JORDAN PETROLEUM REFINERY

UNLEADED GASOLINE

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1. General Information

- The most important refinery product is motor gasoline.
- Gasoline is mixtures of different hydrocarbons with boiling ranges from ambient temperatures to about 200 C.
- The important qualities for gasoline are octane number (antiknock),volatility (starting and vapor lock) and vapor pressure. additives are often used to enhance performance and provide protection against oxidations and rust formations .

1.1.Physical and chemical properties

- Physical state : liquid
- Specific gravity : 0.72-0.76 (water =1)
- Vapor density : 3-4 (air =1)
- Boiling point/range : 20 to 204 C
- Vapor pressure/range : 300-500 mmHg at 38C (0.4-0.65 kg/cm) ,water 0.065kg/cm
- Flash point : < 0 C
- Autoflammability : > 340 C
- Explosive limits :1.4 -7.6, volume %

The following are main hydrocarbon compounds in gasoline

Component name	Conc.%	CAC.No.
Methyl tertiary-Butyl Ether (MTBE)	0-15	163404-4
Tertiary-Amyl Methyl Ether (TAME)	0-15	994-05-8
Ethyl tertiary-butyl ether (ETBE)	0-15	637-92-3
Di-isopropyl Ether (DIPE)	0-15	108-20-3
Tertiary-Amyl Ethyl Ether (TAEE)	0-15	919-94-8

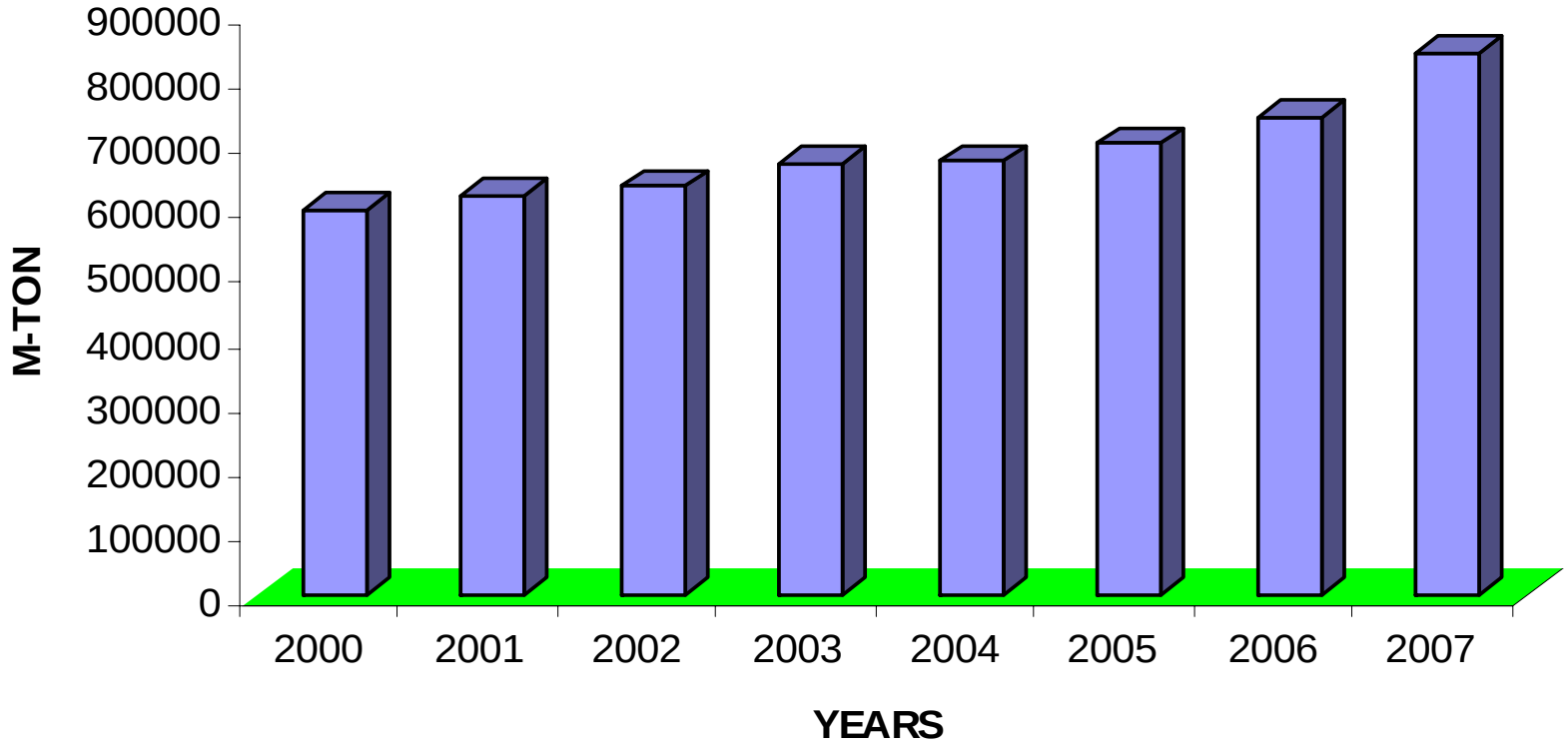
Ethanol	0-10	64-17-5
Pentane, all isomers	5-20	Mixture
Octane, all isomers	5-20	Mixture
Toluene	1-20	108-88-3
Xylene, all isomers	1-18	1330-20-7
Hexane, other isomers	5-15	Mixture
Heptane, all isomers	5-15	Mixture
Nonane, all isomers	0-10	Mixture

Nonane, all isomers	0-10	Mixture
Isopentane	0-10	78-78-4
n-Butane	0-10	106-97-8
n-Hexane	1-8	110-54-3
Methylcyclohexane	1-5	108-87-2
Trimethylbenzene, all isomers	1-5	25551-13-7
Benzene	0-4.9	71-43-2
Ethylbenzene	0.2-4	100-41-4

