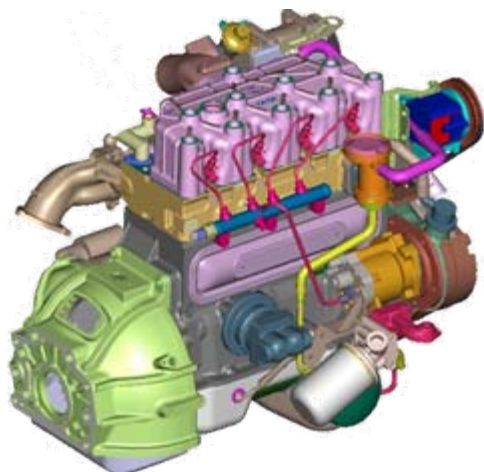


Biodiesel future perspectives

Bio-diesel as Auto Fuel; Present & Future Opportunities



By

S Krishnan

Engg. Research Centre
TATA Motors Ltd., Pune



Overview

- About Tata motors Limited
- Evolution while TML initiatives towards Environment
- Vehicle technological advancements
- Engine development Considerations
- History past to Present on Data
- Heavy Vehicle fuels Diesel, Gas
- Future fuel scenerio
- Current fuel issues – must to be tackled for future requirement
- New Requirement
- Green initiative at TML
- Topic of Today
- Case study of new technology faces in India

About Tata motors Limited

- Tata Motors Limited is India's largest automobile company,
- Revenues of Rs.24,000 crores (USD 5.5 billion) in 2005-06, 7 billion in 06-07.
- Leader in commercial vehicles (SCV,LCV,MCV,HCV,SV)
- Second largest in the passenger vehicles market (Compact, midsize car and UV).
- World's 5th M&HCV manufacturer, and the world's 2nd largest M&H bus manufacturer
- First company from India's engineering sector to be listed in the NYSE (Sep04)

- The foundation of the company's growth over the last 50 years is a deep understanding of economic stimuli and customer needs, and the ability to translate them into customer-desired offerings through leading edge R&D. With 1,600 engineers and scientists, the company's Engineering Research Centre, established in 1966, has enabled pioneering technologies and products.

- The company today has R&D centres in Pune, Jamshedpur, Lucknow, in India, and in South Korea, Spain, and the UK. The pace of new product development has quickened.

- The years to come will see the introduction of several other innovative vehicles, all rooted in emerging customer needs. Besides product development, R&D is also focussing on environment-friendly technologies in emissions and alternative fuels.

Innovation

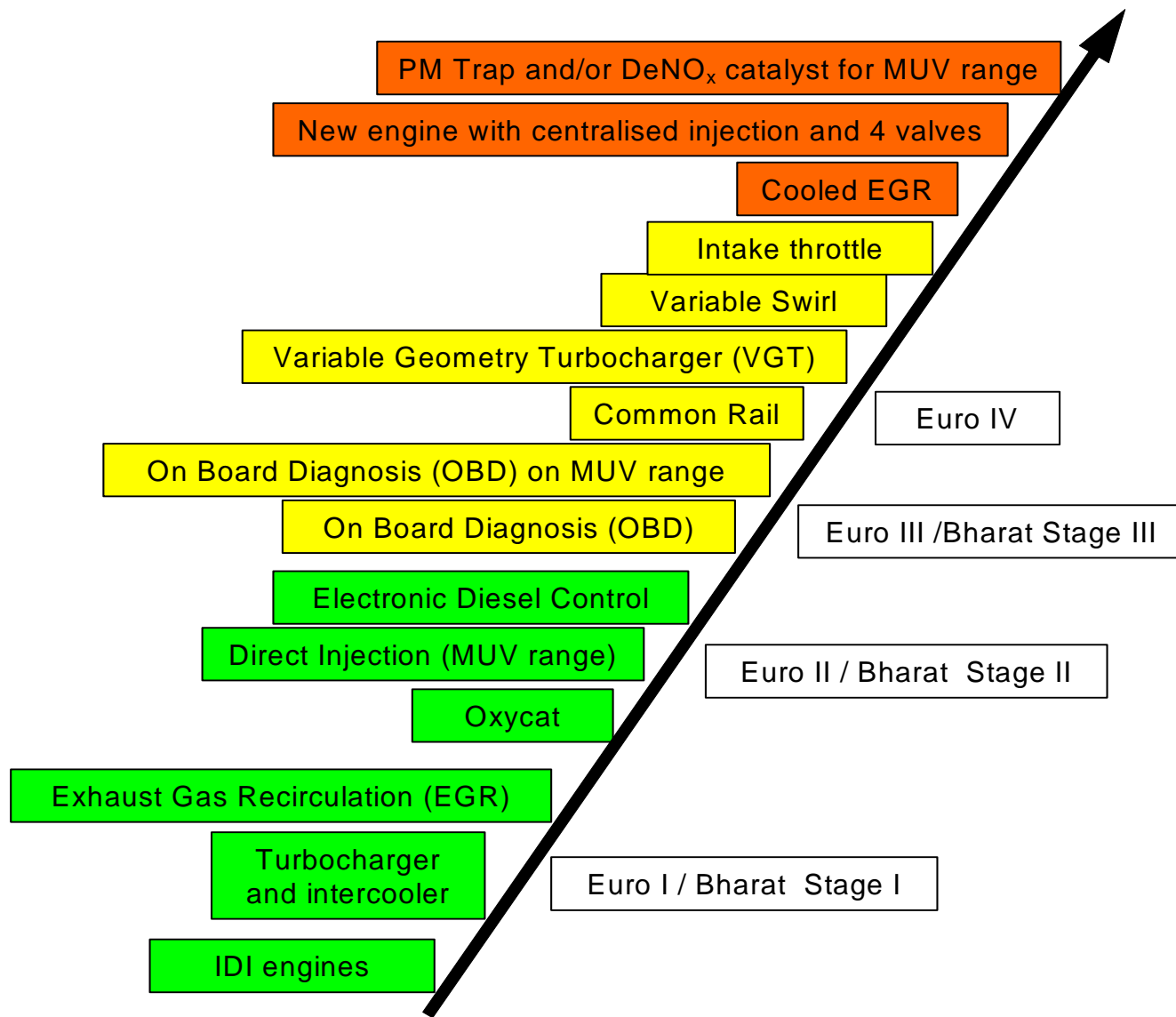
- **Biodiesel** relatively helps to keep the engine afresh through out the life of the engine there by emitting lesser emissions (soot & CO2 by plants) to atmosphere and maintaining uniform performance of engine throughout the life !!!.
- The innovativeness is required for bringing either fuel properties close to petrodiesel to use existing diesel engine or minimum engine modifications to use the fuel as it is or to find a compromise between both. Idea to be conceived, detailed , developed and productionised after elaborate evaluation for components in contact with fuel.
- Time to market, Parts commonality, Investment saving, usage of existing component , usage of existing vehicles on road and manufacturing feasibility were the necessity behind this innovation.
- This should be innovative with respect to the norms in Automobile industry as Dedicated biodiesel engines were to be derived from conversion of Diesel engines and also as vehicles benchmarked has High cost technology & very sensitive.

