustion engines?



Fuel Quality, SI Engine Size & Mileage



Differences Between Flex Fuel Engines & Petro-only Engines

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- In terms of its octane rating, ethanol has a rating of 113.
- A mixture of 10 percent 113 octane ethanol with 85 octane gasoline it increases the octane two points to the normal 87 octane.
- The higher the ethanol content, the higher the octane.
- The octane rating for E15 (15% ethanol) is 88 octane and E85 (85% ethanol) is 108 octane.
- Ethanol reduces greenhouse gas emissions between 34 to 44 percent compared to gasoline.
- Ethanol is cheaper than those synthetic aromatics, gasoline blended with ethanol reduces the price at the pump.
- In a study released by the University of Illinois, ethanol is 35 cents to $1 cheaper than benzene, toluene and xylene

Differences Between Flex Fuel Engines & Petro-only Engines

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- Fuel System Components
- Pulse Control
- Additional Optional Changes

Differences Between Flex Fuel Engines & Petro-only Engines : Fuel System Components

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- Ethanol is more corrosive than gasoline.
- Ethanol tends to absorb moisture which creates additional problems.
- To combat this, magnesium, rubber or aluminium parts should not be exposed to high ethanol-fuel system.
- Fuel lines are replaced with a plastic-lined stainless steel.
- Fuel tanks in FFVs are stainless steel instead of terneplated steel.

Differences Between Flex Fuel Engines & Petro-only Engines : Fuel System Components

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- Ethanol is less energy dense than gasoline, meaning more ethanol is needed in the combustion chamber to produce the same energy output as a gasoline only engine.
- Electronic fuel engine systems must have a a wider range of pulse in the fuel injection sensors allowing up to 40 percent more liquid fuel into the fuel air mixture.
- Special sensors to detect the presence of ethanol and analyse the concentration so the proper amount of high ethanol fuel is injected for the conditions.

Differences Between Flex Fuel Engines & Petro-only Engines : Fuel System Components

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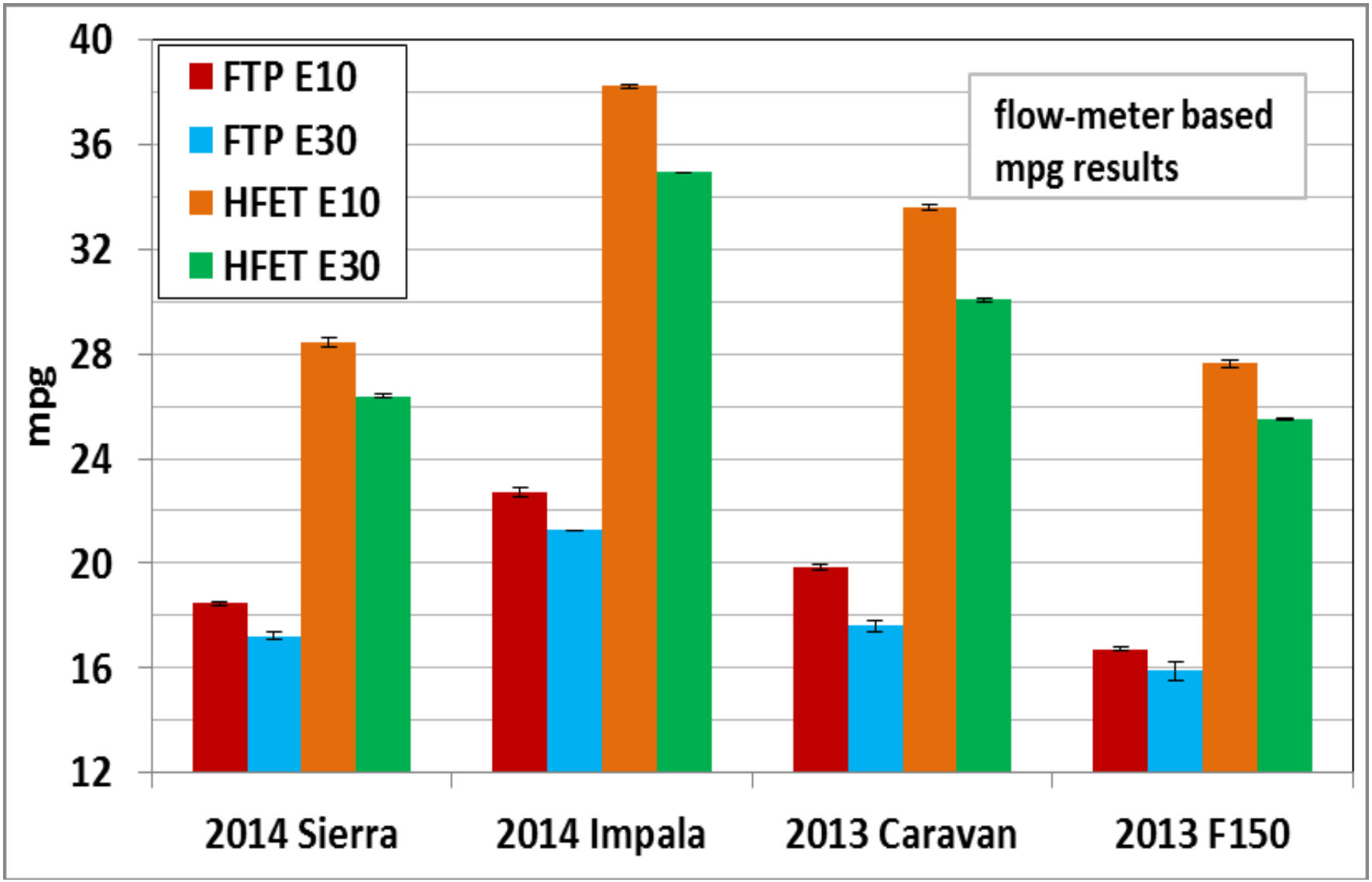
- Ethanol is conductive, meaning it can carry electrical current.
- Automakers may have to include additional safety measures.
- For models with tank-mounted fuel pumps, safeguards against arcing are included in the design.
- Water contamination in the ethanol, results in an abundance of formic acid in the combustion chamber.
- To protect against that unlikely eventuality, acid neutralizing motor oil may be used.