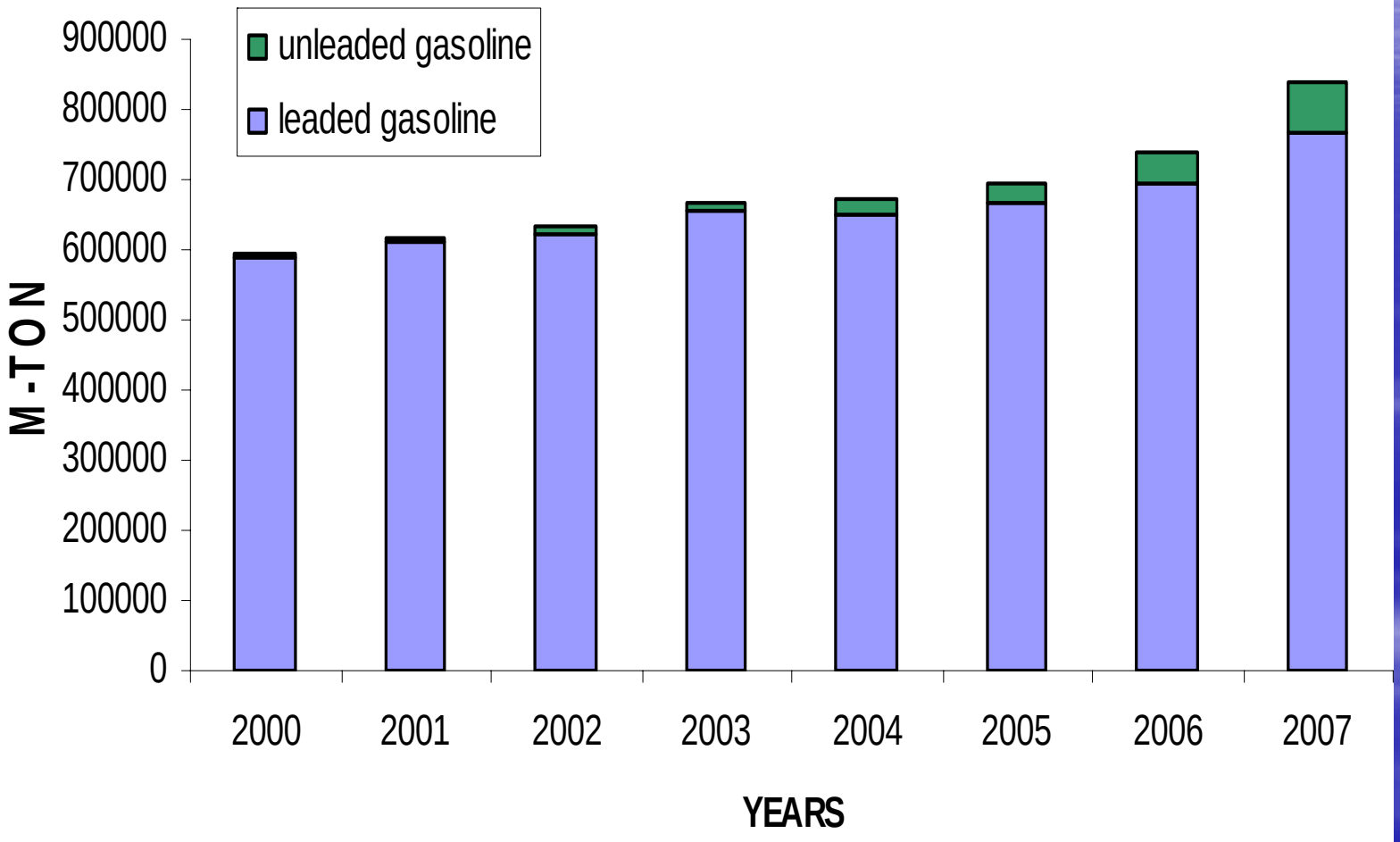
Hexane, all isomers Mixture	1-3	Mixture
Methylcyclopentane	1-3	96-37-7
Cyclohexane	1-3	110-82-7
Ethyl methylbenzenes (Ethyltoluenes)	1-3	25550-14-5
Cyclopentane	1-2	287-92-3
Naphthalene	0.1-2	91-20-3
Indene	0.5-1.5	95-13-6
n-Propylbenzene	0.5-1.5	103-65-1
Styrene	0-1	100-42-5

