Marine Pollution

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Marine Pollution

The Earth's oceans are all connected. In the year 2000, there were four recognized oceans: The Pacific, Atlantic, Indian, and Arctic. In the spring of 2000, the International Hydrographic Organization delimited a new ocean, the Southern Ocean (it surrounds Antarctica and extends to 60 degrees latitude). There are also many seas (smaller branches of an ocean). Seas are often partly enclosed by land. The largest seas are the South China Sea, the Caribbean Sea, and the Mediterranean Sea.

The following table shows the approximate area of sea with their approximate depth.

Ocean	Area (square miles)	Average depth (ft)	Deepest depth (ft)
Pacific Ocean	64,186,000	15,215	Mariana Trench, 36,200 ft deep
Atlantic Ocean	33,420,000	12,881	Puerto Rico Trench, 28,231 ft deep
Indian Ocean	28,350,000	13,002	Java Trench, 25,344 ft deep
Southern Ocean	7,848,300	13,100–16,400	South Sandwich Trench, 23,736 ft deep
Arctic Ocean	5,106,000	3,953	Eurasia Basin, 17,881 ft deep

About 2/3 of the earth's surface is covered with water of oceans and sea. They are life sources for many plants and animals and playing a crucial role in the chemical and biological balance of life on the planet. But increasing pollution has not left them free from pollutants. Increase of these pollutants in such amount that conditions of sea changes physically, chemically and biologically is called Marine pollution.

The main cause of Marine pollution or sea pollution is discharge of waste substances into sea.

The habitats of marine mammals and fish have been degraded severely with pollution responsible for the mass deaths of fish, mammals and corals. Day-by-day increasing pollutants like organochlorine, pesticides, fertilizers, oils and a range of other toxic pollutants accumulates with in fishes and through them to man to cause reproductive disorders.

Pollution and warm ocean waters have also degraded coral reefs in several areas. Due to agricultural wastes run off and waste water; low oxygen dead zones are developed in coastal ocean waters. Excess N_2 has promoted the growth of algae, which promotes toxic organisms like cholera.

According to a rough estimate, about 12000 tonnes of lead, 17000 tonnes of copper, 70,000 tonnes of zinc, 8000 tonnes of arsenic, 900 tonnes of barium, 70000 tonnes of manganese, 6000 tonnes of chromium, 3800 tonnes of antimony, 17000 tonnes of iron, 7000 tonnes of mercury and 4600 tonnes of tin are discharged per year into the sea without any dilution.

The industrial wastes loaded with toxic substances such as acids, alkalies, pesticides, oils, varnishes, plastics, petro-chemicals, rubber, paints, and wastes of paper, soap, sugar, distillery, mine drainage, tannery, cyanides and radioactive substances pollute heavily causing fish killing in different coasts of different nations.

One of the commonest pollutants of the sea is raw or treated sewage. Over burden of these sewage cause prolific breeding of minute plants near the sea surface preventing the sunlight from reaching deep in the sea. As a result photosynthesis is either reduced or stopped in deep water plants and plants starts taking is O_2 and giving out CO_2.

Thus using up more oxygen they die in large amount and decomposed by bacteria, causing further decrease in oxygen level. As a result of this decrease in O_2 level, fish and other animals start to die. This complete phenomenon is known as **“eutrophication”**.

The pollution due to nitrogen, mainly from agricultural run-off and wastewater has almost tripled the occurrence of low oxygen dead zones in past 30 years.

Another major source for sea pollution is agricultural waste.

Many fertilizers like DDT tends to get more and more concentrated as taken by higher consumers of a food chain e.g., fishes, growing in sea water with 0.1 part of DDT per billions part of water will have about 57 mg. of DDT per kg of body weight in higher animals. Other pesticides such as aldrin, endrin and dieldrin are even more dangerous and not biodegradable like DDT.

DDT level increase to 800 mg/kg. for large fishes which feed on these fish. When such small fish migrate from one sea to other also affect there aquatic life where no farmers to make use of DDT.

Like fertilizers and pesticides other chemicals used for various purposes such as in fire extinguishers, coolants in refrigerator A.C. and in paints cause chemical pollution of sea. Like DDT their proportion increase we go up in the food chain.

In recent years the use of trisodium nitrilotriacletate (NTA) to make water soft and alkaline, in place of sodium tripolyphosphate, is increased. NTA is biodegradable but forms complexes with metals like Hg, Pb, Cd and As which are poisonous.