Fuel Economy of vehicles Using E10 & E30



Fuel Economy of vehicles Using E85

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Technical Performance	Small Cars	Medium Cars	Large Cars
Energy Input	Bioethanol E85 (85% Ethanol, 15% Gasoline)		
Base Energy Consumption (l/km)	0.091	0.105	0.161
Base Energy Consumption (MJ/km)	1.96	2.28	3.48
Technical Lifetime, yrs	12	12	12

Baseline Gasoline Vehicles [16]			
Technical Performance	**Small Cars**	**Medium Cars**	**Large Cars**
Energy Input	Gasoline		
Base Energy Consumption (l/km)	0.062	0.072	0.111
Base Energy Consumption (MJ/km)	2.05	2.38	3.64
Technical Lifetime, yrs	12	12	12

Eco-friendly Nature of vehicles Using E85

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Flex-Fuel Ethanol Vehicles [1, 9, 16, 22]			
Technical Performance	**Small Cars**	**Medium Cars**	**Large Cars**
Environmental Impact			
CO_2 and other GHG emissions, g/km (TTW)	20.6	23.9	36.6
CO_2 and other GHG emissions, g/km (WTW)	93.1	108.1	165.3
Baseline Gasoline Vehicles [16]			
Environmental Impact			
CO_2 and other GHG emissions, g/km (TTW)	143.5	166.7	255.0
CO_2 and other GHG emissions, g/km (WTW)	169.1	196.4	300.5

Vehicles Available in International Market

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Ford Transit Connect Van FFV (2022)

Ethanol (E85)
Van

Alternative Fuel Economy:
19 mpg combined / 18 mpg city / 20 mpg hwy
Conventional Fuel Economy:
25 mpg combined / 24 mpg city / 27 mpg hwy
Engine: 2.0L I4
Transmission: Auto
Note: This vehicle is only available in certain states. See dealer for details.

Ford Transit Connect Wagon LWB FFV (2022)

Ethanol (E85)
Passenger Van/Shuttle Bus

Alternative Fuel Economy:
18 mpg combined / 16 mpg city / 21 mpg hwy
Conventional Fuel Economy:
26 mpg combined / 24 mpg city / 28 mpg hwy
Engine: 2.0L I4
Transmission: Auto
Note: This vehicle is only available in certain states. See dealer for details.

