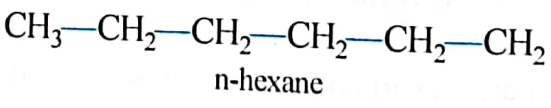
Oil Pollution

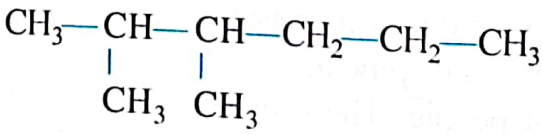
At present, annual consumption of refined petroleum products is more than 25 billion barrels (800 billion gallons). Obviously, such large-scale consumption is associated with some losses, intentional or accidental which pollute the marine environment. The total annual influx of petroleum hydrocarbons into the oceans is about 10 million metric tonnes (1 metric tonne = 2200 lbs). The bulk of this influx is due to transportation-related activities, mainly based on tanker operations. Oil tanker accidents which occur from time to time and are responsible for oil spill in the seas are narrated below (Fig. 12.3).

Crude petroleum is a complex mixture which contains hundreds of compounds belonging to the categories of paraffins (25%), cycloparaffins (20%), aromatics (5%) and naphtheno-aromatics.

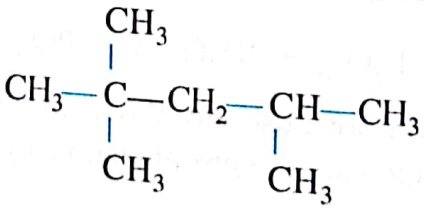
Paraffins



n-hexane



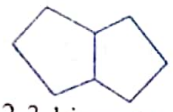
2,3-dimethyl hexane



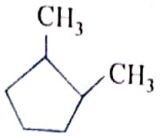
2, 2, 4-trimethyl pentane

Cycloparaffins

Cyclohexane



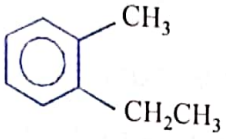
2,3-biocycloctane



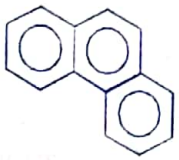
1,2-dimethyl cyclopentane

Aromatics

benzene

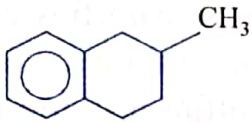


2-methylethyl benzene



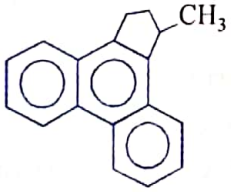
phenanthrene

Naphtheno-aromatics



2-methyl tetrahydronaphthalene

fluoreno



3-methyl dihydro-1-H-cyclopenta[1] phenanthrene

Fig. 12.3 Common types of hydrocarbons occurring in petroleum

Oil tanker accidents are of frequent occurrence which cause massive oil pollution in the seas. In 1967, about 100,000 tonnes of oil poured into the sea after the oil tanker, Torrey Canyon got wrecked on the Ollard Rock near Land End, England. The oil spill, which contaminated 225 km of Cornich coastline in England and to a lesser extent in Brittany (France), caused great concern in the region. In France, 600 naval and civil vessels, and hundreds of workers were engaged to clean the pollution. The accident compelled the international community to frame rigorous oil pollution control laws and stimulated lots of scientific research.

In 1977, a bigger oil spill occurred. The Amco Cadiz oil tanker lost its entire range of 223,000 tonnes of oil on the Brittany coast. In 1989, a still bigger oil spill was reported near *Alaska Coast*, which was well-known for serene ecology with rich wildlife and plenty of vertebrates, scallop and mariner mammals. The oil tanker, Exxon Vaaldez crashed on Prince William Sound in Alaska pouring 11 million gallons of oil into Alaska's waters. The US authorities swung into action to clean up the mess but they came under severe criticism. Even a New York state Supreme Court Judge commented that *a catastrophe of the dimension of Hiroshima had taken place*. This led to tighter US laws for oil tanker traffic in the seas.

Recently the world has witnessed three unprecedented *supertanker accidents* within two months (December 1992–January 1993). The first accident occurred near the northwestern coast of *Spain*. The second accident took place in the *Shetland Islands* area having rich wildlife, fisheries and birds. The oil spill dispersed due to stormy weather and the area became normal without much loss to the

environment. The third accident occurred in the *Bay of Bengal* to the south of the Andaman island when a Danish supertanker collided with an empty tanker and burst into flame. The giant oil spill spread over a wide area and advanced towards the Andaman islands. However, the major calamity was avoided because of the prevailing strong winds, high-temperature over the area and spraying of chemicals to break up the oil slick.

The 1991 *Gulf War* unleashed about 200 million gallons of oil in the Persian Gulf (100 times more than the normal oil spill in the region), which injured the marine ecosystem. Moreover, 700 oil wells burning in Kuwait over 10 months had disastrous effect on the environment (see Chap. 16.2).

Pathways of Oil Spill in Marine Environment and Impact on the Environment

In the marine environment, oil is transported throughout a region by wind, currents, waves and tides. It is subjected to various natural processes such as evaporation, dissolution, emulsification, oxidation, uptake by marine organisms and sedimentation. As a result of these complex interactions, the composition of oil changes continually.

The volatile compounds of oil (low boiling aromatics, paraffins cycloparaffins—12 or less C atoms) readily evaporate. Highly soluble aromatic hydrocarbons are removed by dissolution. Paraffins are readily degraded by bacteria—more resistant cycloparaffins and aromatic hydrocarbons disappear at a much lower rate.

Heavy oil residues that are not degraded or deposited on sediments end up as tar lumps or tar balls, washed into the beaches.

The overall effects of oil on marine organisms are: (a) direct lethal toxicity, (b) disruption of physiological or behavioral activities and (c) changes in biological habitats.

The soluble aromatic fractions of oil (C-10 or less) severely affect marine organisms. Adult marine organisms do not survive after exposure to 1 to 100 ppm of soluble aromatic—for larvae, the lethal dose is 0.1 ppm. Even sublethal dose (10 to 100 ppb) of these compounds disrupts chemical sensing and communication system of marine organisms. Oil and tar-coated beaches are anaesthetic. Birds are specially vulnerable to damage from oil-coating; they lose insulation as the insulative compounds dissolve in oil—hence they can freeze to death in winter.

Hydrocarbons even at low-concentration (ppb) may be ingested and then accumulate in marine plant tissues. In the process plant tissues may contain polycyclic aromatic hydrocarbons which are carcinogenic and the flavour of edible organisms is changed.