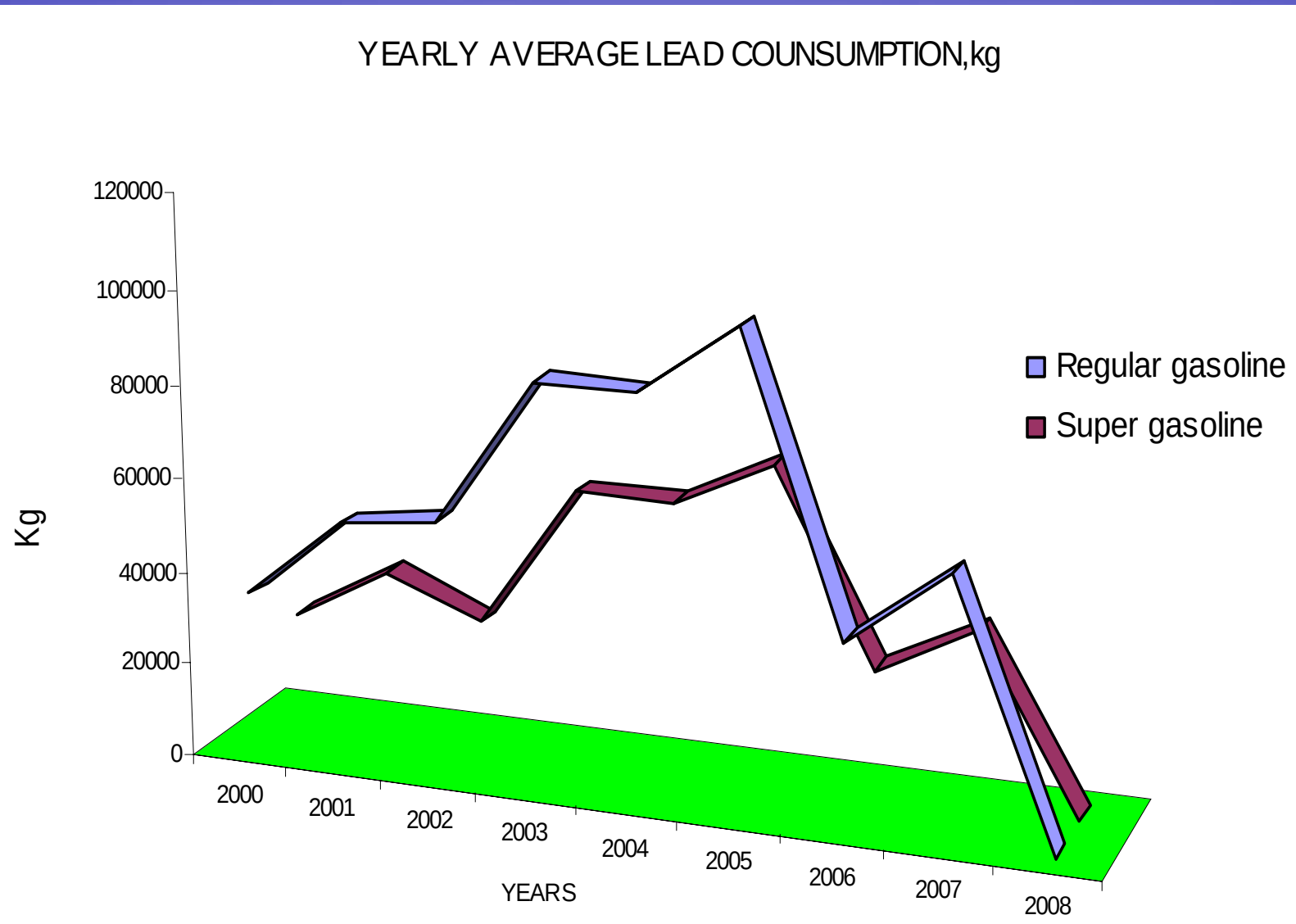
2.Quantities of Consumed gasoline

2.1 GASOLINE CONSUMPTION IN JORDAN FROM 2000 TO 2007 IN MT

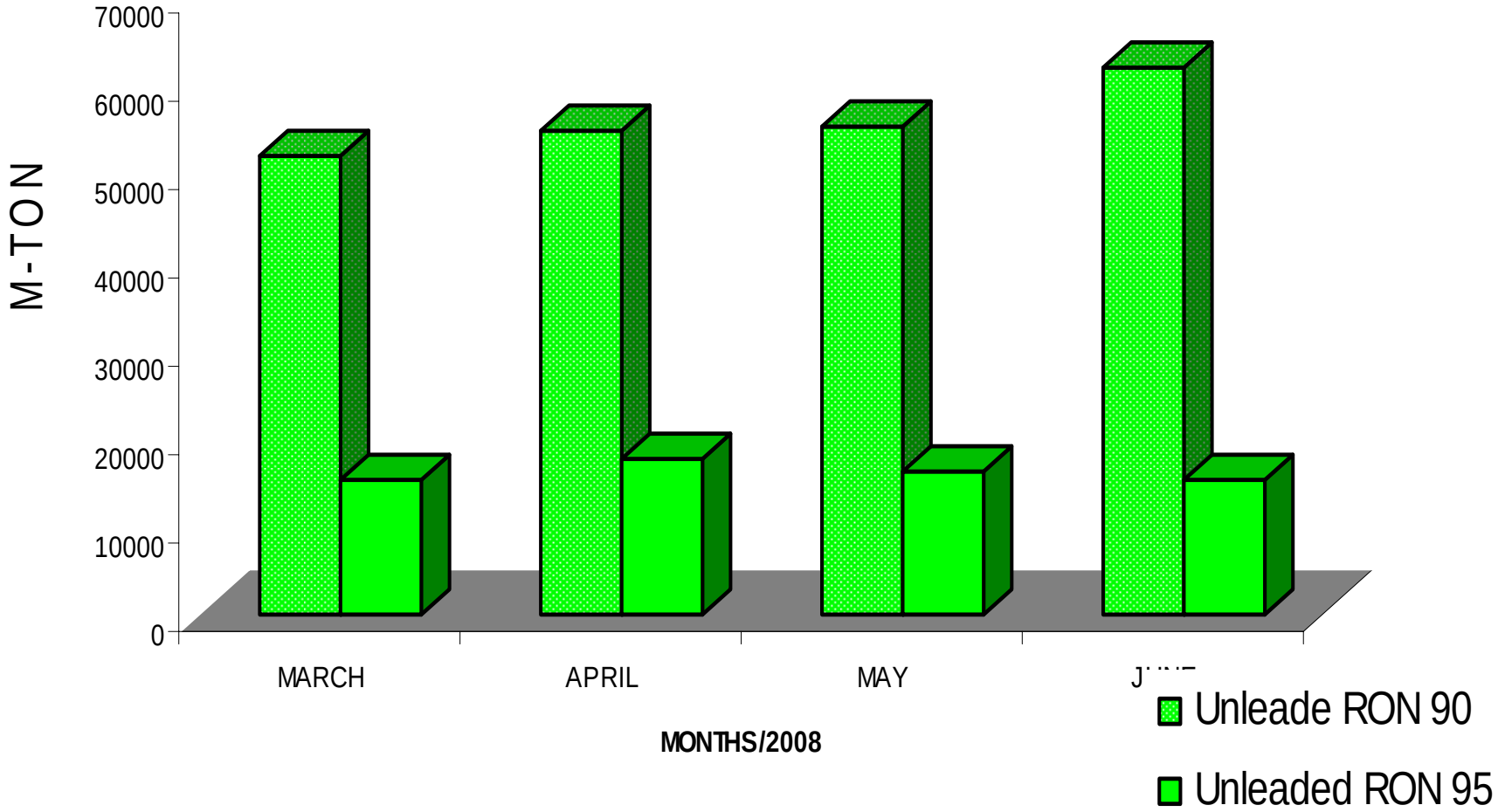


LEDED, UNLEDED GASOLINE CONSUMPTION

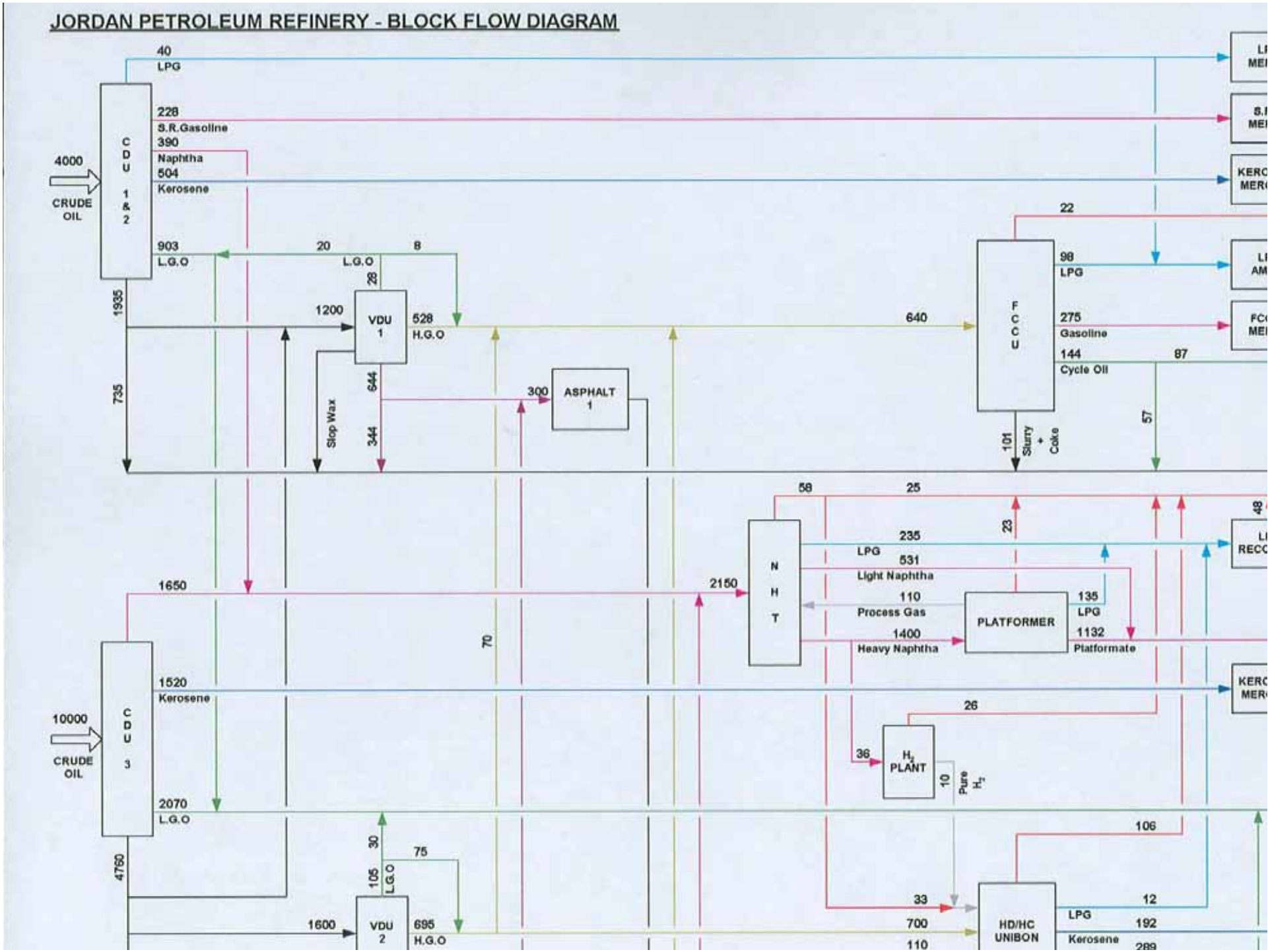



YEARLY AVERAGE LEAD COUNSUMPTION,kg
120000
100000
80000
60000
40000
20000
0
Kg
2000
2001
2002