Chevrolet Silverado 2WD (2021)

Ethanol (E85)
Pickup

Alternative Fuel Economy:
12 mpg combined / 11 mpg city / 15 mpg hwy
Conventional Fuel Economy:
16 mpg combined / 15 mpg city / 19 mpg hwy
Engine: 5.3L V8
Transmission: Auto

Chevrolet Silverado 4WD (2021)

Ethanol (E85)
Pickup

Alternative Fuel Economy:
12 mpg combined / 11 mpg city / 13 mpg hwy
Conventional Fuel Economy:
16 mpg combined / 14 mpg city / 18 mpg hwy
Engine: 5.3L V8
Transmission: Auto

Issues with direct blending of Alcohol with Diesel

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- Ethanol-diesel blends in CI engines have performed better than pure diesel in many trials, with higher energy efficiency.
- Lower PM (smoke), NOx and CO2 emissions.
- In terms of drawbacks, as diesel has an energy content of about 36 MJ/litre and ethanol is 21 MJ/litre, relatively larger volumes of ethanol are needed, compared to diesel, to have the same power output.

➢ Both macro and micro emulsions of ethanol/methanol with diesel is challenging.

➢ Poor cyclic stability.

➢ Local normal boiling point difference creates strong cavitation within injector with high flow rate oscillations.

