

# I C ENGINE FUELS

# STANDARDS FOR TESTING

Most of the gasoline and diesel fuel tests are specified by

1. ASTM-American Society for testing and Materials and
2. SAE- Society of Automative Engineers.
3. API- American Petroleum institute

# SI ENGINE KNOCKING

Spontaneous burning of fuel in localized area instead of progressing from the spark produces “ping” or “knock” or “detonation” sound. It is called knocking.

Knocking causes

1. Loss of power
2. Damage to engine

# A FUEL IS TESTED TO ESTIMATE ITS

1. VOLATILITY
2. BURNING CHARACTERISTICS
3. FREEDOM FROM EXCESSIVE IMPURITIES
4. STORAGE STABILITY

# SI ENGINE ANTIKNOCK QUALITY

**OCTANE NUMBER:** It is a measure of antiknock quality of SI engine fuel.

It is the percentage of iso-octane in mixture of two reference fuels (Iso-octane + normal heptane) that has the same knock intensity as the fuel being tested. it is a measure of suitability of a fuel for use in an engine of given compression ratio.

# Tests for measuring Octane Number

1. The Research Method (ASTM D2699)
2. The Motor Method (ASTM D2700)- More severe operating conditions.

# FACTORS AFFECTING THE OCTANE NUMBER REQUIREMENT

ONR is affected by

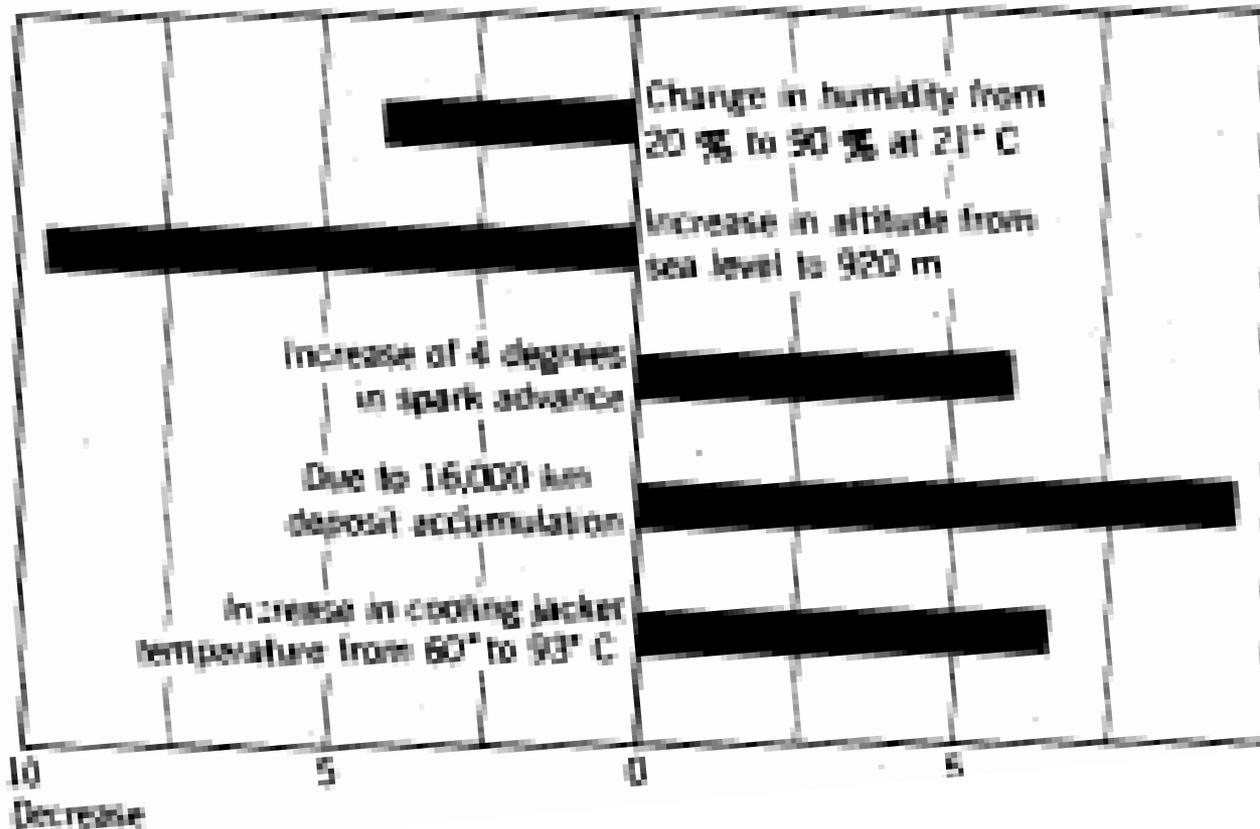
1. Air fuel ratio
2. Compression ratio
3. Combustion chamber design
4. Operating conditions such as speed.
5. Ignition timing