2003
2004
2005
2006
2007
2008
YEARS
Regular gasoline
Super gasoline

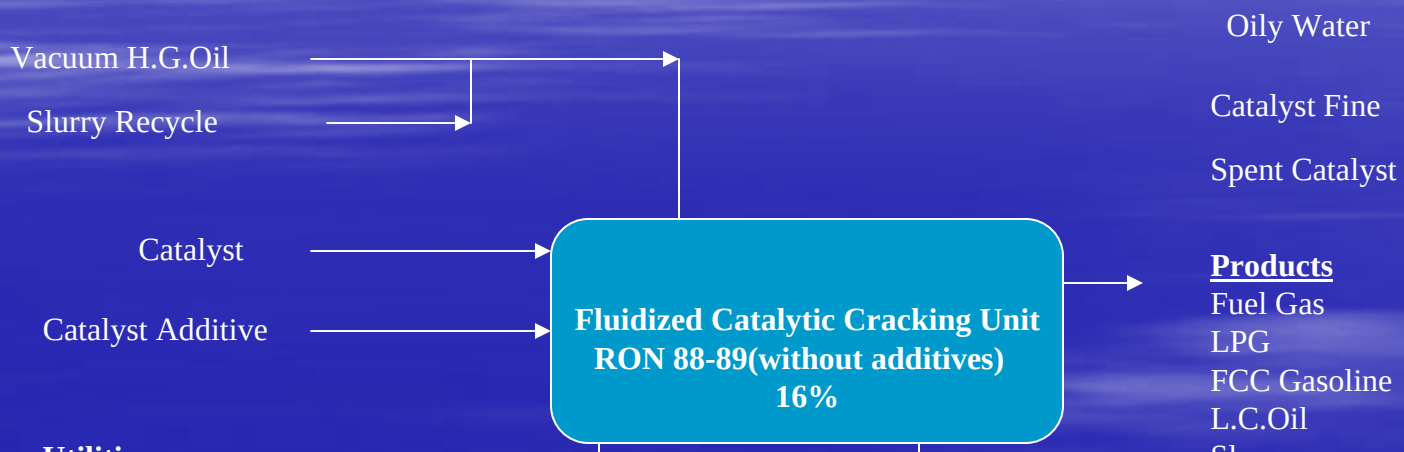
2.3 MONYHLY AVERAGE CONSUMPTION OF UNLEADED GASOLINE



JORDAN PETROLEUM REFINERY - BLOCK FLOW DIAGRAM



FCC Unit



Utilities
Cooling Water
Service Water
Boiler Feed Water
Electricity
Steam
Fuel Gas
Turch Oil
Instrument Air
Refinery Air