Innovation

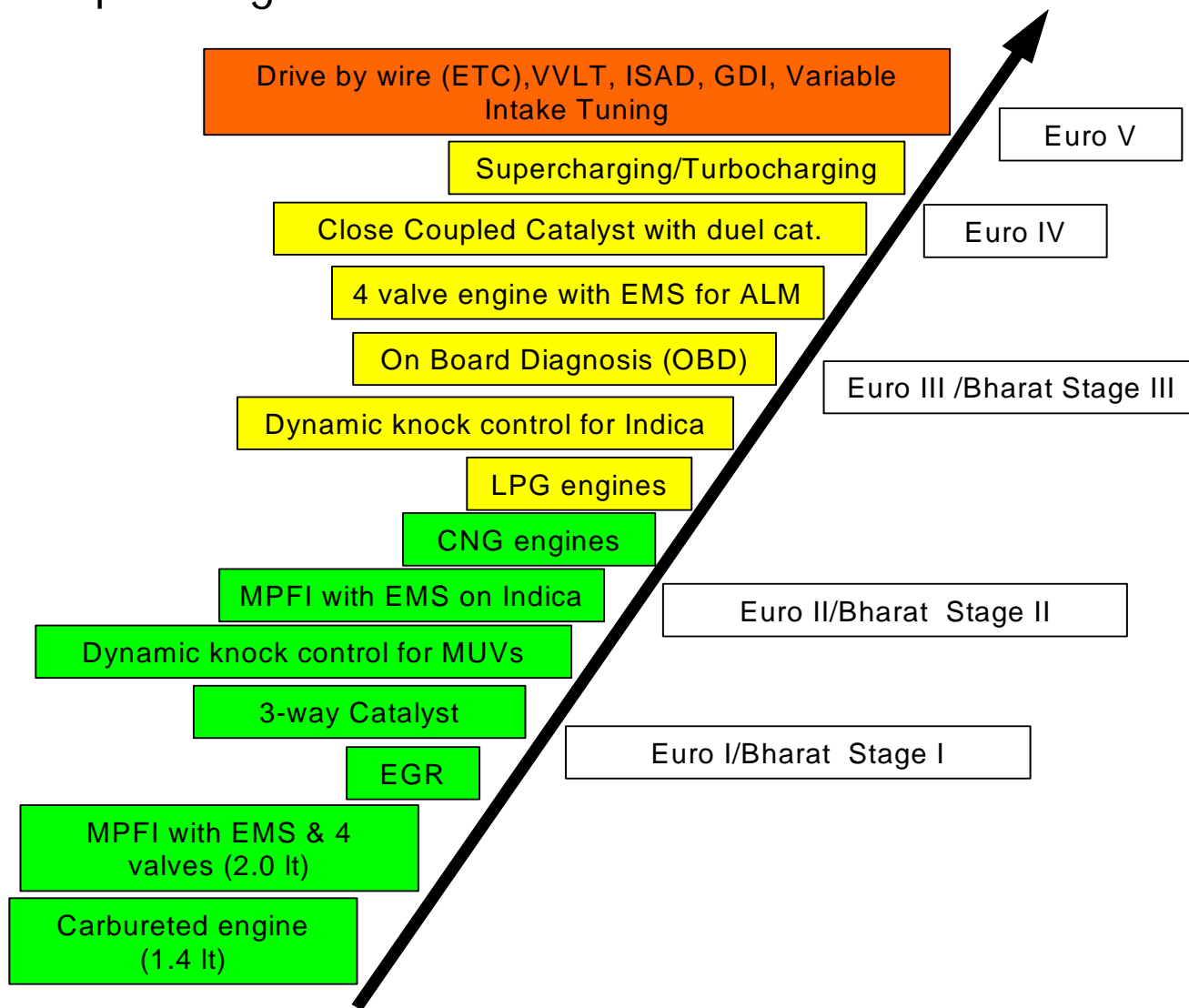
- Emission reduction with low cost technology with Changing fuel only and not technology (Particulate reduction by Biodiesel)
- High reliability through out the life of the engine there by emitting lesser emissions (CO, PM, HC) to atmosphere as it is achieved with min. sensors and lesser controls.
- Demands on the transportation sector to help alleviate the problems of rising fuel Costs and pollution are increasing every year. Transportation fuel accounts for major energy consumed. Hence Innovation for Cost and Reliability along with energy security
- In the recent years legislation has been passed in an effort to help combat air Pollution emanating from the transportation sector. These policies mandate phasing in clean burning fuel vehicles to reduce toxic and polluting emissions.

- Tata Motors Limited (TML)
 - Strive to comply with all applicable legal/regulatory and other environmental requirements and reduce emission levels
 - Working proactively with Industry, Government and other related industries and agencies for the same.
 - Minimize adverse impact of its products, operations and services on environment
 - Uses environmentally sustainable technologies and practices for prevention of pollution and conservation of natural resources
 - Considers energy is one of the major areas of thrust
 - focuses on meeting emission norms ahead of requirements, Low cost emission development strategies and best in class fuel economy.
 - Over the years, the emission levels are becoming stringent. The pollutants which are regulated (CO, HC, NOx and PM) have reduced manifold over the years (7 to 25 times)