# FACTORS AFFECTING THE OCTANE NUMBER REQUIREMENT

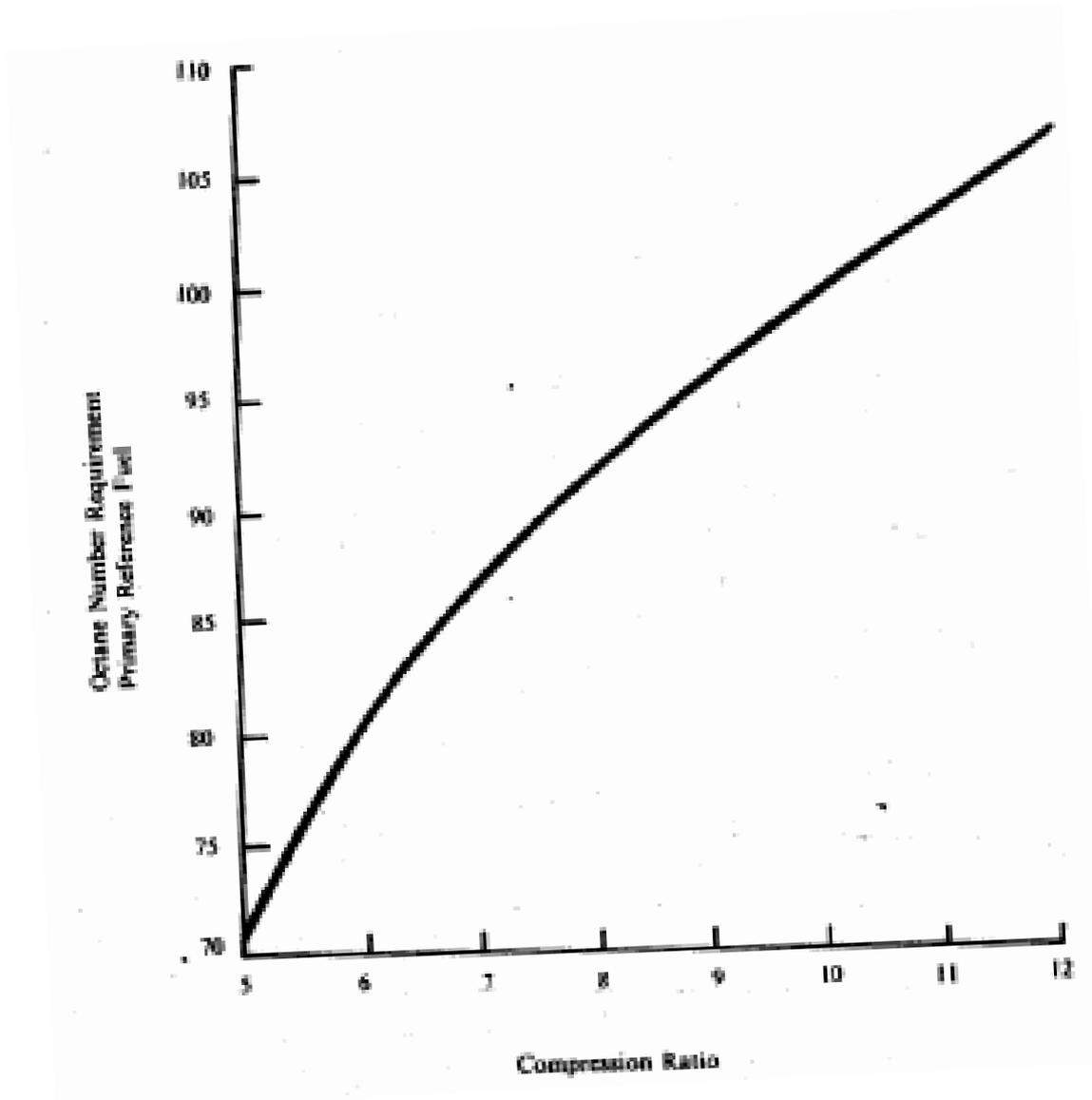
1. As the ignition timing is advanced by 4 degrees ahead of the basic timing, the ONR increases by 6 numbers.
2. An increase in humidity from 4 to 18g/kg of air reduces ONR by 3 numbers.
3. An increase in coolant temperature from 60 degree Centigrade to 90 degree centigrade increases ONR by 7 numbers.