Alcohol with Diesel in Dual Fuel Mode

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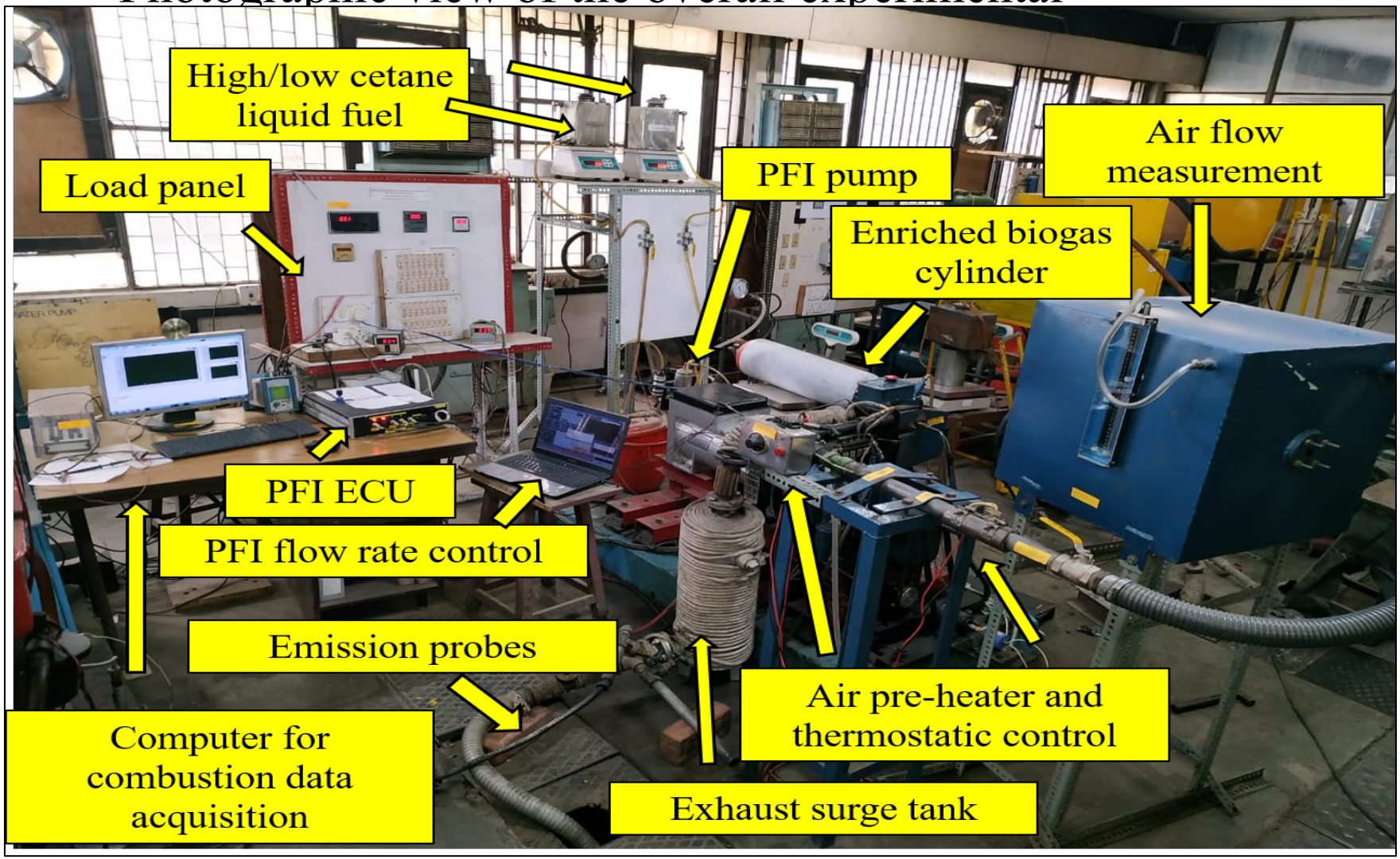
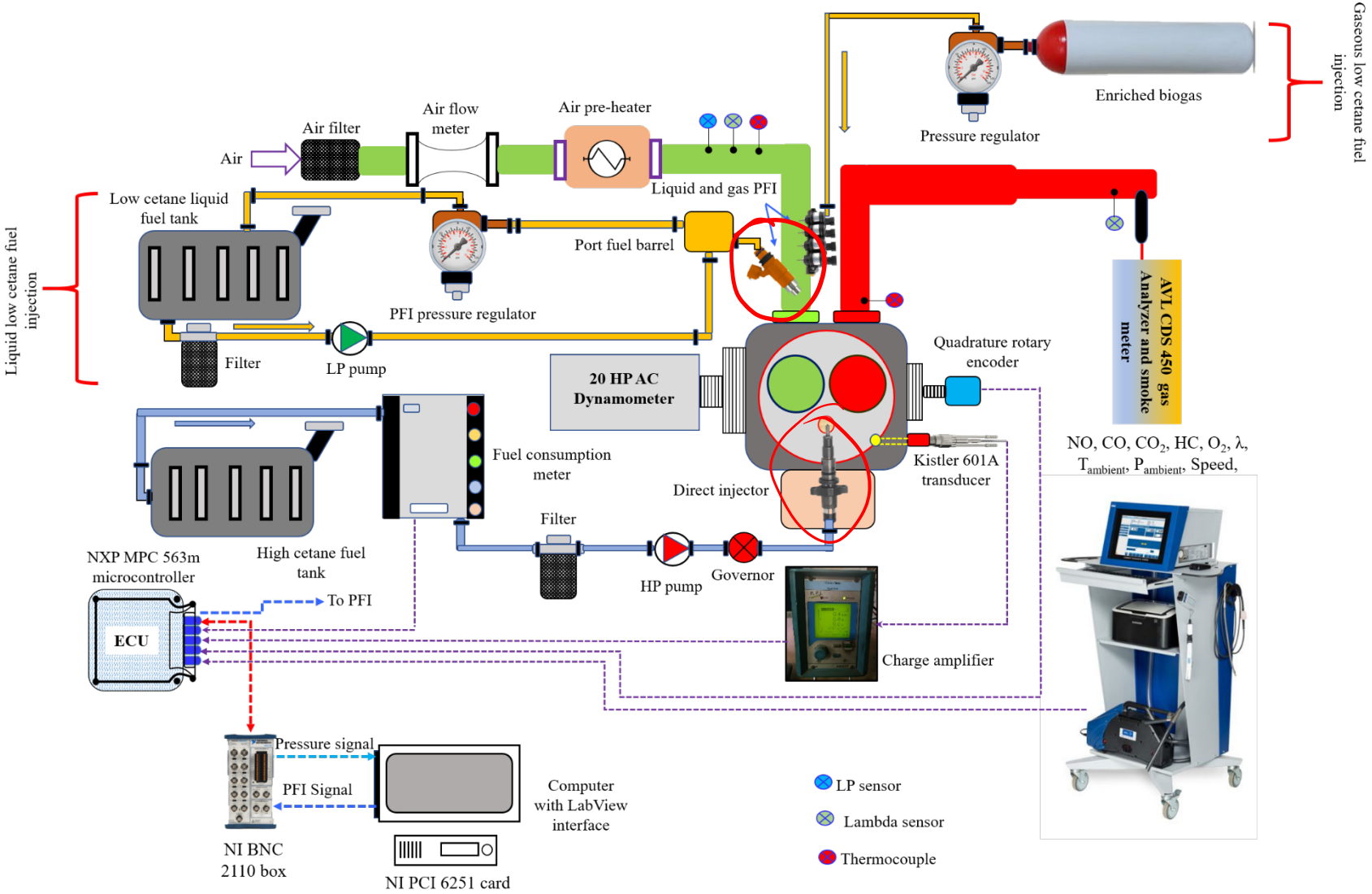
Photographic view of the overall experimental