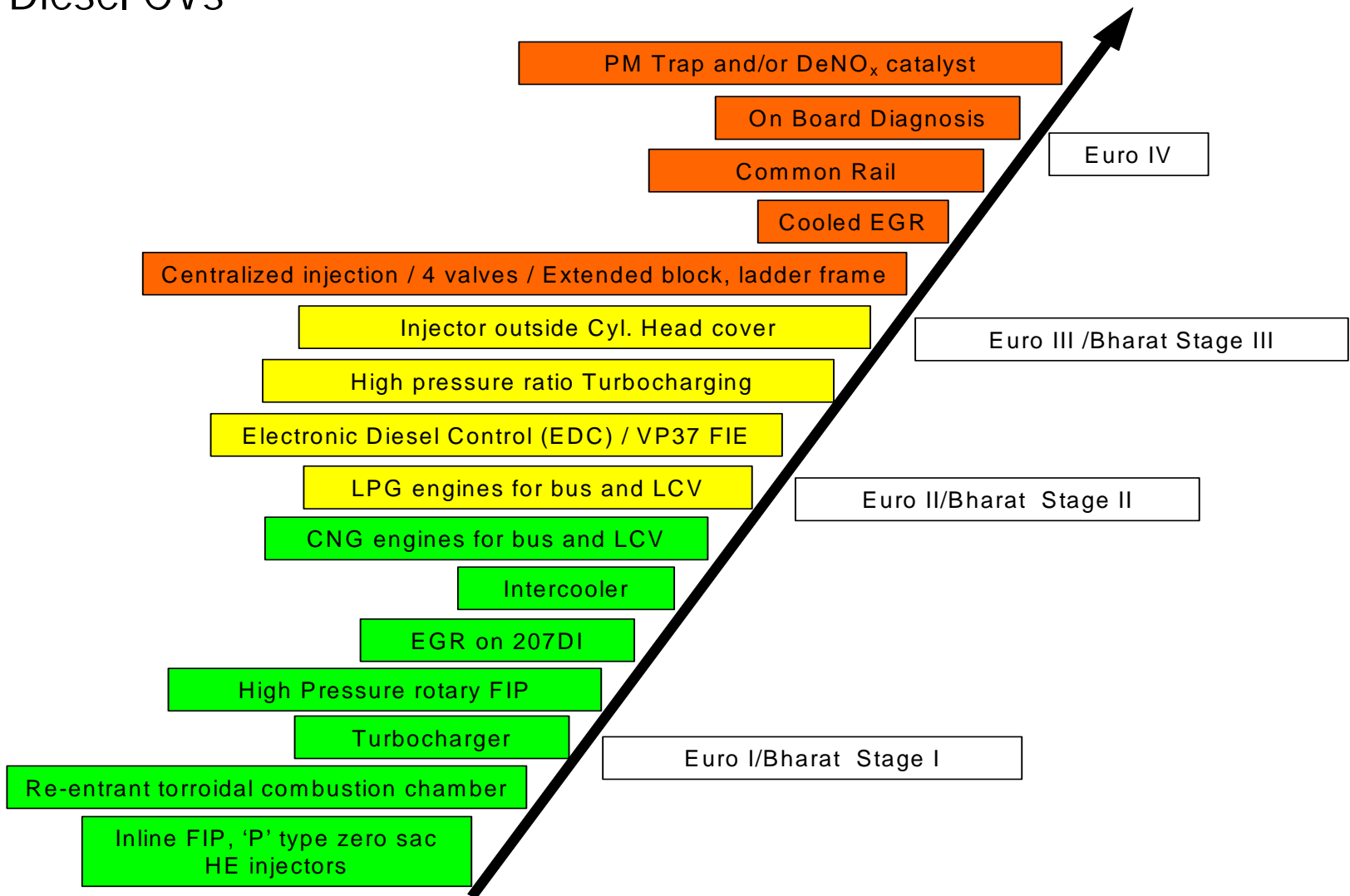
Diesel passenger cars



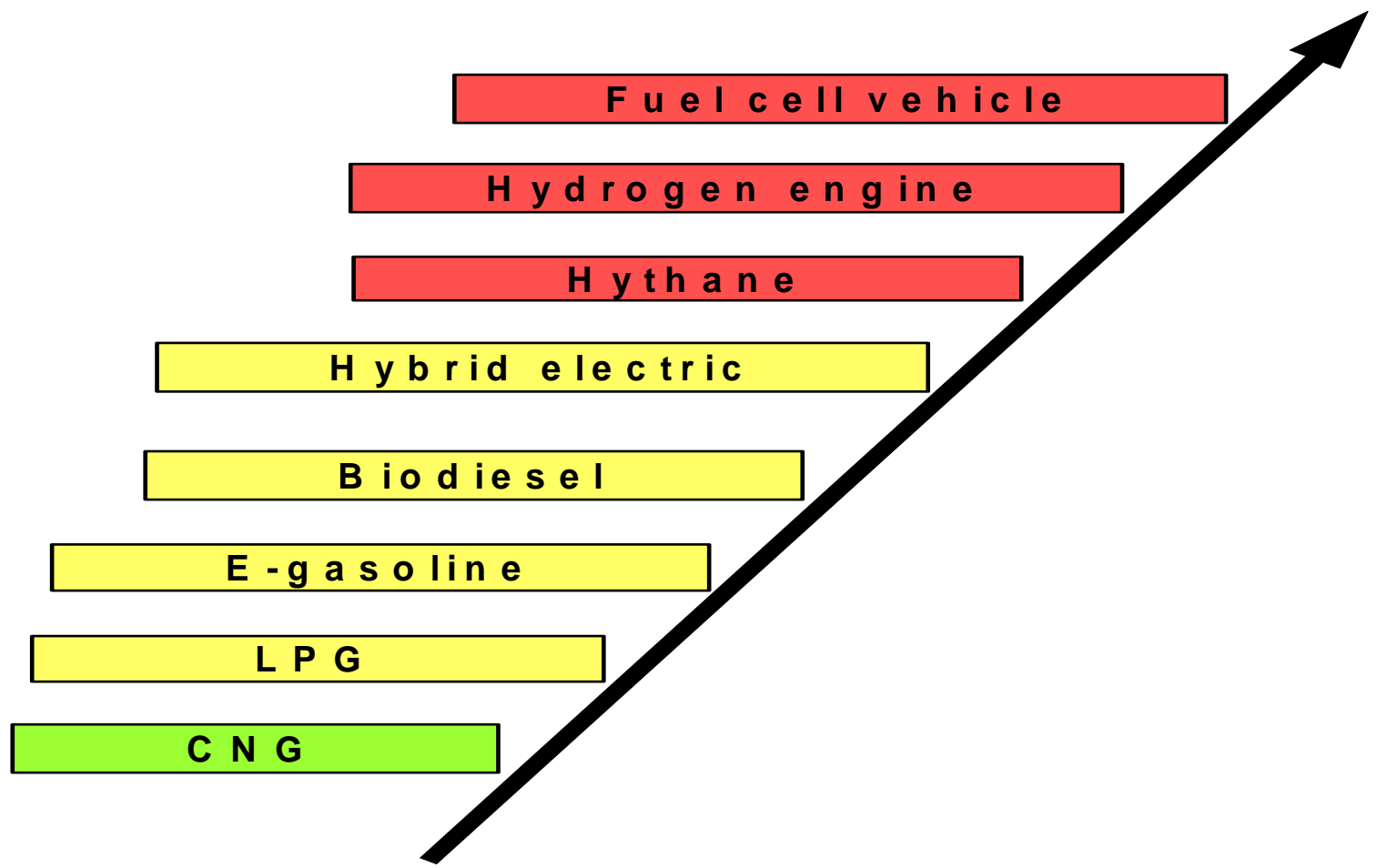
Gasoline passenger cars



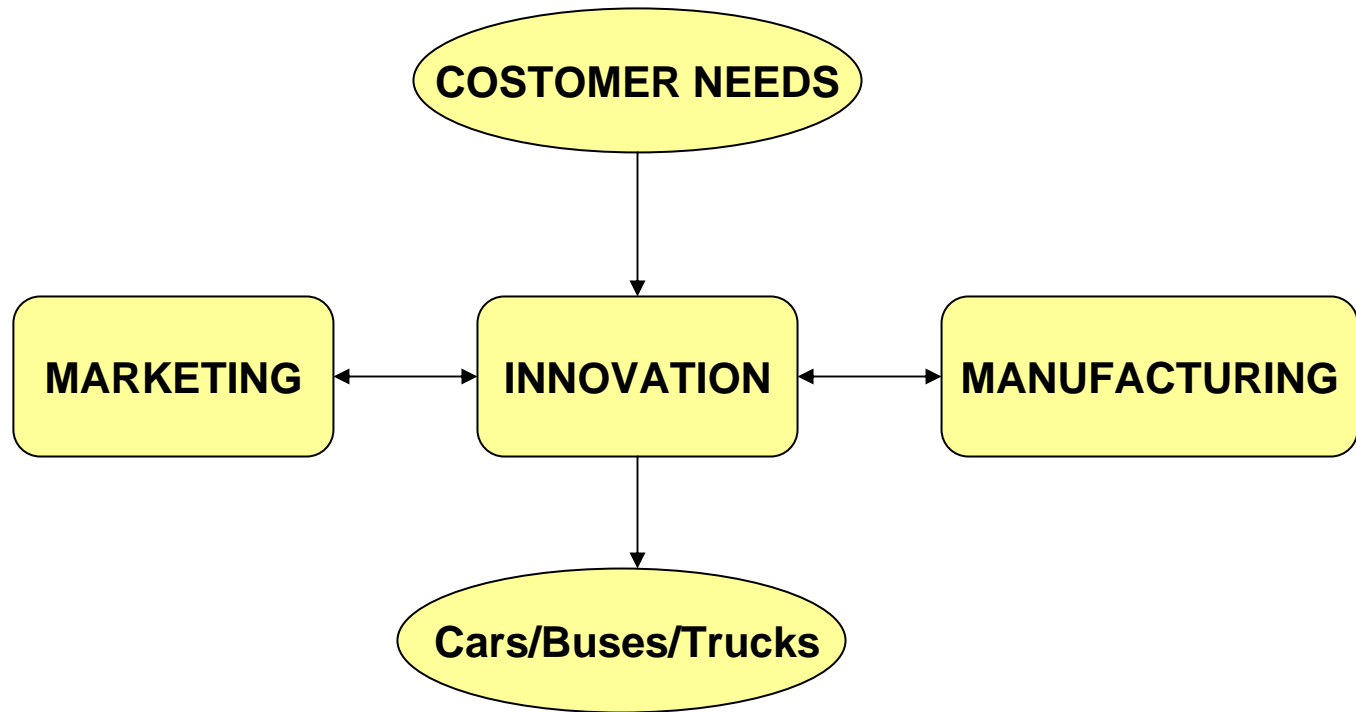
Diesel CVs



Advance engg.



New Product Development



Why Alternative Fuels ?

- **Energy security concerns, the original drive of alternative fuels in China**
 - Rapid increment of importation of crude oil predicted
 - Non-balance of regional energy supplies
- **Environment concerns**
 - Urban air quality deterioration
 - Global warming

Economics .. Micro & Macro ..Raising price

- **Improved Airquality ...** If you change fuel 5 years ahead of emission can be met w/o change of technology.
- **Reduced GHG emissions..Climate**



Green Initiatives at TML

- **Improvements in efficiency & emissions of conventional engines.**
 - CRDI, Catalytic Converters, Electronic Engine Management, 4-valves per cylinder etc.
- **Renewable Fuels:** Bio-Diesel blend, Ethanol-Gasoline blend.
- **Alternative Fuels:** CNG, LPG, Hydrogen-in-CNG (Hythane).
- **Non-Hydrocarbon fuels:** Hydrogen Combustion Engine.
- **Hybrid-Electric** vehicles : Electric Motor + down-sized conventional engine.
- **Fuel-Cells:** Electricity generated by Fuel-Cell powers electric-motors.

Bio-Diesel Initiatives by TML



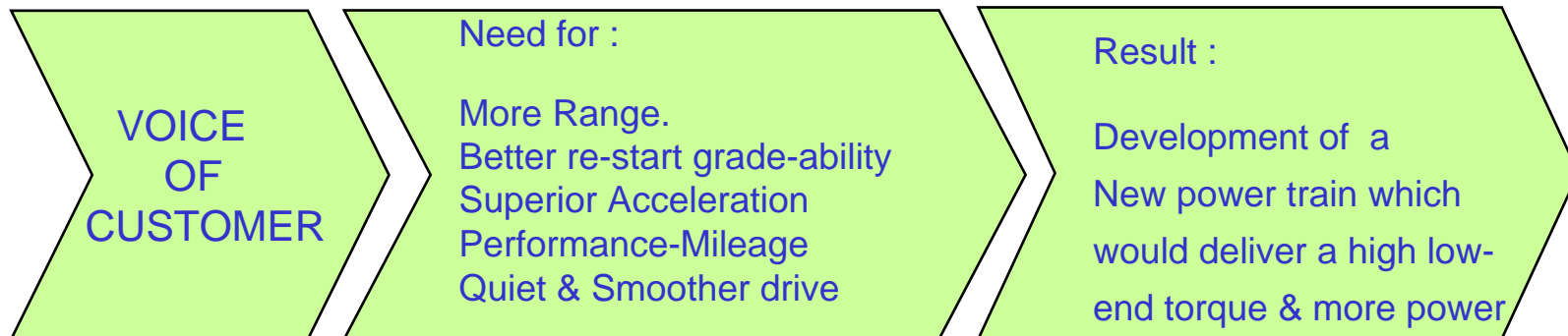
Customer Requirements of vehicle

A QFD survey reflected the basic needs of Indian consumer.

The survey revealed the latent consumer needs.

Upgrading Existing Bus/Truck with new engine is the answer to this need.

QFD EXERCISE FOR CNG Bus – A Quick Assessment on Power Train



CUSTOMER DELIGHT TARGETS

High Reliability

Fuel Economy

Great Value for Money

Vehicle design and fuel quality

- Vehicle design driven by
 - Regulatory requirements
 - Customer expectations (Ease of start, Odourless, smoke less, cost)
 - Reduced noise, emissions and fuel consumption
 - Increased responsiveness/power and durability / Maintenance free.
- Fuel is a key enabler to achieve low emissions and longevity
- Legislation for fuels and emissions is linked.