Oily Water

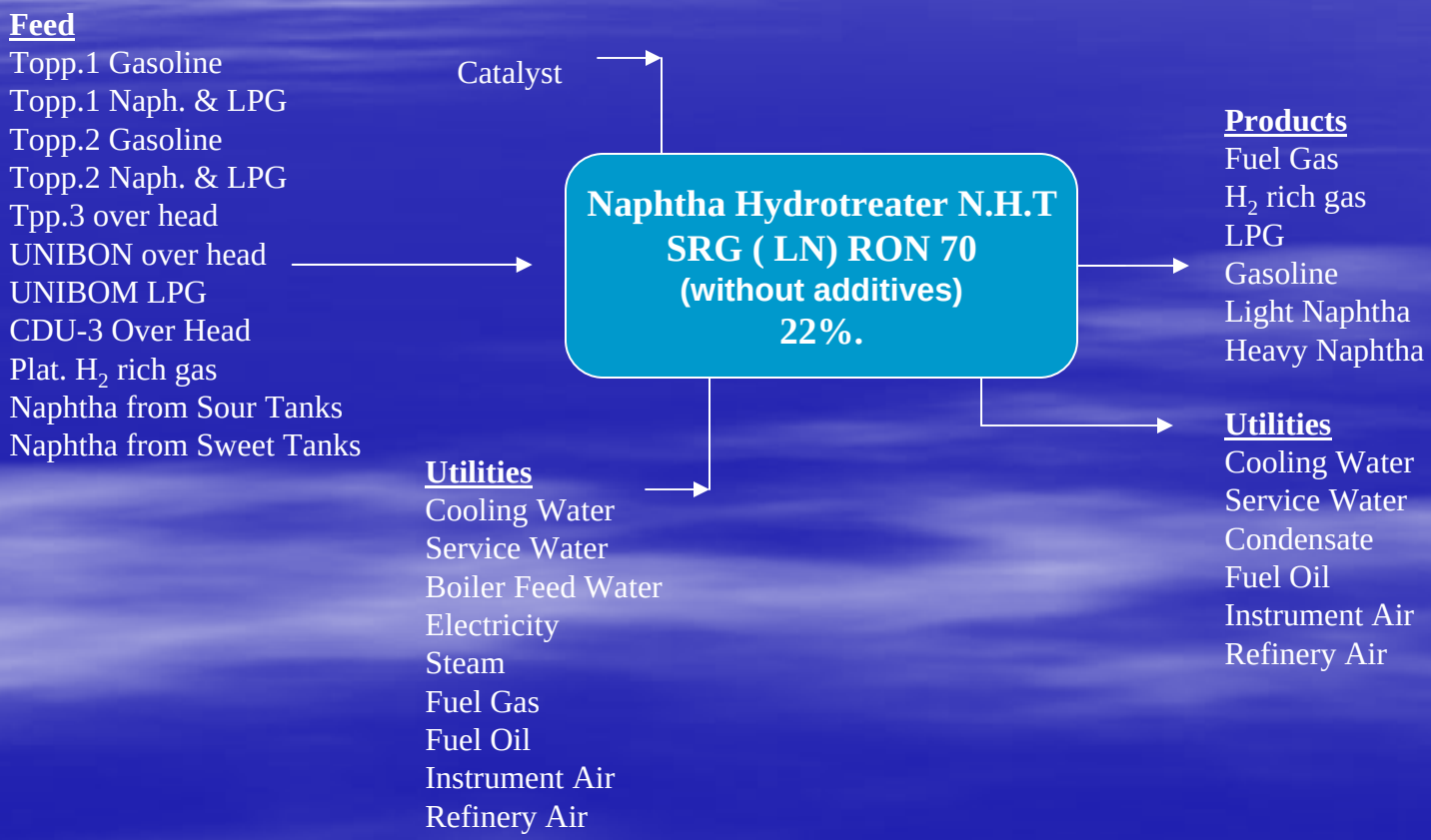
Catalyst Fine

Spent Catalyst

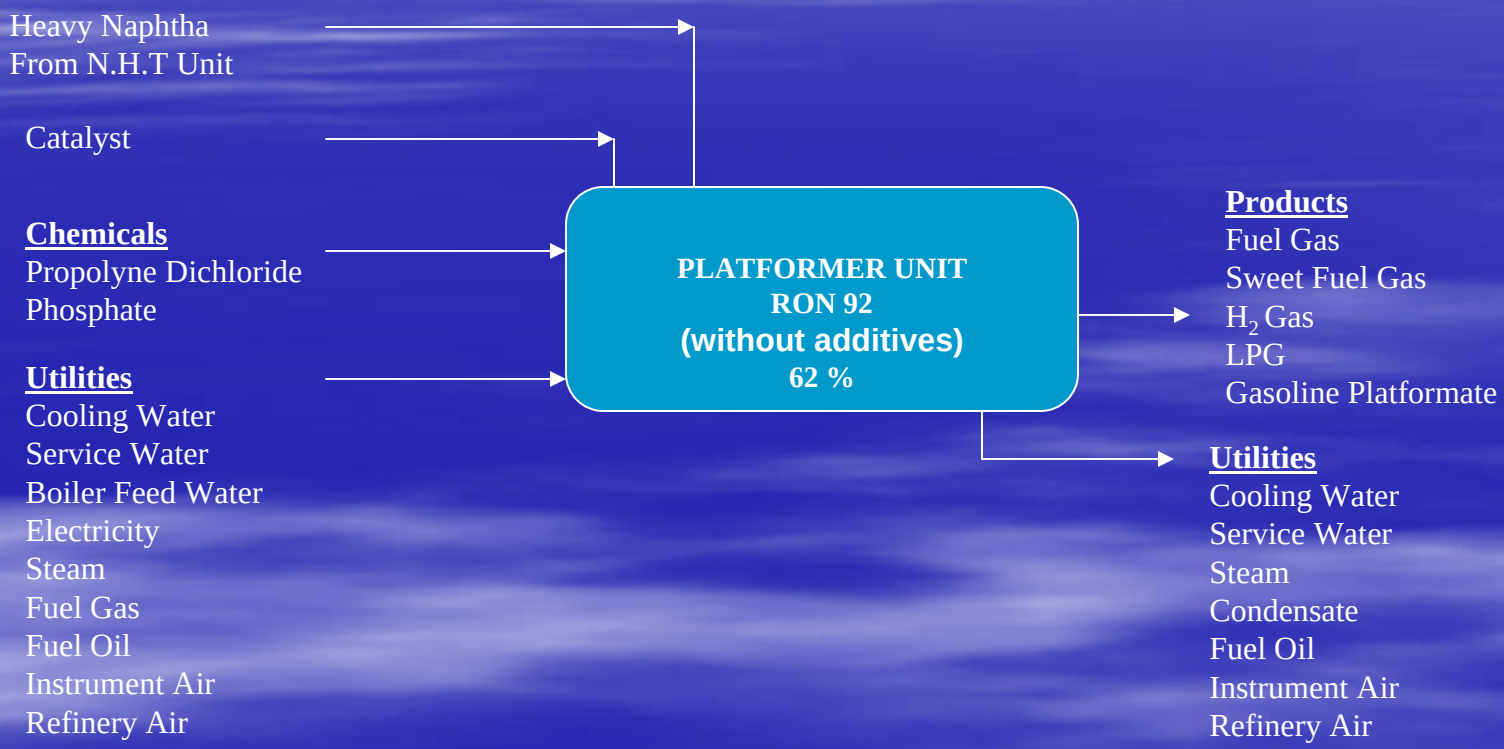
Products
Fuel Gas
LPG
FCC Gasoline
L.C.Oil
Slurry

