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FORENSIC SCIENCE	PAPER No.5: Forensic Chemistry & Explosives
	MODULE No.18: Forensic Examination of Petroleum Products for Adulteration

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FORENSIC SCIENCE

PAPER No.5: Forensic Chemistry & Explosives

**MODULE No.18: Forensic Examination of Petroleum
Products for Adulteration**

1. Learning Outcomes

After studying this module, you shall be able to know

- What is Adulteration?
- What are the common Petroleum Adulterant?
- Indian Standard used for Quality Assurance and Control for Petroleum Products?
- How to pack petroleum sample?
- Preliminary Examination of Petroleum Adulteration.
- Instrumental Analysis of Petroleum Adulteration

2. Common Adulterants

In India, Adulteration of fuel is very booming, due to different price of product with similar concentrations. The dealers of fuel do this adulteration in order to make extreme profit from product ignoring the damages to vehicles and harmful effects to life of humans. For example when adulteration of kerosene takes place with petrol it can be very hazardous as it can be highly inflammable. The main effect of fuel adulteration is on vehicle that uses such adulterated fuel. This causes increase cases of tailpipe emission and hence cause engine knock.

The frequent blending of lubricant into kerosene, kerosene into petrol/ diesel and lubricant into diesel are very common type of petroleum adulteration.

Few common Solvent/Chemical used for Petroleum Adulteration is given in the Table.

Table -1

SBP	Naphtha
Food Grade Hexane	Hexane
Free kerosene	Resol
PDS kerosene	Raffinate/slop
C6-C9 raffination	Pentane
Pyrolysis gasoline	Oxygenated
Aromex	C9 Raffinate
Lomex	MTO

3. Legal Perspective

As per “THE MOTOR SPIRIT AND HIGH SPEED DIESEL” (PREVENTION OF MALPRACTICES IN SUPPLY AND DISTRIBUTION)_ORDER 1993 by Section 3 of Essential Commodities Act (E.C. Act)

Adulteration is the illegal addition of any foreign substance into motor Gasoline / high speed diesel.

Malpractices: it shall include the following acts of omission, commission in respect of motor spirit and high speed diesel:

- Adulteration
- Pilferage
- Stock variation
- Unauthorised exchange
- Unauthorised purchase
- Unauthorised sale

The person involve in malpractices of adulteration can be penalized under the Essential Commodities Act or under section 420 IPC and also under Petroleum Act 1934, unlawful possession, breach of contract, pilferage, etc.,

All Central/States/UTs Forensic Science Laboratories are authorized under Schedule III of Clause 8(5) of EC Act 1955 for testing of Petroleum Product Samples.

4. Various Indian Standards for Petroleum

The Indian Standard Specification for Motor Gasoline / Petrol i.e. **IS 2796/2000** Kerosene **IS 1459/1974** (reaffirmed in 1991) and Diesel **IS 1460/2000** are used to check the various technical parameters in compliance with quality control & assurance. The standards are also used as reference for checking the adulteration in petroleum products by various Central/State Forensic Science Laboratories and National Test House of India.

5. Sampling

The samples shall be taken in clean glass or aluminum vessels. One liter of sample is required for analysis, the vessel containing the sample must be sign and seal by authorized/competent authority.

6. Examination and Analysis for Adulteration

The following Parameters are generally test out during forensic examination Table No.2 of petroleum products.

Table No.2

Sl. No.	Property	Petrol	Diesel	Kerosene
1.	Density	710-770 kg/m ³ at 15 ⁰ C	820 – 870 kg/m ³ at 15 ⁰ C	0.78 – 0.82 g/cm ³ at 15 ⁰ C
2.	Colour (it varies from place to place)	orange dye (Phenyl azo 2-naphthol)	Yellow	Colourless (Regular Blue dyed (Di-alkyl amino anthraquinone) Kerosene for Public Distribution Supply) {PDS}
3.	Flash Point	<-21 ⁰ C	35 ⁰ C to 40 ⁰ C	37 ⁰ C to 65 ⁰ C
4.	Boiling Point	25 to 75 ⁰ C	250 to 350 ⁰ C	190 to 250 ⁰ C
5.	Thin Layer Chromatographic Solvent System (Hexane: Toluene: Acetic Acid [50 : 50 : 2])	Pink or Orange colour R _f Value 0.49 & 0.51	Violet	Blue colour spot at R _f around 0.4

6.	Filter Paper Test (Place two drops of Petrol on a filter paper)	Vanish without leaving any trace behind	Leave Patches	Leave Patches
7.	Ultra Violet Lamp	Chloranil spray reagent: brick-red.	Green/Yellow	Blue Colour
		Rhodamine Spray reagent: Greenish blue / violet coloured.		
8.	Cetane Number	5-20	40-55	NA
9.	Octane Number	90-92	15-25	NA
10.	Viscosity Test	The Viscosity is the property of its resistance to flow. Different units of viscosity are in use, based on a number of seconds taken for a specific and measured quantity of oil to flow in a standard apparatus (Canon Penske Viscometer) at a fixed temperature.		