- Advanced fuel systems contribute significantly to progress in these regards
- Vehicle design includes fuel performance / quality as a constraint.
- **Fuel quality is mainly defined by fuel standards**
- Different fuel qualities will require different vehicles.
 - – Restricts customer choice
 - – Increases vehicle production costs
- The use of common fuel standards in a variety of fuel usage difficult

- The **engine development** takes with advanced contemporary technologies along the emission and performance requirements enhancement.
- Mechanical systems give way to electronic systems, new valve train technologies, variable geometry turbo-charging and so on.
- Apart from regulatory compliance, the performance specifications in terms of power and torque are also enhanced. For example, the engine power at Euro I level gets doubled at Euro III / Euro IV levels with handsome increase in torque.
- Engine development considers
 - **Regulations** : Gaseous , PM , Noise, Fuel consp. / CO2, Recycling
 - **Public** : Smoke, Odour, Noise
 - **Customer** : Fuel consp., Durability, Maintainability, Perf., Reliability, Price
 - **Manufacturer** : Ease , quality, production cost
- All above depend on fuel usage and quality with appropriate Technology

- In 1900, Rudolph diesel unveiled his first diesel in paris. It ran on pea nut oil. Now World is exploring biodiesel.
- There is a whole range of alternatives to the present-day fossil diesel fuel. The alternative we choose depends
 - On availability
 - Environmental impact
 - Fuel efficiency.
 - Cost
 - Customer acceptance
- Alternative fuels and power trains will continually be evaluated in order to reduce dependence on fossil energy in the transport sector.
- Fuel efficiency for the complete vehicle operation will be an area of focus, regardless of the choice of fuel.
- With global warming becoming cause of concern and petroleum reserves dwindling, govt. all over world stepping up research in alternate fuels.

- **Heavy vehicles**

Diesel fuel from crude oil will be the principal fuel for many years to come.
We must switch to other fuels and sources of energy.

