FUEL QUALITY INITIATIVES
- *Indian Experience*

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ALARMING GROWTH OF VEHICLE POPULATION IN INDIA

In thousands, as on 31st March 2000

YEAR	Two Wheeler	Cars & MUV	Commercial Vehicles	All- Vehicles
1981	2618	1160	716	4494
1986	6245	1780	1090	9115
1991	14200	2954	1687	18841
1996	23252	4204	2031	29487
2000 (est.)	36923	5237	2423	44583
2005 (Projected)	49686	6836	2967	59489
2010 (Projected	61378	8167	3439	72984
2015 (Projected)	74594	9398	3877	87869

Ref. SIAM

MAJOR CONCERNS OF AUTOMOBILE POLLUTION - INDIA

- Emissions from large population of 2/3 wheelers
  - HC, CO & Smoke
- Emissions from diesel vehicles (Diesel Consumption very high)
  - Smoke, Particulate & NOx
- Major contribution of pollutants from older in-use vehicles
- Poor maintenance of in-use vehicles
- Different pattern of fuels usage, mixed population of old and new vehicles
- Poor traffic management
- Poor road conditions
- Adulteration of fuels

EMISSION STANDARDS FOR PASSENGER CARS

	INDIA		EUROPE		
	1996	2000*	1992 Euro I	1997 Euro II	2000 Euro III
• CO g/km	8.68-12.40	2.72	2.72	2.20	2.30
• HC+NOx (g/km)	3.00-4.36	0.97	0.97	0.50	0.35
• HC					0.20
• NOx					0.15

* Euro II in NCR of India

EMISSION STANDARDS FOR PASSENGER CARS

	BHARAT STAGE – I *	BHARAT STAGE – II**
CO, g/Km	2.72	2.2
(HC + NOx) g/Km	0.97	0.50

IMPLEMENTATION DATES :

*** APRIL 2000 : ALL OVER COUNTRY**

**** APRIL 2000 : DELHI**
2005 : REST OF THE COUNTRY

INDIAN AND EUROPEAN NORMS FOR HEAVY DUTY DIESEL VEHICLES

	INDIA			EUROPE		
	1992	1996	2000	1992	1996	2000
• CO	14.0	11.2	4.50	4.50	4.00	2.0
• HC	3.5	2.4	1.10	1.10	1.10	0.6
• NOx	18.0	14.4	8.00	8.00	7.00	5.0
• PM for>85 kw			0.36	0.36	0.15	0.1
• PM for <85 kw			0.36	0.61	0.15	0.1

All value are in g/kwh
All measurements as per ECE R49

EMISSION STANDARDS FOR HEAVY DUTY DIESEL VEHICLES

	BHARAT STAGE – I APRIL 2000 – ALL OVER THE COUNTRY	BHARAT STAGE – II 2005- ALL OVER THE COUNTRY APRIL 2000 – DELHI
CO	4.50	4.00
HC	1.10	1.10
Nox	8.00	7.00
PM for > 85 kW	0.36	0.15
PM for < 85 kW	0.36	0.15

*All value are in g/kWh

*All measurements as per ECE R49 cycle

GASOLINE FUEL QUALITY INITIATIVES IN INDIA

CHRONOLOGY OF QUALITY IMPROVEMENT

YEAR	DETAILS
1996	UNLEADED GASOLINE IN METRO CITIES
1996	5% BENZENE IN ENTIRE MS (CPCB DIRECTIVES)
1998	ULG IN ALL STATE CAPITAL
2000	ALL OVER THE COUNTRY UNLEADED GASOLINE

GASOLINE FUEL QUALITY INITIATIVES IN INDIA

CHRONOLOGY OF SULFUR REDUCTION

Year	% S in gasoline
1984	0.25 in leaded gasoline
1998	0.20 in leaded gasoline
	0.15 in unleaded gasoline in all state capitals
2000	0.10 in unleaded gasoline, all over the country

CHRONOLOGY OF GASOLINE SPECIFICATION DEVELOPMENT IN INDIA(IS 2796)