Schematic layout of the experimental set up



Performance of Dual Fuel Diesel Engines

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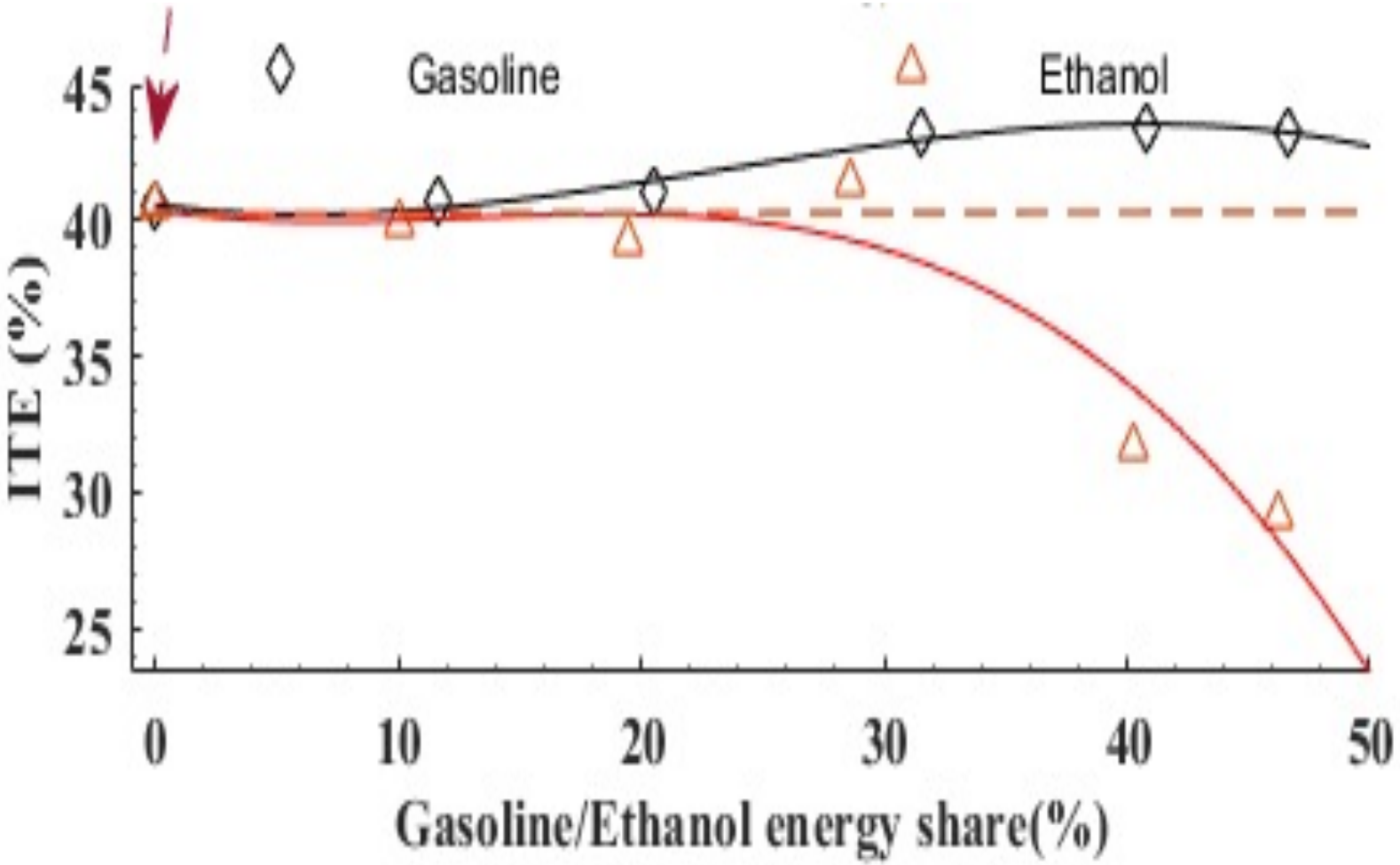
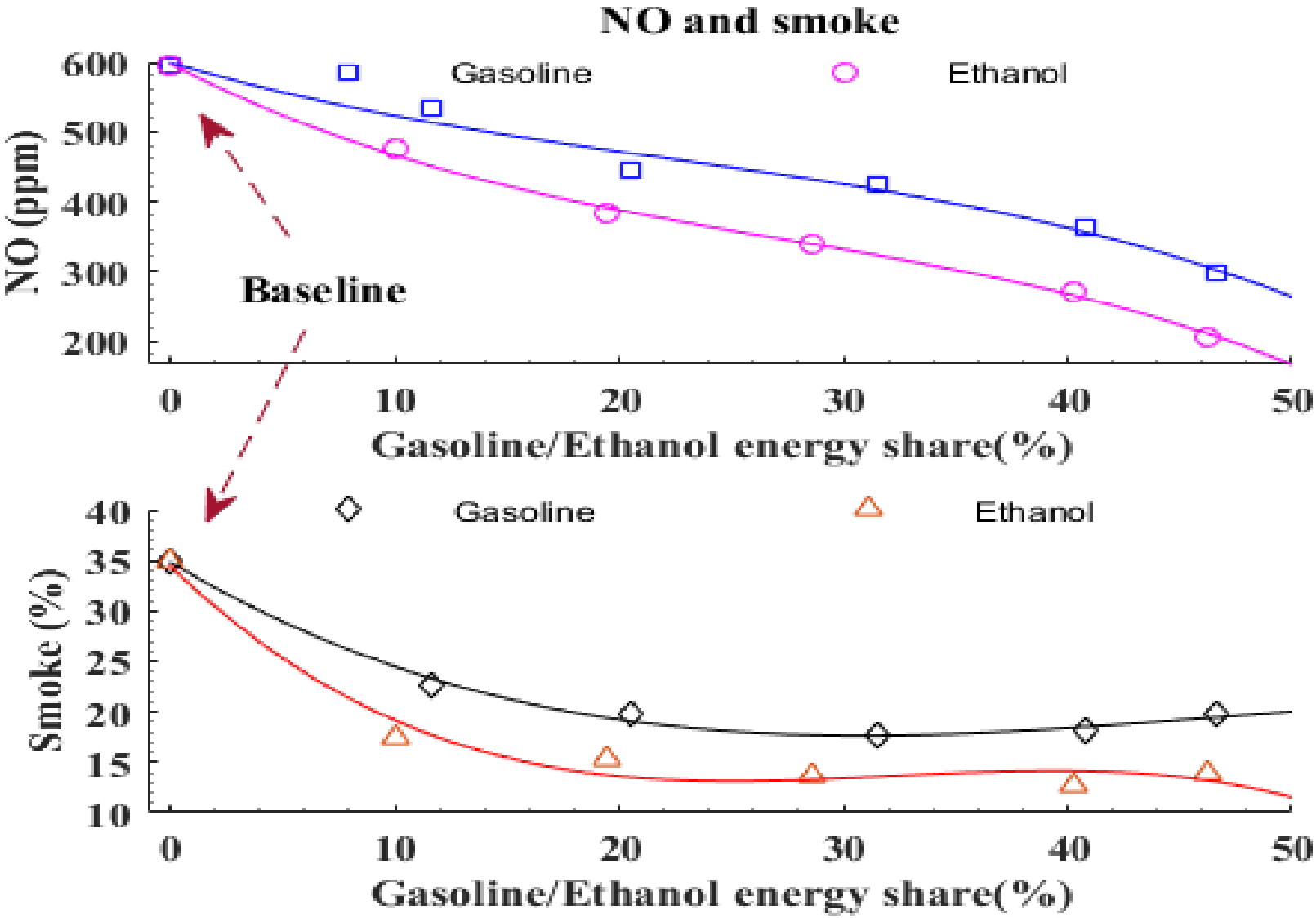