- Diesel fuel cause of concern (Still will be Dominant)
CO2 emissions ... increasing costsDeclining reserves
- Synthetic fuel components may remain the dominant fuel for commercial vehicles for at least two decades later. (GTL)
- Cross-sector optimisation of energy and fuels is need of Day
To ensure the effective use of available energy
The highest potential for CO2 reduction
The lowest cost.
- Methane (natural gas and biogas, compressed or converted) will be used as a fuel for vehicles, due to increasing regional availability and expanding pipeline grids.
- Biogas is close to being CO2 neutral.

- Evolution of alternate fuels is decarbonisation of fuels.
 - Wood to coal took more than thousand years
 - Coal to oil took place in couple of centuries
 - Oil to gas took place in couple of decades.
 - Gas to hydrogen will take place in couple of decades.
- ***Water will be the Coal of future...*** Jules Verne....1874
- .
- Fuel Constituents Directly Affect Emissions
- Fuel Changes Can Immediately Impact on Emissions/Air Quality
- Fuel Composition Can Enable/Disable Pollution Control Technology
- Desulfurization Costs & Benefits.
- Very low Sulfur Levels enhances all Catalyst Technology Performance.

The human civilization has changed from stone era to today' computer era not because of the stones and rocks are exhausted but the civilization has advanced. The same is applicable in case of alternate fuels also. The use of alternate fuels is increasing for following reasons

- Increasing cost of conventional fuels ...Lower operating cost
- Reduction in emission (especially reduction in green house gas emissions)
- Local availability and Government policy

The alternate fuels can be classified as renewable – Bio-diesel, ethanol ; Non renewable – CNG, LPG
Various alternate fuels that can be possibly used in India are-
Natural gas , LPG , Ethanol , Bio-diesel, Hydrogen

The gaseous fuels like CNG & LPG need major modifications in the engine for its use. High conversion cost and inadequate infrastructure may prevent CNG and LPG from becoming popular auto fuels. CNG & CNG fuel system in its simplest form can meet advanced emission norms.

Bio fuels like ethanol and bio-diesel can be easily mixed in gasoline & conventional diesel respectively and subsequently used in unmodified condition for small amount of blends.

All of the above alternate fuels will co exist in market and the use of any fuel will depend on the cost to benefit ratio, availability, policy and customer preferences.

Well to wheel efficiency to be concentrated in future

Energy security and Environment protection resulted in renewable fuel with less Pollution. New vehicle designs sip less fuel without compromise on performance.

•Future Fuels Combination of following

- Gasoline and Diesel refined from petroleum will be major fuel
 - Compressed natural gas (CNG) and LPG will find a substantial growth
 - Fischer-Tropsch (F-T) diesel fuel synthesized from natural gas (GTL) can come
 - Methanol synthesized from natural gas
 - Compressed hydrogen gas synthesized from natural gas
 - Electric power drawn from the national grid
- DME
- Biofuels

Fuel Manufacturer

- o Major new offshore investment (FT plants, methanol, LNG?)
- o Infrastructure expansion and debottlenecking (CNG, H2, electricity)

Fuel Distributor

- o Significant investments (by smaller companies?)
 - New distribution infrastructure for ultra clean fuels (methanol, FTdiesel, etc.)
 - Fuel station storage and transfer facilities for CNG and methanol
 - Reforming, storage and transfer facilities for H2
- o Increased safety concerns
 - Methanol (corrosion? poisonous? environmental fate?)
 - CNG pressure transfer
- o Longer fueling times (e.g., CNG, H2)

- Current issues on diesel are
 - Water contamination ,
 - Particulate contamination
 - Deposits
, Sulphur
 - Lubricity
 - Contamination

Similar in Petrol are

- Corrosion
- Ash forming additives
- Deposits, lead
- Biofuel issues
- Octane boosters lead to cat, sensor, spark plug failures

High quality fuels must become the norm to support the use of modern automobiles

A vehicle cannot distinguish between good and bad fuels, but a bad fuel will increase emissions and reduce engine durability.

- A scheme for monitoring of fuel quality is essential

- **Fuels and lubricants formulations will maximize the potential of high performance engines with benefits in:**
 - Environmental impact (emissions and greenhouse gases)
 - Fuel efficiency (better use of resources)
 - Customer acceptance
- **The conventional fuels will continue to support transportation (as long as they can be produced economically from existing resources)**
- **Energy content**
- **Fuel additives**
- **Stability (as sulfur is removed)**
- **Low temperature operability**
- **Cleanliness (water and impurities)**
- **Worldwide harmonization of fuel specification**
- **Alternative fuels and energy will evolve and grow in competition with traditional fuels**
- **The energy picture of the future will be a combination of various resources and technologies**

- General trend to improve quality of fuels
- Recent emergence of premium diesel fuel quality in some markets.
- High cetane (up to 60+) & detergency
- Good lubricity & Corrosion protection.
- Improved 'fit for purpose' limits , Better water limit definition
- Reduced particulate limits
- Banning of ash forming additives from petrol for catalyst protection
- Mandatory detergency for both petrol and diesel
- Maintain air, fuel and combustion system cleanliness
- Control of ash in diesel
- improved Diesel Particulate Filter life
- Petrol and diesel will remain the main automotive fuel source in the short and medium term
- Bio/renewable fuels will support but not replace fossil
- Alignment of global fuel qualities will continue
- – Improvement in 'fit for purpose' necessary to ensure long term vehicle emissions , durability

On 30/3/05, news in Papers of pune

- **Tatamotors goes green on its staff buses partners with IOC to launch Bio-diesel vehicles**
- **Tata motors has been a fore runner in trying out this fuel on its cars**
- **Tata motors has also undertaken a project to explore hydrogen based fuels and has stepped up its efforts to utilise renewable biofuels.**

Trials on TML staff employee buses with B10 blend

Total no. of buses in program: 43 (24 LP1210,LP1510 big buses and 19 SFC609,LP608/609, 497 NA mini buses)

Start of program: April 2005

Duration of program: 10 months

Total mileage covered: 10,68,001 km

Total Blend Consumed: 2,26,792 litres

Total bio-diesel Consumed: 22,680 litres

Type of vehicles: big buses (LP1210, LP1510), Mini buses (SFC 608, SFC 609, LP 709)

Vehicle aging: Ranging from 2 years to 15 years

Biodiesel used is Karanjia based processed and supplied by Lubrizol.

Above exercise to determine how efficient this fuel is and how well does the Engine respond to it in city based conditions.

- **Parameters monitored during trial:**
- Fuel Economy
- Free Acceleration Smoke (FAS)
- Servicing
- Driveability
- Durability issues for engine, exhaust, fuel system.
- Compatibility of various materials exposed to biodiesel
- Stability of fuel
- Effect of blend on vehicle operation like cooling, NVH
- Operational, logistic issues.

- The fuel economy of vehicles is remaining unchanged for 10% bio-diesel blend. (in fact 2 to 4% improvement observed, averaging measurement accuracy, climatic conditions, road and usage etc)

- Free acceleration smoke value for bio-diesel is less than that for diesel by 6%.

- No clogging of fuel filters when 10% bio-diesel used.

Why should fuels change?