Chlorinated and hydrogenated hydrocarbons used for fire extinguishers, propellants and as solvents and PCB (poly chlorinated biphenyls) used in electrical insulation, coolant, paints and lacquers leaks about 25% into environment during transportation and application out of this 1/10th finds way in sea.

Causes of Marine Pollution:

(i) Oil Pollution:

The most important pollution of sea is oil. Hence we will discuss it here in details. Oil pollution of the sea normally attracts the greatest attention because of its visibility. There are several sources though which the oil can reach to the sea. Every year, approximately 3.5 million metric tons of the oil is released into the world’s oceans.

Sources of Oil Pollution:

Sources of oil input to the marine environment are often divided into natural, sea-based and land-based sources with four main categories of pollutants discharges through natural seeps, discharges during the extraction of oil, discharges during the transportation of oil, and discharges during the consumption of oil (including both sea-based and land-based sources).

These sources result in an estimated average of 706 million gallons of oil pollution entering our oceans each year. Of this, less than 10% is from natural seepage of oil from the ocean floor and eroding of sedimentary rock. The remaining 644 million gallons comes from human activities.

Offshore drilling, as a result of accidental spills and other operations, accounts for just over 2%. Large tanker spills, account for just over 5%. Air pollution from cars and industry accounts for just over 13% of the total, as the hundreds of tons of hydrocarbons land in our oceans from particle fallout aided by the rain, which washes the particles from the air.

Almost 4 times the amount of oil which comes from the large tanker spills, 19%, is regularly released into the ocean from routine maintenance, which includes boat bilge discharge as well as other ship operations.

By far, the greatest cause of oil in our oceans comes from drains and urban street runoff. Much of this is from improper disposal of engine oil. An average oil change uses 5 quarts of oil, which alone can contaminate millions of gallons of fresh water.

Crude oil from tanker accidents and offshore drilling is most likely to cause problems. Most people have seen the images of oil-coated animals and the large oil slicks surrounding the tankers after an accident.

The oil will spread over large areas often continuing to cause harm for many years. When quantities of surface oil are sufficient to coat animal fur and feathers, the animals cannot stay warm and will ingest the toxic oil while attempting to clean themselves.

Many of these oiled animals die as a result of ingesting these toxins. Many marine animals that do not die quickly as a result of the oil spill may develop liver disease and reproductive and growth problems because of ingestion.

Even very small quantities of oil will spread, floating on the surface of the water covering vast areas of water. These thin sheets can kill marine larvae, which in turn will reduce the number of marine animals.

(ii) Industrial Wastes:

Thousands of other pollutants also end up in the ocean. More than 2.8 billion gallons of industrial wastewater per day are discharged directly into ocean waters, excluding electric utilities and offshore oil and gas effluents. Heavy metals released from industry, such as mercury and lead, are often found in marine life, including many of those often consumed by humans.

The longer- lived, larger fish such as king mackerel, tilefish, swordfish and shark often contain harmful levels of the pollutant mercury, which can harm the developing brain and nervous system of children and fetuses. The chemical contaminants like pesticides, pharmaceutical agents, and biological contaminants like bacteria, viruses, and protozoa also found their way to sea.

Dioxins from the pulp and paper bleaching process can cause genetic chromosomal degradation in marine animals and may even cause cancer in humans.

PCB (polychlorinated biphenyl), which usually comes from older electrical equipment, typically causes reproduction problems in most marine organisms. Poly-aromatic hydrocarbons (PAH) are another source of marine toxic pollution and typically come from oil pollution and burning wood and coal.

Ship industry has caused a great deal of damage to sensitive marine environments. A typical 3000 ship passenger can produce 255,000 gallons of wastewater and 30,000 gallons of sewage every day. All of this waste is normally discharged directly into the ocean.

This waste can contain bacteria, pathogens, medical waste, oils, detergents, cleaners, heavy metals, harmful nutrients (nitrogen amongst others) and other substances. These substances can be brought back to coastal areas as well as cause serious damage to the aquatic life in the sea, including posing a risk for contaminating seafood.

Nitrogen compounds can also contribute to environmentally hazardous algae blooms. Typically 75—85% of the solid waste from a ship is incinerated at sea adding to sea pollution as the toxins and ash settles back into the ocean.