Normalized emission profiles across Energy Share



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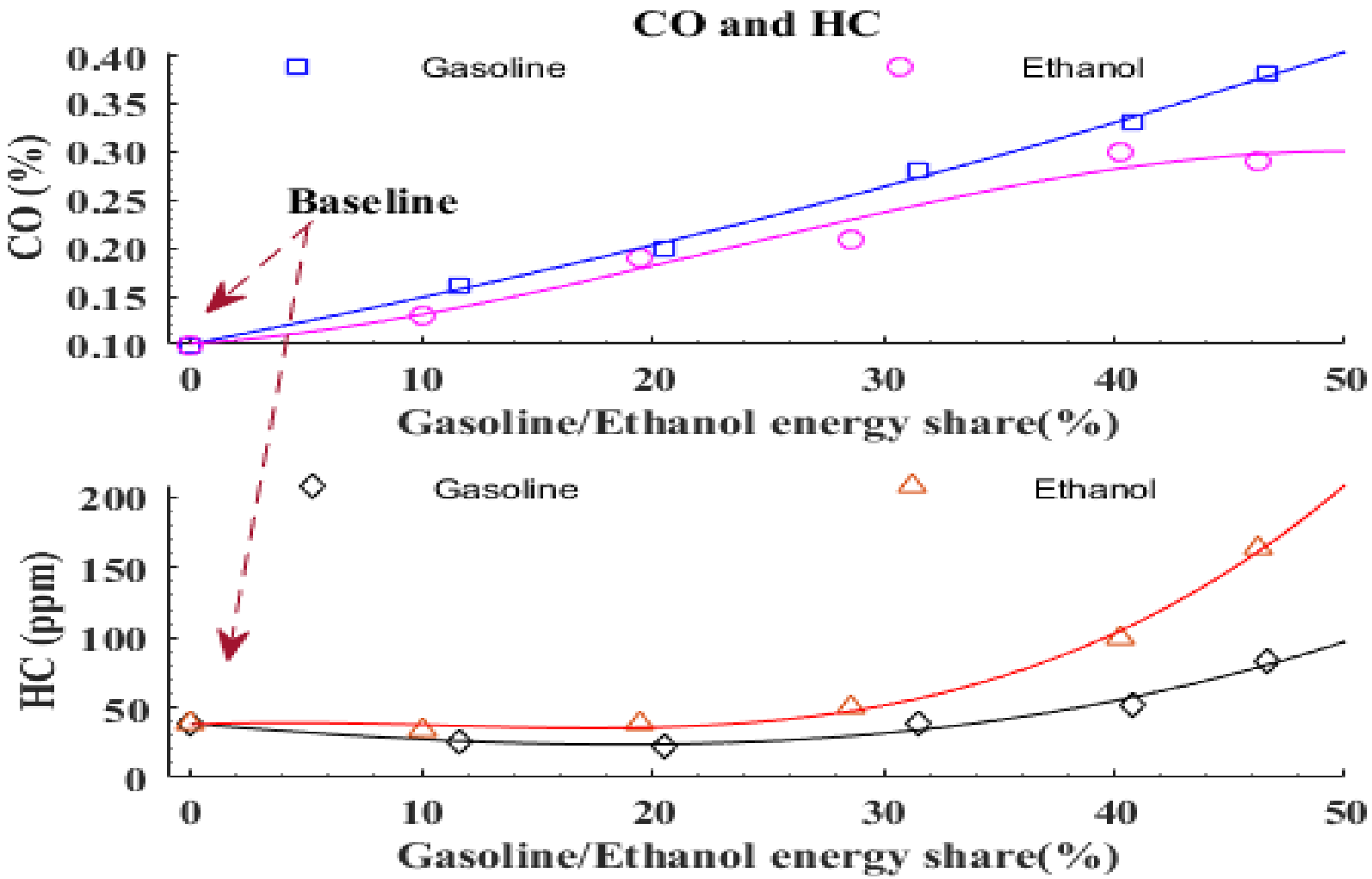