- Local and global environmental concerns
- Current resource constraints
- Availability of alternative sources – Gas (CNG/LPG), Bio fuels, Cleaner hydrocarbon fuels such as GTL fuels, etc.
- To adapt to new engine technology

Changes should be sustainable, fulfil primary requirements while reducing local and global environmental impact and should be acceptable to consumers

- Primarily liquid fuels.
- Primarily made from crude oil in refineries.
- Why liquid fuels ?
 - High energy density – Gasoline ~ 32 MJ/litre, Diesel ~36 MJ/litre
 - Easy transport, storage and handling
 - Extensive distribution network

Threat of Oil Peak has resulted in demand of “Unconventional Fuels” – Bio Fuels, GTL fuels, CNG, Hydrogen etc

Vehicle Technology Trends

- Driven by need to control local and, increasingly, greenhouse gas emissions (e.g. in EU 140g/km by 2009).
- In the developing world rapid growth coupled with older vehicles and poorer maintenance could make local air quality more important
- Increasing engine efficiency while maintaining/reducing engine emissions
- Diesalisation but clean diesels..... Improved exhaust treatment technology ... Hybrid enginesDirect injection gasoline enginesDownsizing with turbocharging Homogeneous Charge Compression Ignition (HCCI) engines ..

Changes in engines as well as fuels are needed

Status of TML Bio-Diesel Trials

- Alternative sources of bio diesel being explored - (Lubrizol India Ltd., Mumbai, is no longer producing Bio Diesel).
 - **Tinna Oils & Chemicals Ltd., Latur.**
 - Sample of Karanja based bio diesel product tested at IOC R & D & at ARAI, Pune for conformance to BIS standards.
 - Visit to TOCL plant made in April 2007 to evaluate capabilities.
 - Recommendations made to M/s TOCL to improve quality and consistency of product.
 - Water-content high, Acid-value high, Contamination value high, CFPP is high. → Properties
 - Commercial aspects being processed by ERC Purchase.
 - **Mint Biofuels Ltd., Pune.**
 - Sample of Karanja based bio diesel procured for purpose of testing and evaluation.
- TML Staff Bus trials to be resumed on B20 blends.
- Endurance trials to be done on 697 engine at TML on B10 blend.
- Tear down study of 497 TCIC engine planned after SFC 709 completed 100, 000 km on B10 at IOC R & D.
- Upon TML's insistence, FIE makers have agreed to participate in and support bio diesel trials.
 - Endurance Testing on FIE.
 - Material compatibility testing of FIE materials.

Current Technology in Biodiesel Production

Plants oil shows viscosities 10 to 20 times higher than viscosity of fossil diesel which results in incomplete combustion and poor fuel atomization

Methods for Biodiesel Production

1. Pyrolysis
2. Microemulsification
3. Transesterification

Apart from these methods Transesterification is better than first two as it shows properties close to diesel

1) Rapeseed oil

- Readily available
- Good combustion characteristics, oxidation stability and cold temperature behavior

2) Sunflower oil

- Better availability but it is a edible oil

3) Soybean oil

- Iodine value 121-149 g I /100 g

4) Plam oil

- High yield but shows high values of cold properties

Oils in INDIA

- Sal oil
- Mahua oil
- Neem oil
- Karanja oil
- Jatropha oil

Out of these Karanja oil and Jatropha oil are preferred because of good properties and better availability

- Jatropha is an ideal agro-forestry crop:
 - Technology for Jatropha cultivation is simple & cost-effective.
 - Will generate large-scale Rural self-employment.
 - Will alleviate Rural poverty & rejuvenate Rural economy.
 - Will alleviate migration of people from rural to urban areas.
 - Low-maintenance (water, fertilizer, pesticides requirements are LOW).
 - Utilization of waste-lands and arid areas.
 - Beneficial effect on climate and ecology (due to greening of land).

Effect of Different properties on engine Performance

1. Density

Because of higher density of Biodiesel as compared to Diesel it **BSFC** is higher than diesel

2. Kinematic Viscosity

Poor fuel atomization and incomplete combustion resulting in gradual coking of injector tips

High drag in injection pump

Injection timing and Ignition tends to be slightly advanced

3) Flash point

Higher than 120

Considered as important safety asset

4) Sulfur content

Lower sulfur content about 10 ppm with good lubricity

5) Carbon Residue

Less carbon residue gives less deposition injector tips and inside combustion chamber

6) Cetane Number

Higher cetane number ensure good cold start behavior and smooth run of engine without noise

7) Ash Content

Higher ash contents leads to engine deposits

8) Water Content

Free water present may cause biological growth which may cause blockage of fuel filters and fuel lines

9) Total Contamination

Higher concentration of insoluble impurities tends to cause blockage of fuel filters and fuel lines and injection pumps

10) Copper Strip Corrosion

It is more than class 1 for some Biodiesel

11) Fuel stability

More sensitive to oxidative Degradation than fossil diesel so some fuel additives are required

12) Cold Temperature properties

partial solidification in cold weather may cause blockage of fuel lines and problems during cold startup

13) Distillation Characteristics

Higher distillation curve gives higher boiling point

Gradual dilution of lubrication oil

Shows unburned fuel in biodiesel exhaust at low temperature working

14) Heating value and fuel consumption

Lower heating values gives

Less power and torque and

Higher fuel consumption

15) Lubricity

Good lubricity with lower sulfur content

It can be used as Blend in Low Sulfur Diesel for improving Lubricity

16) Ester Content

It gives amount of methyl or ethyl ester present in fuel

It should be higher than 96.5 % for better fuel properties

17) Free Glycerol

Which can react with different compounds and cause damage to injection system, increased aldehyde emission and deposits in fuel filter

18) Mono-Di-Tri- Glycerides

Fuels existing limits are prone to coking and may thus cause formation of deposits on Injector

19) Methanol

Higher methanol Content gives higher Flash point

20) Iodine Number

Fuel with higher Iodine number are Tends to polymerize. Form deposits on Injector nozzles Piston rings and piston ring grooves

21) Linolenic acid Methyl Ester Shows Reduced oxidation Satiability

22) Acid Value

High Acid Value leads with corrosion and formation of deposits within engine

23) Group I and Group II Metals

Group I (Na+K) – Formation of ash

Group II (Ca+Mg)– Injection pump sticking

24) Total Contamination

Blockage of fuel filter and pumps

Effect of Biodiesel Fuel Properties on Engine Performance and emission parameter

1) Effect on BSFC

BSFC for biodiesel is higher as compared to diesel Because of.....
Higher Density and Injection is based on Volumetric Basis.

2) Thermal Efficiency

Lower thermal efficiency compared with diesel because of.....
Poor fuel combustion characteristics because of their higher viscosity and volatility as compared with diesel

3) Effect on BSEC

Higher energy consumption because of.....
Lower calorific value it requires more amount of fuel to give same power output.

4) Effect on Exhaust Gas Temperature

Exhaust gas temperature is lower than diesel.

5) Effect on Smoke

Decrease in smoke with use of biodiesel because of.....
presence of oxygen in biodiesel fuel

5) Lubricating oil temperature

Lubricating oil temperature is less in case of biodiesel as compared with diesel because of.....

Higher viscosity and Lubricity helps in reduced friction in engine which leads to reduced heat carried away by lubricating oil

1) Heat Release

Because of lower energy content heat release of biodiesel is less than diesel.