Utilities
Cooling Water
Service Water
Steam
Condensate
Instrument Air
Refinery Air

NAPHTHA HYDROTREATER UNIT



PLATFORMER UNIT



3. Research Octane Number (RON)

- Octane is a measure of a fuels tendency to knock in a test engine when compared to other fuels .
- Knocking occurs when the fuel/air mixture explodes on the compression stroke of the engine cycle, ie before the application of the spark. This creates a loud knocking noise within the engine and can lead to engine damage.

- Research Octane Number (RON) is determined in the test engine at a relatively low speed (600 rpm). This is to simulate city driving at low speed with frequent acceleration.
- Motor Octane Number (MON) is measured at higher speed (900 rpm) which simulates highway driving.

  For most fuel components RON is greater than MON.

4. FUEL ADDITIVES

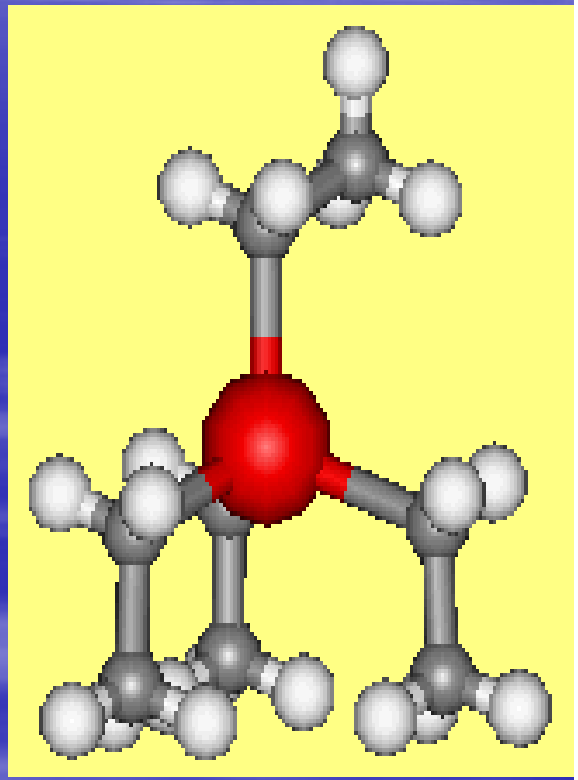
- TEL & TML.

  Tetra-ethyl lead and. Tetra-methyl lead as fuel additives have been used to reduce the knocking tendencies of gasoline since 1922.

  A typical lead content of 0.4g/l, boostes a gasoline's RON by about 6 units.

4.1. What is TEL ?

- Tetra-ethyl lead is a lead atom bonded to a tetrahedral arrangement of ethyl groups.
- The C-Pb bond is quite weak and in the hot environment of an internal combustion engine it fragments producing lead and ethyl radical which can help termination the combustion process by radical reactions.