PARAMETER	1964	1971	1984	1995	2000#
• OCTANE NUMBER, MIN.	83	83/93	87/93	87/93 (87ULP)	-
ANTI KNOCK INDEX, MIN	-	-	-	82	84
SULPHUR, WT% MAX.	0.25	0.25	0.25	0.2 0.15(ULP)	0.2 0.1(ULP)
LEAD CONTENT, g/l, MAX	0.56	0.56/	0.56/	0.013*	0.013
BENZENE, VOL% MAX	-	-	-	-	5
AROMATICS, VOL% MAX	-	-	-	-	-
OLEFINS, VOL% MAX	-	-	-	-	-

- *METROS AND OTHER CITIES # PROPOSED BY BIS
- *** UNDER FINALIZATION

TARGET SPECIFICATION * FOR 2005 & 2010 - GASOLINE

PROPERTY	2000 SPEC.	TARGET 2005 SPEC.	TARGET 2010
Octane Number, AKI	84	RON 91(Metros) RON 89 (Rest of the country)	RON 93(Metros) RON 89 (Rest of the country)
Oxygen Content, % v/v max.	Oxygenates Allowed 2.7	Oxygenates allowed 2.7	Oxygenates allowed 2.7
Benzene, % v/v max	5% (3% in NCR)	1% (Metros) 3% (Rest of the country)	1%
Aromatics, % v/v max	No Limit	40	35
Olefins, % v/v max	No limit	30	20
Sulfur, % m/m max	0.1 (may be 0.05 in NCR)	0.015 or 150 ppm	0.015 or 150 ppm
Lead Content, gm/ltr	0.013	Not Detectable	Not Detectable

** Under discussion in Inter-Ministerial Committee headed by Chairman, CPCB*

DIESEL FUEL QUALITY INITIATIVES IN INDIA
CHRONOLOGY OF SULFUR REDUCTION

YEAR	DETAILS
1995	3RD SPEC REVISION - S - 1%; CN - 45
1996	S - 0.5% (METRO + TAJ TRAPEZIUM)
OCT 1996	S - 0.25 (TAJ TRAPEZIUM)
1998	S - 0.25 (METRO)
1999	S - 0.05% (DELHI LIMITED SUPPLY)
2000	S - 0.25 (ALL OVER THE COUNTRY)
2001	S - 0.05 (NCR + TAJ TRAPEZIUM)

CHRONOLOGY OF DIESEL SPECIFICATION DEVELOPMENT IN INDIA (IS 1460)

PARAMETER	1974	1980	1995	2000#
• CETANE NUMBER, MIN.	42	42	45	48
• DISTILLATION, ºC MAX				
• 85% VOL	-	-	-	350
• 90% VOL	366	366	366	-
• 95% VOL		-	-	370
• SULPHUR, WT% MAX.	1.0	1.0	1.0(0.25*)	0.25(0.05**)
• POLYNUCLEAR AROMATICS, VOL% MAX	-	-	-	-

- * SUPPLIED IN METROS AND TAJ TRAPEZIUM
- ** SUPPLIED IN NCR IN LIMITED QUANTITY . ALL METRO CITIES BY 2002
- *** UNDER FINALIZATION
- # PROPOSED BY BIS

TARGET SPECIFICATION* FOR 2005 & 2010 - HSD

PROPERTY	2000 SPEC.	TARGET 2005 SPEC.	TARGET 2010
Cetane Number	48	50 (All over the country)	51 (All over the country)
Sulfur, % m/m max.	0.2 (may be 0.05 in NCR for Euro II cars).	0.05	0.015 (Metros) 0.035 (rest of the country)
T 95, deg C	370	370	360
Polyaromatics, % v/v	No Limit	11%	9%

** Under discussion in Inter-Ministerial Committee headed by Chairman, CPCB*

APPROACHES FOR MEETING EMISSION STANDARDS THROUGH FUEL QUALITY IMPROVEMENT

- Improving in refinery processes
- Reformulated fuels
- Use of Multifunctional Additives
- After treatment devices
- Retrofitments

RECONFIGURATION OF REFINERIES- STRATEGY TO IMPROVE QUALITY

Gasoline

1. Trimming of Reformer feed to remove benzene & its precursors
2. Integration of FCC with once through Hydrocracker
3. Hydrotreatment of FCC gasoline
4. Isomerisation of Light Naphtha
5. Benzene Saturation
6. Production facility for TAME, ETBE etc.