4. Decreasing the compression pressure decreases ONR.
5. An increase in altitude of 920 m decreases the ONR by 9 numbers.
6. Increasing the compression ratio from 6:1 to 8:1 will increase the ONR by approx.12.
7. Combustion deposits result in reduction in heat transfer rate and increase in compression ratio.Thus increases ONR.
8. Smaller the combustion chamber, lower will be ONR

# FACTORS AFFECTING THE OCTANE NUMBER REQUIREMENT



# Compression ratio-vs-ONR



**TABLE 4-2 Summary of Gasoline Additives**

Additive	Type	Function
Oxidation and corrosion inhibitors	Aromatic amines and phenols	Inhibit gum formation and corrosion
Metal deactivators	Chelating agent	Inhibit gum formation from catalytic action of certain metals
Anti-icing additives	Alcohols and surfactants	Prevent icing in carburetor and fuel system
Detergents	Amines and amine phosphates	Prevent deposits in carburetor
Deposit control additives	Polybutene amines	Removes and prevents deposits in carburetors, PCV systems, and intake ports and valves—controls varnish and sludge deposits on the pistons and in the crankcase
Combustion chamber deposit modifiers	Phosphorus compounds	Minimize surface ignition and spark plug fouling
Antiknock compounds	Tetraethyl or tetramethyl lead	Increase octane numbers
Dyes		Identification

SOURCE: "Motor Gasoline," *Chevron Research Bulletin*, Chevron Research Company, Richmond, CA, 1974.

# Impurities

## 1. Sulfur content

### Corrosive Sulfur-

Immerse a polished strip of copper in the fuel for 3 hour at 50 deg Centigrade. Any decoloration indicates presence of corrosive sulfur.

### Quantity of sulfur-

0.5%ASTM-D1266

max. 0.1% (ASTM D439)

# GUM AS IMPURITY

2. Gum content- Viscous liquid having tendency to stick to the wall.
3. ASTM D439 sets a max gum as 5 mg gum per 100 ml of fuel.

# Diesel Fuel Requirements

1. Cetane Number
2. Heat Value; Bomb Calorimeter
3. Viscosity: ASTM D445 Viscosity in centistokes at 40deg centigrade
4. Carbon residue; measured after heating fuel for 20 min at 549 deg centigrade ASTM D524
5. Flash Point (ASTM D93): Temp at which fuel catches fire
6. Pour point (ASTM D97); Lowest temp at which fuel ceases to flow
7. Cloud point (ASTM D2500); Temp at which paraffin wax or other solid substances crystallise out. Generally 5 degree Centigrade above the pour point.
8. Ash Content (ASTM D482): max 0.01% ASTM

# CETANE NUMBER

**CETANE NUMBER:** It is a measure of antiknock quality of CI engine fuel.

It is the percentage of normal cetane in mixture of two reference fuels (Iso-octane + alpha methyl naphthalene) that has the same knock intensity as the fuel being tested. It is a measure of suitability of a fuel for use in an engine of given compression ratio.

OR

CETANE NUMBER (ASTM D613)

= % of n-cetane + 0.15\*(%of heptamethylnonane)

Commercial diesel fuel have cetane number  
ranging from 33 to 64

**TABLE 4-3 Detailed Requirements for Diesel Fuel Oils\***

Grade of Diesel Fuel Oil	Flash Point, °C	Cloud Point, °C	Water and Sediment, vol %	Carbon Residue on 10% Residue, %	Ash, weight, %	Distillation Temperatures, °C		Viscosity		Sulfur weight %	Copper Strip Corrosion	Cetane Number
						90% Point		Kinematic cSt at 40°C†				
	Min	Max	Max	Max	Max	Min	Max	Min	Max	Max	Max	Min
No. 1-D A volatile distillate fuel oil for engines in service requiring frequent speed and load changes	38	— <sup>d</sup>	0.05	0.15	0.01	—	288	1.3	2.4	0.50	No. 3	40
No. 2-D A distillate fuel oil of lower volatility for engines in industrial and heavy mobile service.	52	— <sup>d</sup>	0.05	0.35	0.01	282 <sup>e</sup>	338	1.9	4.1	0.50	No. 3	40

SOURCE: Condensed from *Diesel Fuels*, SAE J913 Jun 86. Published by permission of the Society of Automotive Engineers.

**TABLE 4-4 Comparison of Physical Properties of Some Fuels**

Fuel	Density, kg/L	High Heating Value, kJ/L	Octane Number, <sup>a</sup> Average	Nominal Compression Ratio	Stoichiometric Air/Fuel Ratio, by Mass
Propane	0.509	25 640	111	8.4:1	15.7
Butane	0.575	28 430	98	8.0:1	15.5
Ethanol	0.784	21 200	111	9.0	9.0
Regular gasoline	0.733	34 560	93	7.4:1	14.7
Diesel, No. 1-D	0.823	37 630	—	16.6:1	—
Diesel, No. 2-D	0.847	39 020	—	16.6:1	—

<sup>a</sup>Research method employed.