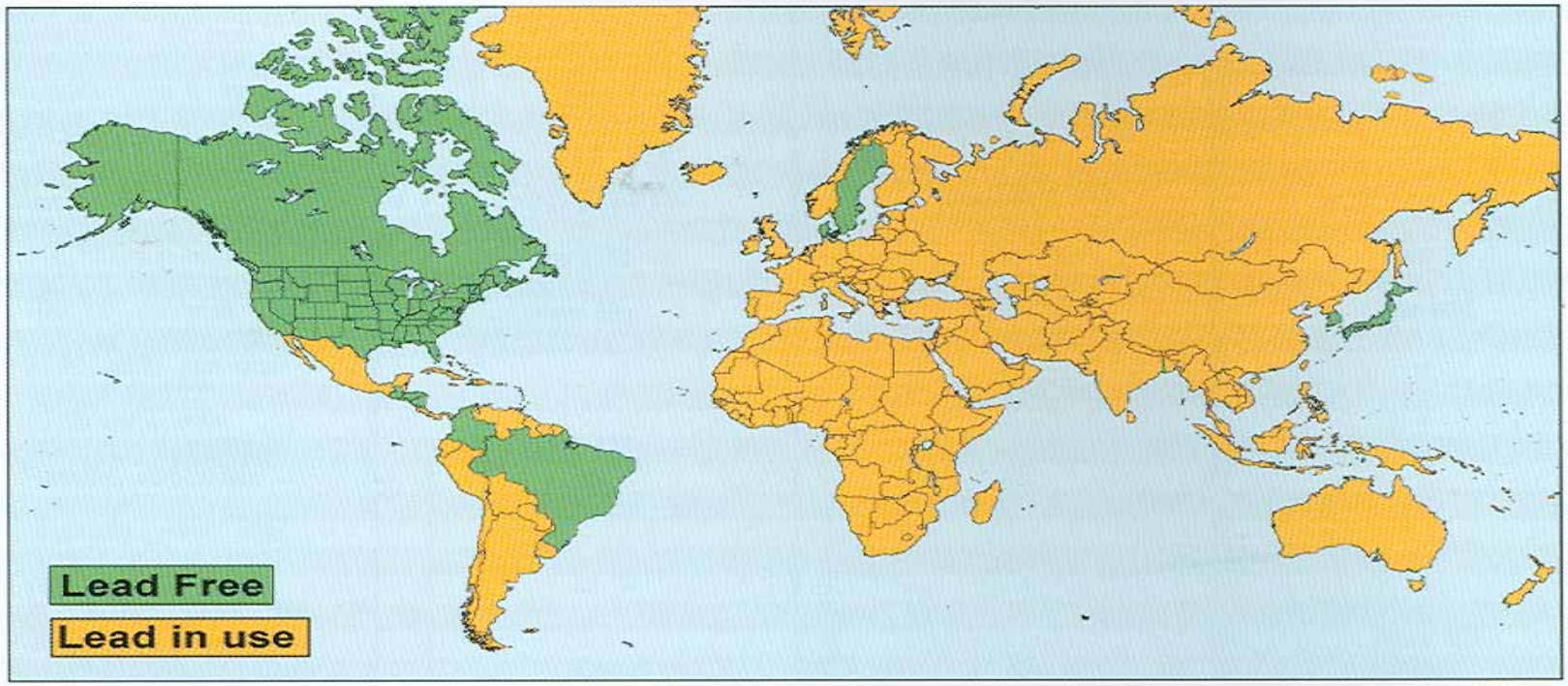


4.2 H&E IMPACT

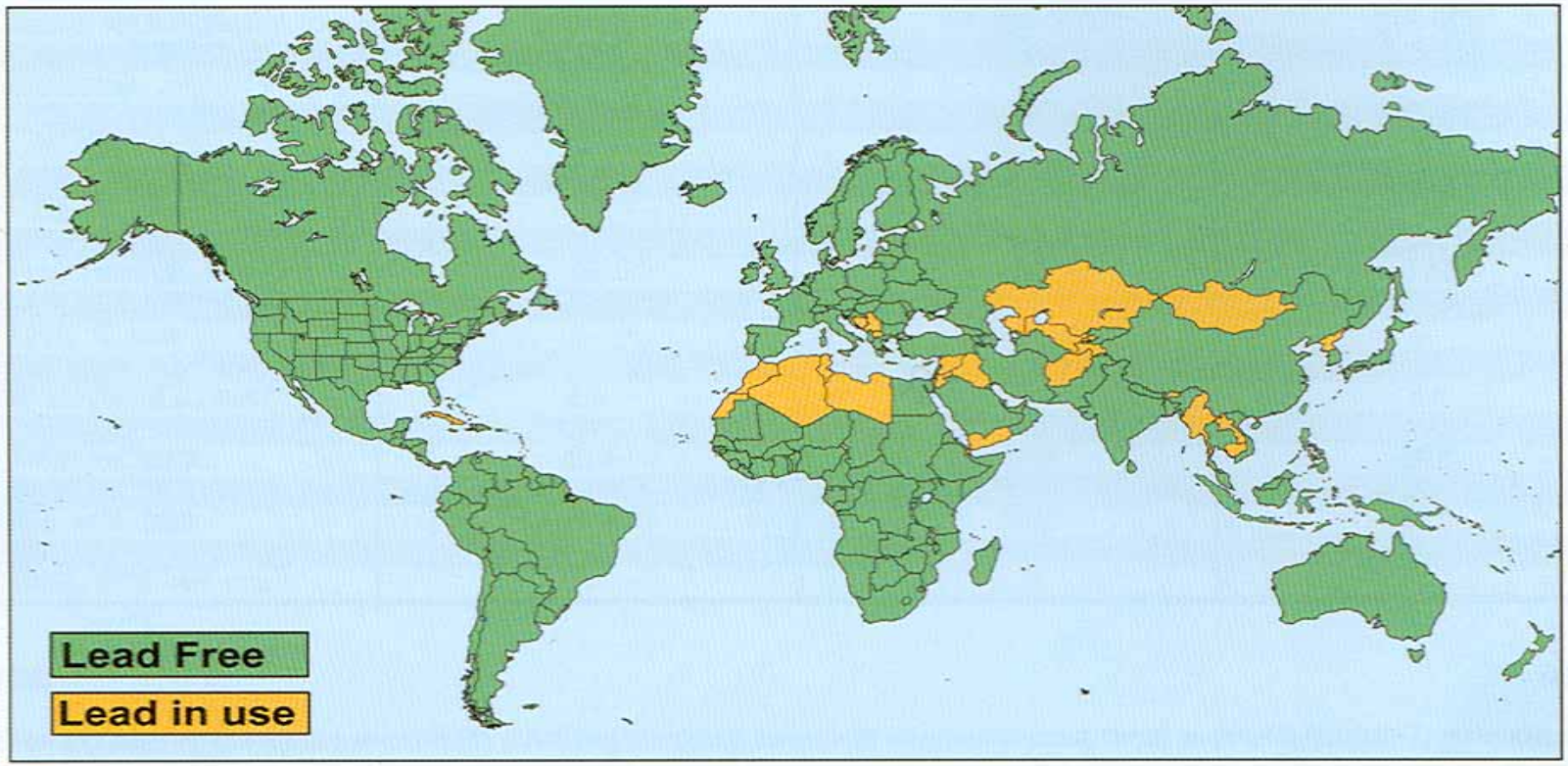
- LEAD deposits poison catalytic converters and exhaust oxygen sensors, so exhaust gases cannot be removed.
- Reduced mental capacity in children and high blood pressure in adults.
- In 1990 the U.S. Congress prohibited the addition of lead to gasoline, effective January 1,1995.