2) Ignition Delay

Because of Higher Cetane Number biodiesel shows least Ignition Delay.

3) Fuel Inline Pressure

Fuel Inline pressure of biodiesel is more because of...

.....**Higher Bulk Modulus**

Higher viscosity of biodiesel has effect of decrease in amount of fuel leakage that occurs past the plunger that develops pressure in Injection System. This increased pressure and decreased leakage attributes to earlier Injection Timing

4) Incylinder pressure

It is slightly higher incase of Biodiesel but the Effect is not Significant.

5) Incylinder Temperature

The peak temperature with Biodiesel is higher than diesel which leads to formation of Nox. This is because of complete combustion and oxygen availability in fuel.

Benefits of Usage of Biodiesel

- **Reduction in toxic engine-emissions: (because Bio-diesel contains oxygen) :**
 - **Unburnt hydrocarbons (HC) , Particulate Matter (PM) & Carbon-monoxide (CO).... up to 50 % with pure Bio-Diesel**
- **Reduction in engine-emissions of CO₂ & due to plantations → Reduction in global-warming problem.**
- **No sulphur-dioxide emissions → reduction in acid-rain problem.**
 - » **→ No poisoning of Catalytic Converter.**
- **Greater lubricity → Improved life and performance of fuel-pump & injectors.**
- **Higher flash point of bio-diesel → improves safety of operation.**
- **Nontoxic & bio-degradable. Bio-diesel is a Renewable fuel.**
- **Displaces petroleum-derived diesel fuel → Reduces need for petroleum imports**

Material	Bio-diesel Type	Effect compared to petrodiesel
Polypropylene	B 100	Hardness -10%
	B 100	Swell +8-15%
Polyvinyl Viton A401 - C	B 100	Much worse
	B 50	Worse
	B 40	Worse
	B 30	Worse
	B 20	Comparable
	B 10	Comparable
Tygon	B 100	Worse
Material	Bio-diesel Type	Effect compared to petrodiesel
Teflon	B 100	Little change
Nylon 6/6	B 100	Little change
Nitrile	B 100	Hardness -20%
	B 100	Swell +18%
Viton A401 - C	B 100	Little change
Viton GFLT	B 100	Little change
Fluorosilicon	B 100	Little change in hardness
	B 100	Swell +7%
Fluroethane	B 100	Little change in hardness
	B 100	Swell +6%

WHAT IS BIODIESEL?

- Bio diesel is the most efficient and valuable alternative source of diesel engine fuel.
- It is eco-friendly and its performance is exactly similar to the petro-diesel.
- It can be produced from renewable biological sources like edible and non-edible oils.
- Fuels derived from renewable biological resources for use in diesel engines are known as *Biodiesel Fuels*.

- Animal fats, virgin and recycled vegetable oils derived from crops such as soybeans, canola, corn, sunflower, and some 30 others can also be used in the production of biodiesel fuel. Tall oil produced from wood pulp wastes is yet another possible feedstock source.
- Biodiesel is a pure 100% fuel conforming to ASTM Specifications D 6751.

- It is referred to as B100 or “neat” biodiesel. A biodiesel blend is pure biodiesel blended with petrodiesel. Biodiesel blends are referred to as BXX. The “XX” indicates the amount of biodiesel in the blend.
- A B20 blend, for example, is a 20% volumetric blend of biodiesel with 80% petrodiesel. B20 easily meets ASTM Specifications D 975.

Compared with petrodiesel, **Biodiesel:**

1. Is cleaner burning, Is odor free, non-toxic, and biodegradable,
2. Is free of sulfur, Is safer for people and the environment,
3. Reduces EPA targeted emissions, Achieves more complete fuel combustion,
4. Is safer to handle, transport, and store and has higher lubricity,
5. Reduces black smoke and Eliminates the nauseating smell,
6. Has a flash point above 150°C (302°F) and therefore exhibits a lesser potential for explosion,
7. Reduces greenhouse emissions, and Is a plant-based fuel replacement.

May give popcorn smell if with Corn...

Handling and storage:

Is safer than petrodiesel to handle and store. Biodiesel does not produce dangerous vapors at normal ambient temperatures, and can be stored in the same containers and tanks as petrodiesel.

Environmental considerations:

Is safer for the environment than petrodiesel. Is also less toxic than table salt, is as biodegradable as sugar, and contains no carcinogenic aromatics.

Availability and supplies

Bio-Diesel Trials



Features

- Trials using bio diesel blends up to 20 % without engine modification.
- Eco friendly vehicle.

- Product Deliverables

- Exhaustive trials of bio-diesel fuel → TML vehicles capable of bio-diesel running.

- Partners

- M/s IOC R & D, Faridabad.
 - M/s MICO / Bosch and M/s Delphi Diesel Systems.

- Benefits

- Green Initiative of using a renewable fuel that displaces petroleum-diesel.
 - Readiness for anticipated mandated use of bio-diesel blends.
 - Reduced emissions of HC,CO,PM.

- Application

- Initially, all commercial vehicles, Passenger vehicles → All Tata Diesel Vehicles.

TML Bio-Diesel Program

Evaluating Bio-Diesel Blend as a Potential Automotive-Fuel :

- Joint Program between **TML & Indian Oil Corporation R & D (IOC R & D) Centre.**
- Bio-Diesel used for trials to be manufactured from native feedstock.
- Only Non-edible oil-seeds to be used as feed-stock for bio-diesel.
 - (Because India is already a net importer of edible-oil).
- Jatropha or Karanja-based bio-diesel selected.
 - (as per Government's bio-diesel roadmap).

Summary of Bio-Diesel Trials

	Neat Diesel	B5	B10	B20
Commercial Vehicles			TML Staff-Buses (LP 1510, LP 1210, SFC 608) Road-trials of 1.1 million kms completed. No problems encountered.	Road-Trials planned on Staff-Buses.
	SFC 709 TCIC BS-2 @ IOC R & D 40, 000 kms completed		SFC 709 TCIC BS-2 50, 000 km covered. Road-trials continuing till 100, 000 kms. Thereafter, tear-down of engine & FIE.	
Passenger Cars	Indica BS-2 40, 000 km completed @ IOC R & D Tear-down of engine & FIE planned	Indica BS-2 40, 000 km completes @ IOC R & D Tear-down of engine & FIE planned	Indica BS-2 40, 000 km completed @ IOC R & D Tear-down of engine & FIE planned	Indica BS-2 40, 000 km completed @ IOC R & D Tear-down of engine & FIE planned
			Indigo BS-2 30, 000 km covered at TML.	
Engines			497 TCIC BS-3 125 Ps	497 TCIC BS-3 125 Ps
			2000 hour endurance-test planned on 697 TCIC BS-2 130 PS engine.	2000 hour endurance-test planned on 697 TCIC BS-2 130 PS engine.
Material Compatibility testing			Testing of engine and vehicle-materials completed. Correlation to be done with components from tested engines.	Testing of engine and vehicle- materials completed. Correlation to be done with components from tested engines.

Logistics of Fueling Bus-Fleet with Bio-Diesel Blend

Weekly:

- Consignment of 10 numbers of 200-litre barrels of pure Bio-Diesel (Karanja-based) delivered by road.
- From Lubrizol India Ltd. (Mumbai) → IOC outlet in Pune.