Once in 1985 at Haji port of Bombay, about 80,000 fishes are were found dead due to industrial effluents containing cyanide irons and mercury. Due to mercury-poisoned fishes, about 20,000 people in Japan fell sick and many died in 1978. The disease was given the name Minamata on the name of the city of Japan.

Similar diseases due to metallic poisoning have already been reported by France, Belgium, England, Holland, Pakistan, Bangladesh and Ceylon. The compounds of mercury are highly toxic. In aquatic environment mercury gets converted into methyl mercury which accumulates in fish cells and through them in human beings.

Industrial effluents often contain metallic compounds. For example, Halifax, a small city in eastern Canada, discharged into its harbor during the 1990s about thirty-three tons of zinc and thirty-one tons of lead per year, with lesser amounts of copper and other metals.

These metals are held in the sediment in a relatively inert from, but if stirred up into the water column, they become oxygenated and toxic. Tin is another common pollutant in harbors. It occurs as tributyltin (TBT), which is used as component of antifouling paints on the undersides of ships.

When taken up by shellfish, it accumulates in their tissues and has proved toxic to the shellfish and to organisms that consume them. The United States began to phase out TBT in 1988, and it will be banned internationally in 2008.

Industry also produces organic compounds such as polychlorinated biphenyls (PCBs) and various pesticides. These accumulate in the fatty tissue of plants and animals low in the food chain, and as they pass through the food web to larger and long-lived animals, there is an increase in concentration of the substances in their fat, a process known as bioaccumulation.

The St. Lawrence River, which drains the Great lakes, has accumulated large amounts of organochlorines, which have compiled in the tissues of Beluga whales. Many animals have tumors and disease. There is mounting evidence that chronic exposure to contaminants causes suppression of the immune responses of marine mammals. Similar problems have occurred with seals in the Baltic Sea.

Almost all rivers of the world are highly polluted and they carry the domestic sewage and mixture of industrial effluents into the sea without any treatment.

(iii) Agricultural Wastes:

Another serious type of marine pollution is nutrient pollution. This pollution is caused primarily from agricultural runoff that contains fertilizers and growth stimulants as well as from airborne nitrogen compounds that comes from automobile exhaust, industrial pollution and ammonia from manure. These cause eutrophic (over nutrient) conditions in coastal areas.

The main cause of eutrophication is excess nitrogen run-off from farm fertilizers, sewage and industrial pollutants. It reduces water clarity and depletes oxygen.

Reduced water clarity can starve sea grasses and algae that live in corals due to lack of light, which results in reducing their growth or killing them. While wind and waves aerate surface waters, the pycnocline layer acts as a barrier to oxygen exchange in bottom waters.

In major rivers, excess nutrients can be added as a result of fertilizer runoff, sewage, animal feed-runoff, or air pollution. The phytoplankton consumes these nutrients and oxygen which, in turn, causes a decrease in the amount of dissolved nitrogen and phosphorus in the water body. As the nutrients become depleted, the algae can no longer survive creating red tids.

The dead phytoplankton sinks to the bottom of the water column where they are consumed by decomposers. Since these decomposers break down the algae using dissolved oxygen. Resulting low oxygen levels can be detrimental to fish health; if dissolved oxygen drops to below 2 mg/1, mass fish kills can result.

This is known as hypoxia. The areas in which hypoxia has occurred are known as Dead Zones. Dead zones have been a factor in the Gulf of Mexico and Chesapeake Bay on the U.S. east coast, and are now spreading to other bodies of water, including the Baltic Sea, Black Sea, Adriatic Sea, Gulf of Thailand and Yellow Sea. There are now nearly 150 dead zones around the globe with some extending 27,000 square miles.

(iv) Marine Garbage:

Marine garbage disposal is another major form of ocean pollution. The world's oceans are a virtual dumping ground for trash. Sometimes the garbage includes fishing nets, plastics and household garbage.

Garbage in the oceans is a serious issue as fish entangle themselves in fishing nets and animals sometimes eat trash products and die. There are numerous examples of dolphins, sharks and whales entangling themselves in fishing nets and dying from oxygen starvation.

Marine garbage can often enter into animal gut; plastic pop tab rings accidentally strangle animals and so forth. Controlling this form of pollution is important to maintain a healthy ocean ecosystem.

Even simple plastic bags can have large pollutive impacts within the ocean. In one case, a deceased sperm whale was found to have a plastic balloon blocking its digestive system. The whale died from inability to process its food and died of starvation. Plastics can also have negative impacts to boats if they accidentally plug water intake lines.