Lead Phase Out

1996



January 2008



Source: IFQC, Jan. 2008

5. OXYGENATY ADDETIVES

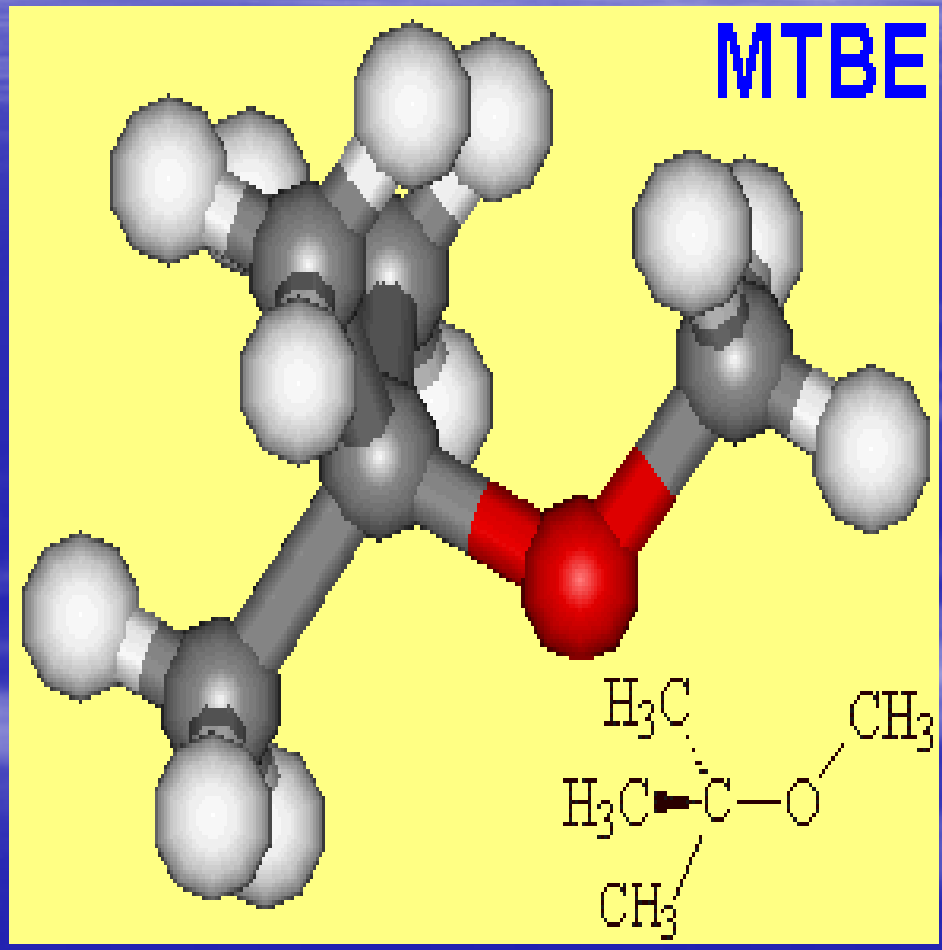
- Oxygenates are hydrocarbon compounds which contains oxygen atoms.
- Tow types of oxygenates are commonly added to gasoline Alcohols and Ethers.
- Oxygenated fuels are used to reduce ozone forming smog ,hazardous carbon monoxide pollution and other toxic air pollutants.

Ethers		Alcohols	
Compound	CAS #	Compound	CAS #
DIPE *(Di- Iso-Propyl-Ether*	*108-20-3*	***Methanol***	*67-56-1*
ETAE *(Ethyl-Tertiary-Amyl Ether*	*919-94-8*	***Ethanol***	*64-17-5*
ETBE *(Ethyl-Tertiary-Butyl-Ether*	*637-92-3*	***TBA*** *(Tertiary Butyl Alcohol; 2-Methyl-2-Propanol)*	57-65-0

TAME *(Tertiary-Amyl-Methyl-Ether*	*994-05-8*	***IPA*** *(Iso Propyl Alcohol, 2-Propanol)*	67-63-0
MTBE *(Methyl-Tertiary-Butyl Ether*	*1634-04-4*	***n-Propanol*** *(1-Propanol)*	71-23-8
		n-Butanol *(normal butyl alcohol, 1-Butanol)*	71-36-3
		iso-Butanol *(isobutyl alcohol, 2-Methyl-1-Propanol)*	*78-83-1*

5.1 What is MTBE

- MTBE is the most widely used fuel oxygenate, due to its combination of technical advantages and supply availability.
- MTBE delivers high octane value at relativity low cost.



Methyl Tertiary-Butyl Ether

Physical and chemical properties			
	MTBE	Oxygenate gasoline (max 15%v MTBE)	Leaded gasoline
Molecular weight	88.15	Mixture	Mixture
Boiling point C	55	20-210	20-210
Melting point C	-109	-	-

Flash point C	-25	< 0	< 0
AutoignItion temp. C	425	Min.340	Min.340
Flammability limits %	1.5-8.5	1.4-7.6	1.4-7.6
R. Density @20C	0.740 g/ml	0.72-0.77	0.72-0.78
V. Pressure @ 20C	245 mmHg	450-600 @38C	450-500
Water solubility	42 g/l at 25C	MTBE 23g/l BTX EB 2.6g/l	BTX EB 2.6g/l

5.2. Benefits of MTBE in gasoline

- The important reason for the widespread use of MTBE is feedstock flexibility.
- Air quality benefits :

  - more complete fuel combustion
  - reduction of olefins, aromatics and benzene levels

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- The use of reformulated gasoline containing 10-15 % MTBE, reduced the pollutants as following :

CO	20-25 %
Unburned hydrocarbons	10-15 %
Particulate matter	30 %
Benzene	20-30 %
Nitrogen oxides	5 %

6. EXPOSUR LIMITS

- MTBE : 40 ppm (TLV) , ACGIH
  - Carcinogenic : IRAC (NO)
    : OSHA (NO)
    : NTP (NO)
    : ACGIH (A3) possible for animals
- BENZENE : 0.1-0.5 TWA & 1-5 STEL (ACGIH,OSHA,NIOSH EPA and NTP)
  - Carcinogenic : yes (ACGIH,OSHA,NIOSH,EPA and NTP)

7. SUMMARY

- Appling effective control programs during handling MTBE is the convenient way to achieve requirements related to Health, Safety & Environment.
- Using MTBE in gasoline is only temporarily.
- Through 4th Expansion Project reformate gasoline will by produced.

- TWA: time weighted average
- ACGIH: American conference of governmental industrial hygienists
- NTP : national toxicology program
- IRAC : International Agency for Research on Cancer,
- **OSHA** - Occupational Safety and Health Administration, U.S. Department of Labor
- **EPA** - United States Environmental Protection Agency
- **STEL** - The ACGIH Short-Term Exposure Limit
- **TLV** - ACGIH Threshold Limit Value,
- **CAS #** - American Chemical Society's Chemical Abstract service registry number which identifies the product and/or ingredients.