Weekly:

Blending occurs at IOC outlet (Every week).

- Tanker-truck decants Diesel (12 kL) into underground tank.
- Bio-diesel (in proper ratio) added to underground tank from barrels.



Daily: Staff-buses are filled with bio-diesel blend at fixed time-slot.

Daily: Data collected at pump at time of filling-up in Bus.

- Quantity of fuel to top-up tank of each bus.

Data Collected for TML Bio-Diesel Bus Trials

- Measured Fuel Economy.
- Measured Free-Acceleration-Smoke.
- Driveability issues.
- Maintenance frequency and schedules.

Bio-Diesel Trials on Indigo Passenger-Car at TML

- Type of Engine: 475 IDI TC engine.
- Pure Bio-Diesel (Karanjia-based) added to BS-3 dies to make B10 blend.
- Average daily distance covered: 500 kms
- Average daily fuel consumption: 35 litres
- Duration of bio-diesel program : 80,000 km.
- Data collected at time of filling-up.
 - Quantity of fuel to top-up tank.
 - Odometer reading.
- Emission testing performed on chassis-dynamometer after every 10,000 km



Material Compatibility Trials at TML

Motivation: What is the effect on various materials of exposure to bio-diesel ?

Components Tested: All components coming in contact with fuel
(from fuel-tank to combustion chamber).

Materials Tested:

- Elastomers (NBR, NBR + PVC, Viton)
- Gaskets
- Steel
- Copper

Test method:

- Rubber / Plastic specimen to be kept immersed in bio-diesel at 55 °C for 2000 hours.
- Metal components to be kept immersed in bio-diesel at 55 °C for 2000 hours.
- Mechanical Properties Testing and Visual Examination conducted on completion of exposure to bio-diesel.

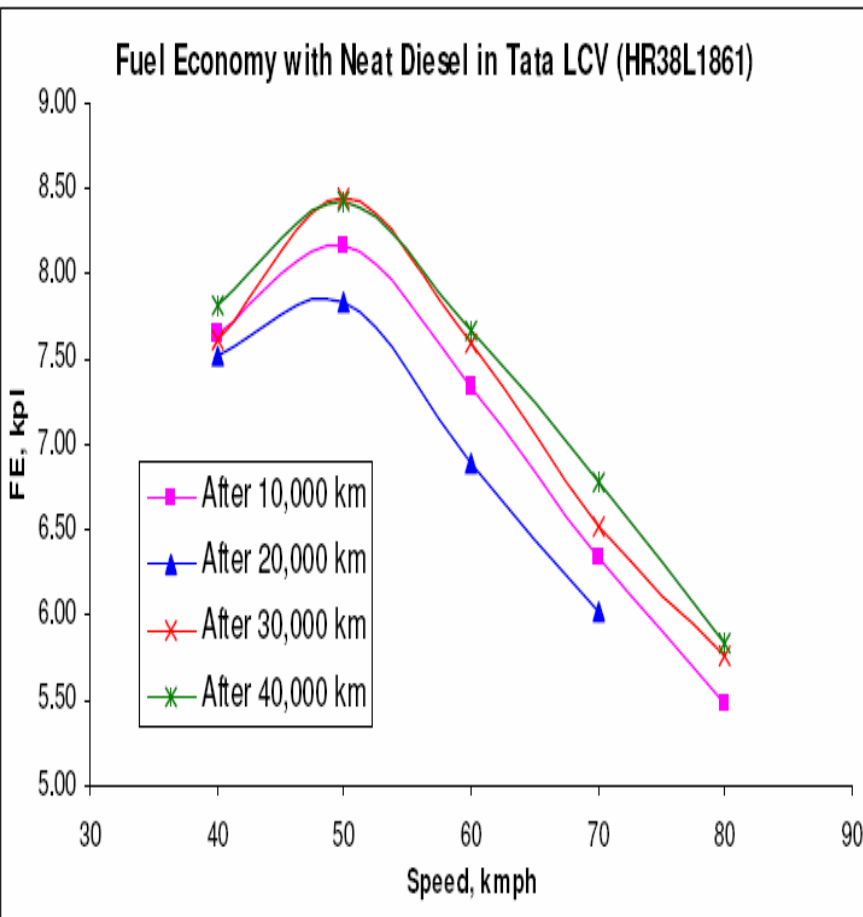


Figure 19 Fuel economy with Neat Diesel in TATA LCV

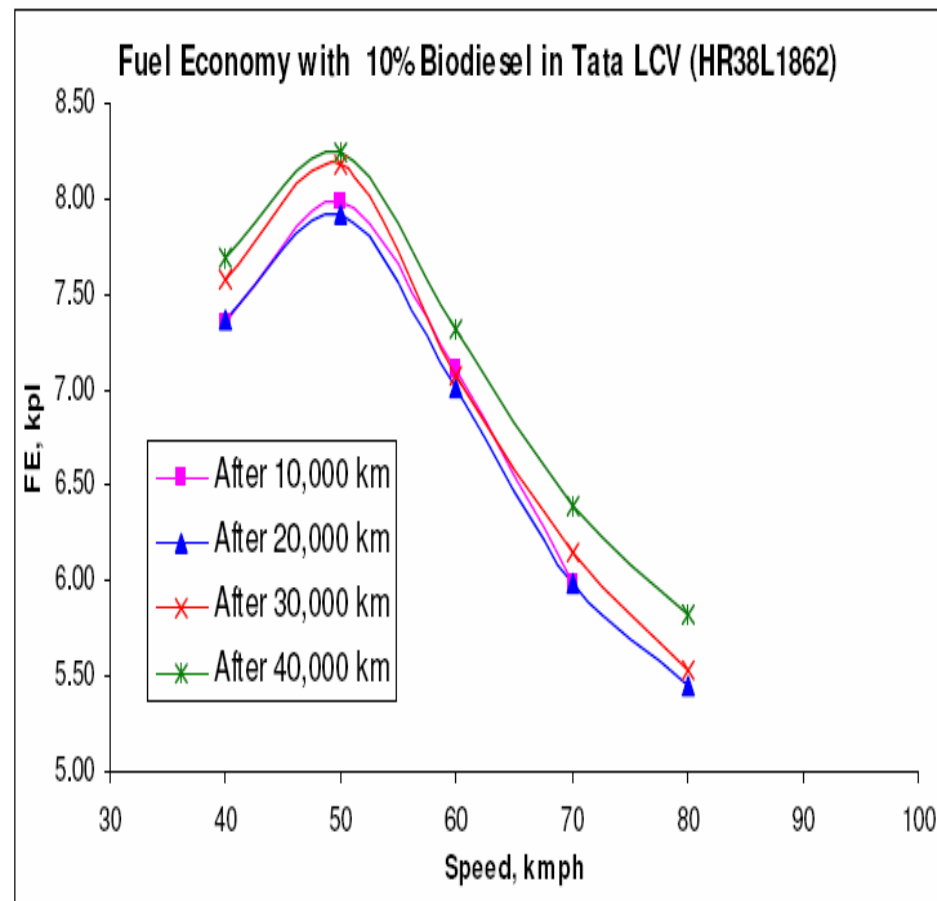


Figure 20 Fuel economy with 10% Biodiesel blend in TATA LCV