RECONFIGURATION OF REFINERIES- STRATEGY TO IMPROVE QUALITY

HSD

1. **DHDS Units for Sulphur Reduction**
2. **DHDT units for deep desulphurisation and Cetane Improvement**
3. **Isomerisation**
4. **Hydrocrakers**

STEPS TAKEN FOR SULPHUR REDUCTION IN DIESEL

- Diesel hydro de-sulphurisation (DHDS) units installed at 9 refineries
- Time frame - 4 years

  Decision taken : 1996

  Completed in 8 refineries : 2000

REFINERIES REQUIRE MORE TIME TO REACH EURO-II/EURO-III NORMS

FUEL QUALITY IMPROVEMENT REDUCES REFINERY PROFIT MARGIN SIGNIFICANTLY

Diesel	
? 9 DHDS units for sulphur reduction to 0.25%	Rs. 5600 crores.
? Increase in cetane no. & change in distillation specs	Rs. 1500 crores
Gasoline	
? Phasing out of lead, increase in octane, reduction of sulphur & benzene	Rs 3000 crores
Meeting fully Euro norms	
? Euro II norms at additional cost	Rs. 25,000 crores
? Euro III at further cost	Rs 35,000 crores

Low return on investment to refiners !

REFORMULATED FUELS

MAIN COMPONENTS USED FOR RFG

- **ALCOHOLS:**
  - METHANOL
  - ETHANOL
- **ETHERS :**
  - MTBE - METHYL TERTIARY BUTYL ETHER
  - TAME - TERTIARY AMYL METHYL ETHER
  - ETBE - ETHYL TERTIARY BUTYL ETHER

✍ ETHANOL AVAILABLE FROM AGRICULTURAL SOURCES

✍ ETBE CAN BE PRODUCED FROM BIO-ETHANOL AND OLEFINS FROM UNSATURATED C4 AND C5 REFINERY STREAMS

THERE IS NEED FOR PROVIDING INCENTIVES FOR PRODUCTION OF COSTLY RFG

ETHANOL : INDIAN EXPERIENCE

- **1979- The Ministry of Petroleum, Chemicals and Fertilizers, constituted an Inter- Departmental committee to examine the use of alcohol as fuel in admixture with gasoline.**
  - **R&D programme taken up to assess the performance of ethanol gasoline blends in motor vehicles.**
- **1980 - Trials were conducted on 15 passenger cars and 21 2/3 wheelers by IOC(R&D) in collaboration with IIP, Dehradun.**
  - **Fuels - Neat gasoline, 10% and 20% anhydrous ethanol blends.**
  - **Limited marketing under brand name Petrol-M involved under recovery to the OCC, estimated to be between Rs. 14-30 lakhs per day**
  - **Marketing suspended in September 1994**
- **2000-01-Decision taken by Government to carry out pilot trial with gasoline having 5% alcohol to generate the data on field experience**

MULTIFUNCTIONAL ADDITIVES

WORLD SCENARIO

- **MULTIFUNCTIONAL ADDITIVES IS AN ESSENTIAL INGREDIENT USED IN AUTOMOTIVE FUELS IN DEVELOPED COUNTRIES**
- **SOME OF THE OTHER COUNTRIES USING FOR LAST FIFTEEN YEARS OR MORE**
- **USED TO ENHANCE OR IMPROVE THE QUALITY OR VALUE OF BASE HSD/MS**
  - **TO MEET SPECIFICATION**
  - **TO HELP REDUCE AIR POLLUTION**
  - **TO PROVIDE UNIQUENESS/MARKETING ADVANTAGE**
  - **TO PREVENT DAMAGE TO DISTRIBUTION SYSTEM AND/OR ENGINE**
  - **TO GAIN PRODUCT ENDORSEMENT FROM VEHICLE MANUFACTURERS**