(v) Sewage Disposal in Ocean:

Sewage is yet another major source of marine pollution. Typically, the problem with sewage is that it causes massive nutrient loading in the ocean ecosystem. Nutrient loading triggers algal blooms in the water leading to the loss of dissolved oxygen. After the depletion of oxygen levels, many organisms in the ocean die from being unable to breathe properly.

The waste water release due to washing our clothes, faces, dishes and cattle, is ultimately headed to the sea. This includes everything from our homes (toilets, washing machines, bathtubs, dishwashers and so forth), industrial effluents and even chemicals such as paints and fertilizers that we dispose of down the drains.

(vi) Marine Debris:

Marine beaches serve as natural traps for marine debris. Globally, the most common materials are plastics, followed by glass and metal. The chief dangers to marine life result from the ingestion of these fragments, which may block the gut, and from entangling, which may cause suffocation or prevent locomotion and feeding.

In a survey of U.S. beaches close to urban centers, cigarette butts were the most abundant debris, followed by packing items (boxes, bags, caps, and lids), medical waste, and sewage. A high proportion of this material reached the sea by way of sewers. Even street litter can be washed into surface drains and then to the sea.

The dumping of sewage and waste by ships is another source. Public revulsion at the state U.S. beaches was a key factor in the enactment of stronger environmental protection laws, like the Ocean Dumping Ban Act of 1988 that prohibited the dumping of sewage into the ocean. On sites more remote from cities, pieces of rope and netting are the most common types of marine debris.

Effects of Marine Pollution:

Apart from causing eutrophication a large amount of organic wastes can also result in the development of **'red tides'**. These are phytoplankton blooms of such intensity that the whole area is discoloured. Many important, commercially important marine species are also killed due to clogging of gills or other structures.

When liquid oil is spilled on the sea, it spreads over the surface of the water to form a thin film called and oil slick. The rate of spreading and the thickness of the film depend on the sea temperature, winds, currents, and the nature of the oil.

Oil slicks damage marine life to a large extent. Salt marshes and mangrove swamps are likely to trap oil and the plants, which form the basis of these ecosystems, thus suffer. For salt-marsh plants, oil slicks can affect the flowering, fruiting and germination.

If liquid oil contaminates a bird's plumage, its water-repellent properties are lost. Water then penetrates the plumage and displaces the air trapped between the feathers and the skin. This air layer is necessary as it provides buoyancy and thermal insulation.

With this, the plumage becomes waterlogged and the birds may sink and drown. Even if this does not happen, the loss of thermal insulation results in exhaustion of food reserves in an attempt to maintain body temperature, often followed by death.

Drill cuttings dumped on the seabed create anoxic conditions and result in the production of toxic sulphides in the bottom sediment thus eliminating the benthos fauna.

Fish and shellfish production facilities can also be affected by oil slicks. However, the most important commercial damage can come from **'tainting'** which imparts an unpleasant flavor to fish and seafood and is detectable even at extremely low levels of contamination. This reduces the market value of seafood.

Some other Effects of Marine Pollution are:

(i) Decomposition of organic matter causes a drop in dissolved oxygen, particularly in calm weather and sheltered bays. This can cause the death of marine plants and animals, and may lead to change in biodiversity.

(ii) Effluent, rich in nitrogen and phosphorus, results in **'eutrophication'** (over fertilization), which may cause algal blooms. These blooms can discolour the water, clog fish gills, or even be toxic, e.g., red tides. Microbial breakdown of dead algae can cause oxygen deficiencies.

(iii) Pathogenic microorganisms cause gastric and ear-nose-throat infections, hepatitis, and even cholera and typhoid. Filter feeding animals (e.g. mussels, clams, oysters) concentrate pathogens in their gut, so eating shellfish from polluted waters is a health risk.

(iv) Effects from industrial discharges in South Africa are generally limited to the area next to be discharge (the mixing zone). Water quality guidelines specify maximum levels of pollutants allowed in the receiving water.

(v) Oil spills prevent respiration in marine plants and animals.

(vi) In seabirds and mammals it can cause a breakdown in their thermal insulation.

(vii) Pesticides, such as DDT, and other persistent chemicals e.g., PCBs, accumulate in the fatty tissue of animals. These chemicals can cause reproductive failure in marine mammals and birds.

