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NOTE

Petrochemicals into Environment and Health Effects†

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Petroleum damages the environment due to its physical nature. Formation of petroleum, organic components of petroleum, chemical effect of oil (causes anaesthesia and narcosis and low b.p. aromatic hydrocarbons are toxic), and other polycyclic aromatic hydrocarbons are discussed in this study. Route of metabolism of aromatic compounds is the formation of areneoxides ingested in mammals inducing changes in the P-450 cystochrome enzymes (cited mainly in liver, but also in kidneys, lungs and intestines).

Petroleum causes harm to living organisms due to chemical reaction. It damages the environment due to its physical nature and impermeability to oxygen. Thus, when petroleum coats organisms, they die from asphyxiation. Contaminated areas of the environment suffer from oxygen depletion. Its hydrophobic properties are associated with chemical stability. Petroleum is a mixture of alkanes containing, on average, 1% by weight of aromatic hydrocarbons. The cumulative effects of the many minute spills that have occurred both on land and sea may be least as serious.

Formation of petroleum is largely found biogenetically from matter deposited in shallow seas and subsequently compressed by the overburden of deposited clays and shales. An intermediate coal-like material formed by bacterial action on the deposits is known as *Kerogen*. This may be formed by (i) algae, (ii) marine plankton, (iii) higher plants. H_2S, a typical product of organic decay, may also be formed.

Organic Compounds of Petroleum

1. Aliphatic compounds—methane, ethane and propane.
2. Alicyclic aromatic compounds—benzene, toluene, phenol, stearic acid, cyclopropane and cyclopentane.
3. Nitrogen compounds—pyrrole and pyridine.
4. Sulphur compounds—thiophenol, phenyl alkyl thioether, thiophene, benzothiopene, dibenzothiophene. According to boiling points the constituents of petroleum is divided as below.

Natural gas—methane, propane and butanes,

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Light naphtha—20–100
Heavy naphtha—100–150
Kerosene—150–235
Light gas oil—235–345
Heavy gas oil—345–565 (steam assisted)

Toxic effects of oil are of 2 types: (i) primarily physical, and (ii) chemical. Physical effects are caused by oil coating the organisms or their immediate environment. It can be seen on water birds that are covered with oil. The oil destroys the insulative capacity of feathers, reduces buoyancy in water and prevents flight. Oil film on organisms in surface or natural water reduces light transmission and hence photosynthetic primary production. Such films also retard oxygen uptake by water and lowers the D.O. and causes death of many organisms.

Chemical effects of oil upto octane, produce anaesthesia and narcosis in lower animals. Low boiling point aromatic hydrocarbons are more toxic, and their greater water solubility tends to enhance their distribution and uptake by aquatic organisms, *e.g.*, C_6H_6, $C_6H_5—N(CH_3)_2$, C_6H_8 and phenanthrene $C_{14}H_{10}{\cdot}C_6H_6$ inhibit blood cell formation in bone marrow all cause local irritation of respiratory system and depression of the central nervous system. Many compounds may be

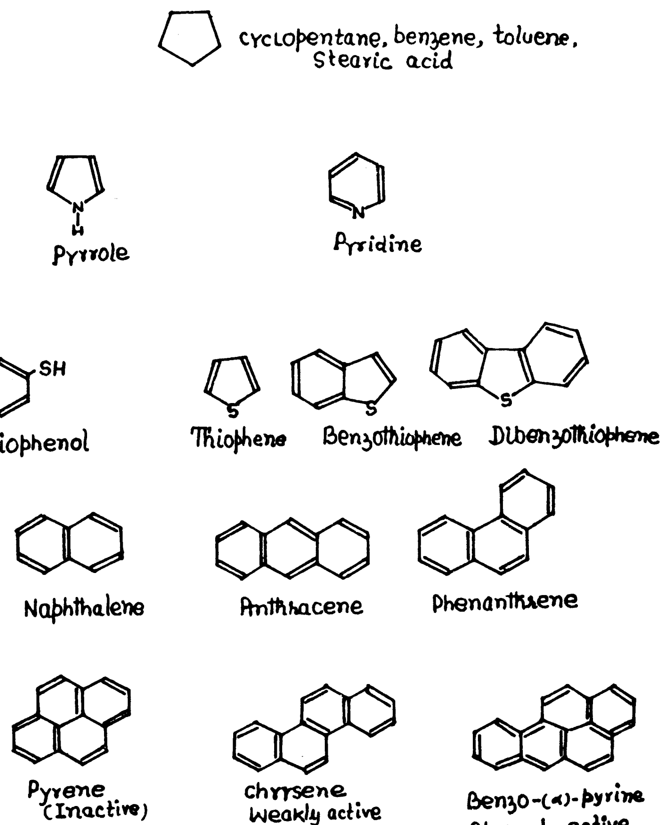

Fig. 1. Structures and activity of petrochemicals

mutagenic, carcinogenic or teratogenic. High boiling point or saturated and aromatic hydrocarbons may not exert much direct toxicity.[1] Detergents may be used to disperse the oil. This may give aesthetically satisfactory results. All detergents are toxic and facilitate uptake of oil by aquatic organisms. Further, they may cause oil on beaches to penetrate the sand more deeply thereby prolonging harmful effects on intertidal animals and plants.

Polycyclic aromatic hydrocarbons (PAH): Naphthalene, anthracene and phenanthrene occur in considerable amounts in natural fuel deposits and are formed during coking of coal and on pyrolysis of fossil fuels. Benzene homologues are given here. The level of activity is given alongside the structures in Fig. 1 Benzene-(α)-pyrene (Ba-α-P) is regarded the most dangerous of the group as it is widely distributed and strongly carcinogenic. In a test on the skin of mice, activity was noted at a dose level of 5.6×10^{-5} mol. Liver damage and keratogenicity were also observed in mice. Benzo-(e)-pyrene is much less active than its (α-) isomer. It is known that initiation requires the binding of the PAH to cellular macromolecules DNA, RNA or protein. A key step in the activation of benzo-(1)-pyrene is its conversion into the epoxide and that the ease of PAHs by free radicals is indicative of their level of activity. Oxidized derivatives of PAHs also occur in the environment. The recommended accepted level is 0.2 $\mu g/m^3$ which was always exceeded for coke oven workers. PAHs are formed by pyrolysis in petrol and light disel engines owing to the limited air supply. Aircraft engines typically emit 10 mg of BaP during each minute of operation. PAH enter the water body from fall-out from the above sources and also from run-off from bitumen treated roadways. PAHs are found in food either by deposition on leaves (lettuce) or from heated fats (sleak, sausage). Gas central heating in a non-smoking household genetates BaP in the range of 0.1–0.6 ng/m^3. For smokers these limits lie between 0.4 and 1.8 ng/m^3. 45 individual compounds in smoke were detected including some heterocyclic N-compounds such as carbazole. Number of methylated PAH were detected including several other methyl chrysenes at level upto 7 ng in cigarettes. The 5-methyl isomer is the most toxic to these isomers.

Principal route in metabolism of aromatic compounds is the formation of areneoxides which then isomerize to phenols.[2, 3] In mammals including man, ingestion of these substances induces changes in the P-450 cytochrome enzymes within the endoplasmic reticulum. This is mainly cited in liver, but also in the kidneys, lungs and intestine. Oxides of phenols formed in this way become conjugated with water solubilizing molecules and are then excerted.

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