MULTIFUNCTIONAL ADDITIVES

INDIAN SCENARIO

- **GASOLINE**
- TILL RECENT PAST ONLY LEAD ALKYLS AND ANTIOXIDANTS WERE USED
- USE OF MFAs MADE MANDATORY IN 1995
- LACK OF AWARENESS PERSISTS
  - CONSISTENT DOPING BY THE REFINERIES ? ; OR
  - UNDER DOPING ?
- **KEY ISSUE**
- REIMBURSEMENT OF ADDITIVE COST; OR
- PASSING THE COST TO CUSTOMER

MULTIFUNCTIONAL ADDITIVES

INDIAN SCENARIO

- **DIESEL FUEL**
- ONLY CETANE IMPROVER AND DIESEL STABILISER ADDITIVES ARE BEING INCORPORATED
- NOT ALL INDIAN REFINERIES ARE USING STABILISER ADDITIVES - STABILITY PROBLEM CONTINUES
- MFAs NOT USED
- **KEY ISSUES**
- DIESEL CONSUMPTION IS MORE IN INDIA THEREFORE INCLUSION OF MFAs WILL YIELD LARGER BENEFITS W.R.T. EXHAUST EMISSIONS, FUEL ECONOMY etc.

MFAs NEED TO BE MADE MANDATORY IN DIESEL. INCENTIVES TO OIL COMPANIES AND COST TO BE ADDED TO THE FUEL COST

USE OF AFTER TREATMENT DEVICES

- **Two wheelers**
  - Oxidation catalysts are currently being used in limited scale
  - Gradual switch over to 4-stroke two-wheelers
- **Passenger Cars**
  - Two way Oxidation catalysts are being used
  - Three-way redox catalysts are also available
- **Diesel Vehicles**
  - Options available
    - Diesel Oxidation Catalysts - can work with 500-700 ppm S levels of diesel
    - Diesel Soot filters - can work upto 500 ppm S diesel (Engelhard)
    - Continuous Regenerative Traps(CRT)- works with 50 ppm S diesel

Need for mandatory use in all new vehicles and retrofiting in old vehicles

FUTURE FUEL CHANGES

- **2000-2005**
  - **NEW CLEANER M.S. / DIESEL SPECIFICATION**
  - **REMOVAL OF ETHERS FROM GASOLINE**
  - **USE OF ETHANOL, ETBE OR TAME IN GASOLINE**
- **2005-2010**
  - **LPG / CNG POWERED CAR / BUSES / LIGHT DUTY TRUCKS**
  - **ALTERNATE FUELS, e.g., DME, GTL etc.**

SOURCE : OIL & GAS JOURNAL, VOL 97, NO. 28, 1999

OTHER TECHNOLOGIES UNDER STUDY

	Water Emulsion	Diesel Oxidation Catalyst	Continuous Regenerative Traps (CRT) types	Fuel Additives
• Sulphur in diesel	Any level	500-700 ppm	50-500 ppm	Any level
• Cost (Rs.) per bus	Nil	30,000	2.5 Lakhs	Nil
• Extra Cost of fuel	Marginal	Nil	25.30%	Marginal

All above technologies are under trial

CONCLUSIONS

- **Indian vehicle population and fuel consumption pattern vastly different from Europe.**
- **India has made significant fuel quality improvements in a short span of last 5 years in spite of resource crunch.**
- **Oil refineries need time to improve fuel quality in line with the European experience.**
- **Fuel quality will continue to improve for first decade of the millennium.**

CONCLUSIONS

- **Huge investment by refineries is expected to comply with environmental regulations imposed by Hon'ble Supreme Court**
- **Concerns for negative margins to refineries**
- **Need for realistic long term time frame on fuel quality and more incentives to compensate for the fuel quality improvement**