(viii) Ships often paint their hulls with anti-fouling substances, e.g., tributyl-tin or TBT, which prevents growth of marine organisms. These substances leach into water and, in high traffic areas such as harbors and marinas, can affect animal life.

(ix) Plastics kill many marine animals. Turtles, for example, often swallow floating plastic bags, mistaking them for jellyfish. Animals are often strangled when they become entangled with plastic

Policies to Protect the Marine Environment:

With the growing scope for national action, the need for regional action has also increased. Regional co-operation can be very cost effective in areas such as monitoring tanker traffic tracking down oil slicks, reinforcing inspection of ships, and providing mutual assistance in the case of emergencies.

Europe took a lead in this respect with the 1969 Bonn Agreement for the North Sea, the 1974 Agreements on the Baltic and on the North West Atlantic, and the 1976 Agreement on the Mediterranean Sea. More recently, it extended this lead with the revision of the Bonn agreement and the adoption of the Pairs Memorandum on Port State Control.

Action would be strengthened, however, if the authorities of a port state were in an effective position to initiate proceedings against tankers that discharge oil pollution into the economic zone of the port state or even into the economic zone of another state.

This is recognized in the new law of the Sea Convention. Regional co-operation could lead to agreements under which authorities in the states party to it would agree to assist each other in prosecuting tankers which violate international pollution prevention laws in their economic pollution prevention laws in their economic zones.

In effect, this would introduce the principle of non-discrimination, long advocated by OECD, into the field of marine pollution with violations of the law anywhere in the area being subject to prosecution in all ports of the area. It would greatly increase the effectiveness of measures taken by coastal states against ships that deliberately release oil at sea.

While the scope of national action and potential for regional action has increased, action at the international level remains vital. As oil is transported on a world-wide basis, most coastal states cannot reasonably impose measures on tankers visiting their harbors unless other states agree to do the same.

Moreover, oil transportation is to a large extent controlled by multinational corporations, and they can operate in various ways that make it difficult to pinpoint their liability, as the French authorities discovered with the amoco Cadiz.

Concerted international action started in 1954 with the **"Convention of the Prevention of Pollution of the Sea by Oil."** and this was followed by an impressive series of conventions negotiated mostly within the framework of the IMO.

International action has been successful because these conventions were ratified ultimately by most of the major shipping nations-although there are a few outstanding exceptions such as Greece, Panama, and the United States.

It is a slow process, however, it took 10 years for the 1973 Convention on the Prevention of Pollution of the sea to enter into force and when it did only two of its parts came into force and they affected only 68 percent of the gross tonnage of the world fleet.

Nevertheless, this Convention is very significant, because it deals with concrete techniques and measures to reduce oil releases to the sea. In particular, it provides for the creation of reception facilities, the operation tankers with segregated ballast and crude oil washing and the use of oil separators.

With its entry into force in 1983, one can expect to see a significant reduction in oil pollution of the sea stemming from routine operations.

The 1982 Convention on the Law of the Sea is potentially the most important Convention for protection of the marine environment. It gives a special role to the coastal states in protecting their economic zones. It also gives enforcement powers to the port states and the coastal states in case of pollution incident and also in case vessels violate applicable international rules and standards relating to seaworthiness.

Between 1969 and 1984, ship-owners liability was reduced fourfold because of inflation. In 1969, the liability of the owner of a new 210,000 grt tanker was 71 percent of the value of the ship: in 1983 it was only 27 percent Increasing the liability of ship-owners for oil pollution at sea would no doubt, help to keep down accidental oil spills.

The principles in the Law of the Sea Convention will need to be developed and enforced at the national level, and states in regions such as Western Europe or the North Sea will have to examine and as far as possible, harmonize legal and practical measures to better protect their economic zones.

Tanker traffic in Western Europe is nearly always in national waters and most of it goes to Western European ports. A number of important states may not ratify this Convention, but all states will probably find it desirable to adopt environmental policies that reflect their new rights and duties in their economic zones.

(i) Floating Particulate Petroleum Residues:

A geographical plot of the location at which samples of floating particulate petroleum residues were collected clearly reflects the contribution to MAPMOPP from national and regional programs of marine pollution monitoring.

These programs provided detailed data for the North Sea and Norwegian Sea, both coasts of North America and the seas around Japan. In addition, data were collected along several transects of the North Atlantic and in the mid-Pacific. On the other hand, very few samples were collected south of the equator.