7. Instrumental Analysis

The instrumental analysis of petroleum adulteration are done by the following scientific tool and techniques-

(a) High-Performance Liquid Chromatographic method (HPLC)

High Performance Liquid Chromatography (HPLC) was developed in the late 1960s and early 1970s. Today it is widely applied for separations and purifications in a variety of areas including pharmaceuticals, biotechnology, environmental, polymer and food industries.

HPLC has over the past decade become the method of choice for the analysis of a wide variety of compounds. Its main advantage over GC is that the analyses do not have to be volatile, so macromolecules are suitable for HPLC analysis. HPLC is accomplished by injection of a small amount of liquid sample into a moving stream of liquid (called the mobile phase) that passes through a column packed with particles of stationary phase. Separation of a mixture into its components depends on different degrees of retention of each component in the column. The extent to which a component is retained in the column is determined by its partitioning between the liquid mobile phase and the stationary phase. In HPLC this partitioning is affected by the relative solute/stationary phase and solute/mobile phase interactions.

High Performance/Pressure Liquid Chromatography unit incorporated with RP– C-18 column or any equivalent column variable wavelength UV detector fitted with integrator recorder.

Instrumental Conditions for Test:

Quantity of injection: 10ml of Petrol (P), Kerosene (K) and various (P: K) admixtures (liquid) samples each separately diluted 100 times with methanol.

Mobile phase: Isocratic solvent system of acetonitrile: water (8:2)

Flow rate: 1ml / min at ambient temperature

UV detection at 275nm, 285nm and 220nm.

Specific peaks at Rt 4.9, 6.2 and 8.0 +0.1 min were observed for naphthalene, 1-methyl naphthalene and 2,6 dimethyl naphthalene.

The peak height increased with the increasing percentage of kerosene in the (P: K) admixtures.

(b) Gas Chromatography:

This chromatographic method is used to detect the built on the discriminating affinity of components to the adsorbent materials. Making use of GS syringe the sample is introduced in the liquid/gas form into the injection port. At the injection port vaporization of sample takes place and passed through column with the help of mobile phase which is continuously in motion. Mobile phase is mainly H₂ that gets separated/detected at the detection port with suitable temperature programming. We visualize this on computer in the form of peaks.

The gas chromatography is a very robust tool for analysis of adulteration of petrol, diesel and kerosene. The instrument is calibrated first and then set the following setting for sample analysis-

- I. **Carrier gas:** Nitrogen
- II. **Flow rate:** 10 mL/min
- III. **Fuel gas:** Hydrogen
- IV. **Flow rate:** 25 mL/min
- V. **Air Flow rate:** 250 mL/min
- VI. **Injector Temperature:** 280°C
- VII. **Detector Temperature:** FID Detector 300°C
- VIII. **Oven Temperature:** 40°C Hold 2 minute

8. Summary

- Adulteration is the illegal addition of any foreign substance into motor Gasoline / high speed diesel.

Malpractices: it shall include the following acts of omission, commission in respect of motor spirit and high speed diesel:

- Adulteration
- Pilferage
- Stock variation
- Unauthorised exchange
- Unauthorised purchase
- Unauthorised sale

Adulterants like SBP, Food Grade Hexane, Free kerosene, PDS kerosene, C6-C9 raffination, Pyrolysis gasoline, Naphtha, Hexane, Resol, Raffinate/slop, Pentane, Oxygenated, PDS kerosene & MTO etc, are also in trend.

- Adulteration of Petroleum products are cognizable offence under Essential Commodities Act (E.C. Act) (Central Act 10 of 1955).
- **The standard like IS: 2796/2000** Kerosene **IS: 1459/1974** (reaffirmed in 1991) and Diesel **IS: 1460/2000** is used to check the various technical parameters in compliance with quality control & assurance.

- Only Glass/ Aluminum Containers are used to seize the petroleum sample.
- Container should be properly seal, packed and labeled by the competent authority only.
- Forensic Examination (Preliminary) of Petroleum Products for adulteration are based on the following type of characteristics:
 - Density
 - Colour (it varies from place to place)
 - Flash Point
 - Boiling Point
 - Thin Layer Chromatography (TLC)
 - Filter Paper Test
 - Ultra Violet Lamp
 - Cetane Number
 - Octane Number
- Forensic Examination (Confirmatory) of Petroleum Products for Adulteration are done by following Instruments:
 - HPLC
 - Gas Chromatography