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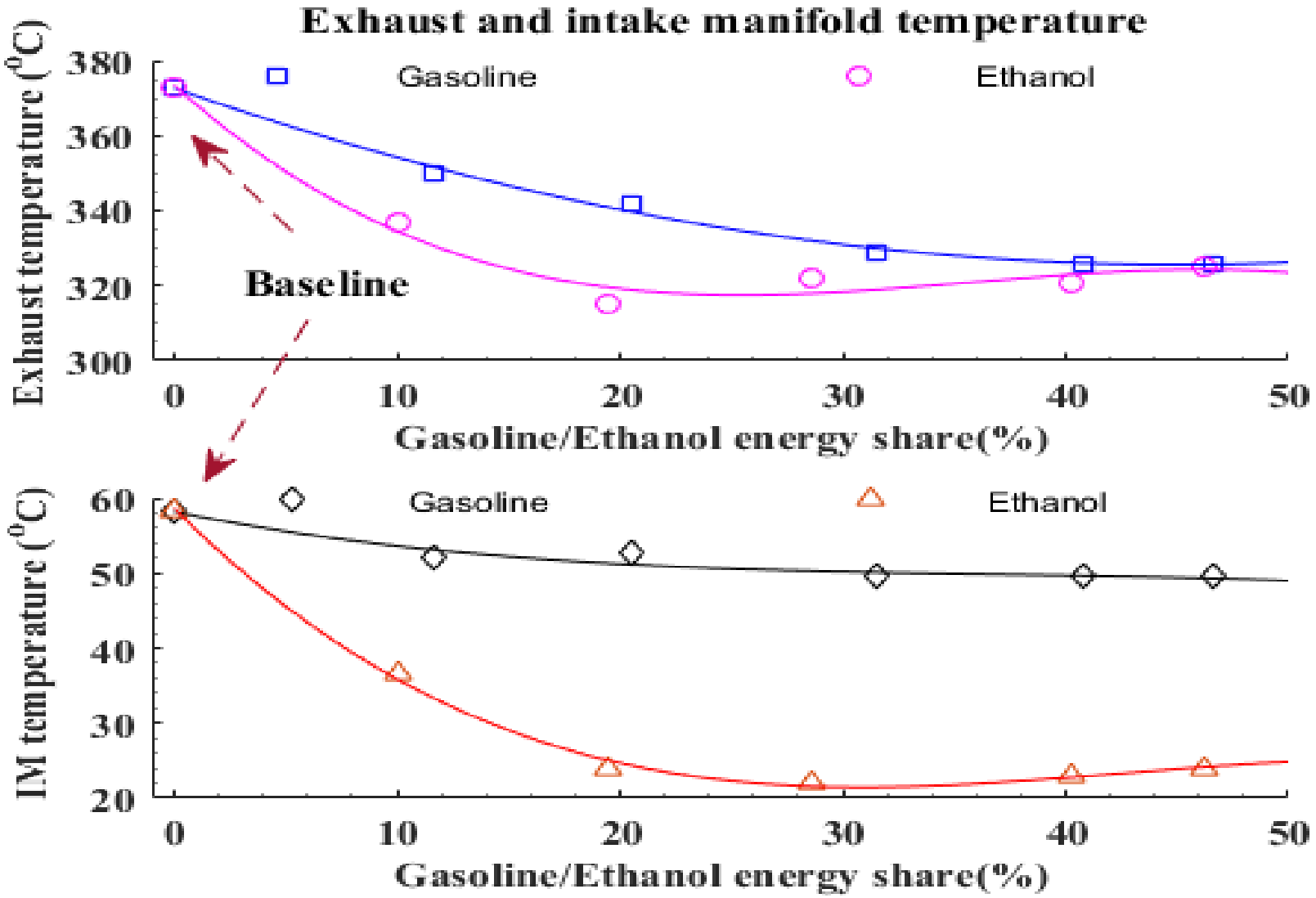

Concluding Remarks

- Ethanol blending in gasoline with flexi-fuel approach in SI engines is easy to implement.
- However, SI engines are not efficient (low compression ratio).
- High compression ratio CI engines can use ethanol as emulsions in diesel.
- Creating and stabilizing diesel-ethanol (or methanol) emulsions is challenging.
- Even with emulsion, high usage of alcohols in CI mode is not possible/beneficial.

Concluding Remarks

- Dual fuel combustion model (RCCI) can use high volume fractions of ethanol with significant performance and emission benefits.
- However, RCCI setup development demands modifications in the existing hardware with provision for two fuel induction methods and advanced control.
- Operational optimization in dual fuel (RCCI) mode is another critical challenge.