(ii) Seas Around Japan and Southeast Asia:

The most detailed study of dissolved dispersed petroleum residues during MAPMOPP was carried out in the seas around Japan.

As was the case with the Mediterranean data, two sub-populations were present, and the general level of contamination as indicated by the higher one was 0.19p.g/. This is remarkably low for an area through which there is a very large volume of tanker and ship traffic and where the data for oil slicks and floating tar indicated that high levels of pollution were present.

The highest levels of contamination in this region were in the waters east of Tokyo and Yokohama and the Sea of Japan, Concentration in the South China Sea and in the Strait of Malacca were 0.17 and O.I3jag/l, respectively. The latter, in particular, as a surprisingly low level in view of the massive amounts of oil that are transported through this very narrow passage.

(iii) Indian Ocean:

Data for dissolved dispersed petroleum residues in the India Ocean were clustered around the coastline of India and along a single transect between the Strait of Malacca and South Africa. This set of data contained very few values below 10 ng/l. While some values exceeded 300 µg/l (GM = 8.9 µg/l).

This suggests either that this region was much more highly polluted than any other area of the world ocean or that the data are suspect. Nevertheless, there was a tremendous difference between the concentration of dissolved/dispersed petroleum residues along the west coast (GM = 86.4 µg/l) and those along the east coast (GM = 0.7 µg/l) of India.

This, presumably, is a consequence of the tanker lane that passes along the west coast of India and across the Bay of Bengal en route to the Strait of Malacca and of the monsoonal circulation of surface water in this area.

(iv) North Sea:

MAPMOPP data for the North Sea were collected at a group of stations in the North Sea oil fields and along lines of stations extending from Norway to the Shetland Islands and across the Skagerrak to Denmark. These data were unique in that 81 of the 90 values were reported as zero and the remaining 9 were reported as either 0.1 or 0.5 (J.g/1. consequently).

A rigorous statistical analysis was not possible, although the data suggest that the general level of contamination in the North Sea is remarkably low for a semi enclosed sea which is not only bordered by the most highly populated and industrialized countries of northern Europe but is also an area containing numerous offshore oil drilling platforms.

(v) Baffin Bay:

Most of the samples collected from Baffin Bay and Lancaster Sound contained dissolved/dispersed petroleum residues at concentrations less than 0.1 µg/l and none exceeded 1 µg/l.

Although this value was biased by many of the samples having been collected along the east coast of Baffin Island in areas where natural seepage of petroleum is known to occur the impact of this seepage on the water column is localized and has little effect on the levels of contamination in the region as a whole.

Furthermore, the surrounding land masses are only very sparsely inhabited, there is very little shipping and the sea is covered with ice during much of the year. Consequently, the major input of fluorescing non-polar organic compounds to this region is atmospheric fallout of polycyclic aromatic hydrocarbons produced from high temperature combustion of petroleum and other organic materials.

Therefore, Baffin Bay is one of the least polluted regions of the northern hemisphere, and the background level of dissolved/dispersed petroleum residues there can be taken as a baseline against which the levels of contamination in other areas of the world ocean can be compared.

(vi) North American East Coast:

The MAPMOPP data for the east coast of North America indicated that the general level of contamination in this area was 0.09 µg/l. It is noteworthy that the level of contamination in this area of concentrated fishing and active shipping should be the same as that observed in Baffin Bay.

(vii) Global Assessment:

MAPMOPP data for dissolved/dispersed petroleum residues were highly regional in character and so sparse over such enormous expanses of the world ocean that it is not possible to obtain a complete assessment of the levels of these substances on a global scale. Nevertheless, the data suggest some general trends.

Analysis of the data for the eastern hemisphere by 20° × 20° squares of latitude and longitude not only pointed out the paucity of the data but indicated an extensive area in the southwest Pacific where the level of contamination by dissolved/dispersed petroleum residues was around 0.1 µg/l, while somewhat higher concentrations were present in the waters adjacent to Japan.

Concentrations seemed to be remarkably low around Japan considering the amount of oil consumed in that country and were only slightly higher in the Strait of Malacca where tanker and other ship traffic converges while passing into the Pacific from the Indian Ocean.

Concentrations in the northern part of Indian Ocean were very much higher and reached 0.7 µg/l in the Bay of Bengal and along the east coast of India. The highest concentrations of all were found along the west coast of India where the geometric mean as 86.4 µg/l. Such high concentrations suggest that the water contained dispersed particles or droplets of oil from tankers that passed through the area.

Control of Marine Pollution:

The control of marine pollution is really a difficult task, since it involves national as well as international issues.

Several methods are used to deal with accidental discharge of oil, but as with all pollutants, the only effective measure for controlling contamination by oil of the aquatic environment is the prevention of avoidable spills and releases. Bioremediation is considered a useful tool in which macro organisms are used to degrade the oil that has spread over the large surface.

Cleaning oil from surface waters and contaminates beaches is a time- consuming and labor-intensive process. The natural process of emulsification of oil in the water can be accelerated through the use of chemical dispersants, which can be sprayed on the oil.

A variety of slick-tickers in which a continuous belt of absorbent to extract the oil have been designed. Rocks, barbor walls can be cleaned with high-pressure steam or dispersants after which the surface must be hosed down.

One way of reducing the pollution load on marine waters is through the introduction of sewage treatment plants. This will reduce the biological oxygen demand (BOD) of the final product before it is discharged to the receiving waters. Various stages of treatment such as primary, secondary or advanced can be used, depending on the quality of the effluent that is required to be treated.

(i) Primary Treatment:

These treatment plants use physical processes such as screening and sedimentation to remove pollutants that will settle, float or are too large to pass through simple screening devices. This includes stones, sticks, rags or any such material that can clog up pipes.

A screen consists of parallel bars spaced 2-7 cm apart followed by a wire mesh with smaller openings is used to separate these kind of pollutants. The polluted material collected on the screens is used in a device called a comminuter, which grinds the coarse material into small pieces.

After screening the wastewater passes into a grit chamber. The detention time is chosen to be long enough to allow lighter, organic material to settle. From the grit chamber the sewage passes into a primary setting tank (also called as sedimentation tank), where the flow speed is reduced sufficiently to allow most of the suspended solids to settle out by gravity.

If the waste is to undergo only primary treatment it is then chlorinated to destroy bacteria and control odors after which the effluent is released. Primary treatment normally removes about 35% of the BOD and 60% of the suspended solids.

(ii) Secondary Treatment:

There are three commonly used approaches:

Trickling filters, activated sludge process, and oxidation ponds. Secondary treatment can remove at least 85% of the BOD. A trickling filter consists of a rotating distribution arm that sprays liquid wastewater over a circular bed of **'fist size'** rocks or other coarse materials. The spaces between the rocks allow air to circulate easily so that aerobic conditions can be maintained.

The individual rocks in the bed are covered with a layer of slime, which consists of bacteria, fungi, algae, etc., which degrade the waste trickling through the bed. This slime periodically slides off individual rocks and is collected at the bottom of the filter along with the treated wastewater and is then passed on to the secondary setting tank where it is removed.

In the activated sludge process, the sewage is pumped into a large tank and mixed for several hours with bacteria-rich sludge and air bubbles to facilitate degradation by microorganisms. The water then goes into a sedimentation tank where most of the microorganisms settle out as sludge.

This sludge is then broken down in an anaerobic digester where methane-forming bacteria slowly convert the organic matter into carbon dioxide, methane, and other stable end products. The gas produced in the digester is 60% methane, which is valuable fuel and can be put to many uses within the treatment plant itself.

The digested sludge, which is still liquid, is normally pumped out onto sludge drying beds where evaporation and seepage remove the water. This dried sludge is potentially a good source of manure. Activated sludge tanks use less land area than trickling filters with equivalent performance.

They are also less expensive to construct than trickling filters and have fewer problems with flies and odor and can also achieve higher rates of BOD removal. Thus, although the operating costs are a little higher due to the expenses incurred on energy for running pumps and blowers, they are preferred over trickling filters.

Oxidation ponds are large shallow ponds approximately 1-2 m deep, where raw or partially-treated sewage is decomposed by microorganisms. They are easy to build and manage, accommodate large fluctuations in flow, and can provide treatment at a much lower cost. However, they require a large amount of land and hence can only be used where land is not a limitation.

(iii) Advanced Sewage Treatment:

This involves a series of chemical and physical processes that removes specific pollutants left in the water after primary and secondary treatment.

Sewage treatment plant effluents contain nitrates and phosphates in large amounts. These contribute to eutrophication. Thus, advanced treatment plants are designed to specifically remove these contaminants. These plants are very expensive to build and operate and so are rarely used.