

BIOCHEMOPHYSICAL ALTERATIONS OF SPILLED OIL ON WATER.

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ABSTRACT

Oil on water whether from point or non-point sources can be visibly observed floating with the ocean current in mix-colour patches referred to as oil slicks. Its presence on the water surface inhibits the passage of sunlight needed for photosynthesis and also prevents diffusion of gases into the water. These often lead to suffocation and subsequent death of marine organisms in the immediately affected area. Petroleum oil entering the ocean undergoes a variety of physical, chemical and biological processes which determine its distribution and fate.

INTRODUCTION.

The behaviour and disappearance of spilled petroleum oil on ocean water is controlled principally by the following process:

Spreading: This occurs immediately the spilled oil reaches the water surface. The extent of spread is determined by some environmental factors such as water temperature, wind, wave action, thickness of oil, its degree of dispersion (Torrey Canyon 1970) and nutrient levels (Conney et al 1985).

Dissolution: Most components of the spilled oil are soluble in water. Their solubility decreases with increasing molecular weight. Formation of oil-in-water emulsion occurs and these are sometimes transported to the shore by wave action.

Evaporation: The low boiling fractions of the spilled oil evaporates leaving the oil in a viscous hydrocarbons which constitute more than 40% of the mature petroleum, as such evaporative losses are usually quite remarkable (Goldberg 1975).

Photo-oxidation: The viscous oil exposed to radiant energy is photo-oxidised in the presence of oxygen. This process changed the viscous oil to a weathered state (tarry particles). Wave action and storms breaks the weathered oil into particles and lumps which can either float or sink to the ocean bottom.

Sedimentation: There is aggregation of tar particles into larger lumps. When the density of the lumps exceeds that of water, they sink to the sea floor. Sedimentation can also take place in the presence of dead organic matter and clay minerals. Tarry lumps can easily be attached and be absorbed by these surfaces.

Biodegradation: Marine bacteria are capable of degrading some components of the weathered oil. The rate of microbial degradation varies with the chemical complexity of the hydrocarbon, the microbial population and some environmental conditions (Floodgate 1973).

These processes singly and in combination contributes to the degradation of the spilled oil into tarry lumps (tar balls). The floating tar (having densities less than seawater) is

subjected to several oceanographic processes that transport it to the beach. These processes include longshore current velocity, wind speed and direction, wave height, breaker wave type, wave period and occasional storm tides. The magnitude of these processes for Ibeno beach have been investigated by Enyenihi and Antia (1985) and Asuquo, (1991). Tar sizes collected for the Ibeno beach range from less than 1mm to 8.5cm (Asuquo, this issue).

CASE STUDY: TAR ON IBENO BEACH

Spilled petroleum oil on the beach is reddish-brown but tar balls (weathered crude) is black. There are world wide reports of tar balls stranded on the beach (Golik 1982, Oostdam 1984, Golik 1985, Robertson-smith et al 1985, Okonya and Ibe 1985, Njock and Ikome 1985, Golik et al 1987).

The intertidal zone is the most visible portion of the marine environment during low tide. Stranded tar balls can be seen clearly where they have been deposited. They are usually scattered horizontally and parallel to the water line. The level, abundance and distribution of tar on Ibeno beach have been reported (Enyenihi and Antia 1985, Enyenihi et al 1989, Asuquo, (this issue). The amount of stranded tar balls collected were greatly influenced by some geomorphological features such as beach profile (flat), sandy textures (fine-grained), existence of rivulets/creeks, formation of temporary scarp heights (due to swash action of waves), accretion processes and others.

Antia and Nyong (1986) have reported that the spilling breaker waves dominate and aid the distribution and deposition of tar on the Ibeno beach. The accumulation of tar on this beach was more pronounced when there was flushing of oil storage tanks by the oil companies than at other times. During such operations, about 2-4 meters stretch of the intertidal zone (vertical) was covered with the tar residues. Tar balls formed from tank flushing can be easily identified and differentiated from tar obtained from spill in the open ocean. They were very numerous, tiny and soft, accumulating few meters away from the point of discharge. They were fragmented due to the continuous impact of breaker waves on the oil at the point of entry into the ocean. The Ibeno Atlantic coast has semi-diurnal tide. Thus, the residence time for most of the tar was one tidal cycle after which they were carried away by the swash action of waves.

Stranded pelagic tar were sometimes buried by sand due to accretion process generated by wave action about 2cm below the surface. The accumulation of sand usually takes place during the dry season and in the rainy season the buried tar residue may be released if it had not melted under the impact solar radiation.

EFFECTS

Floating oil strains the water surface with coloured patches (films). Oil films on sandy beaches percolates into the sediment where it comes in direct contact with the infauna. Their presence in large amounts causes the mass extinction of intertidal marine organisms thereby littering the beach with the shells and skeletons of these organisms.

The unpleasant effect of the tar balls and spilled oil includes soiling and fouling of the beach, coats and stains the legs and feathers of sea birds, damage to food resources of higher organisms including man and hinders the regular use of the beach for recreational activities like tourism.

Oil on the beach may affect organisms not only at the time of spill but through the release of oil from an oil-contaminated sediment even several months after the spillage. Apart from creating an esthetic insult, the littering of the beach by tar balls and shells of dead organisms hampers the use of the beach for economic purpose. This in itself appears to be the primary impact of petroleum residue (tar balls) upon the public.

CONCLUSION AND RECOMMENDATIONS

The pollution of the marine environment by petroleum oil and its degraded products is an inevitable consequence of our dependence on oil-based technology. Losses during exploration and exploitation of oil is almost impossible and marine pollution is magnified

through anthropogenic inputs. Spilled oil and tar balls are commonly observed floating on the oceans and their sources can only be traced through proper chemical analysis of the oil or tar sample using modern analytical instruments such as Gas chromatography/mass spectrophotometer (GC/MS) equipment.

Spilled oil in water does not only originate from broken pipelines and offshore production activities but may be added through oil seepages, marine operations, sabotage, accidents involving ships carrying oil and many others. The oil in water undergoes physical, chemical and biological changes resulting in the formation of semi-solid residues called tar balls.

Floating tar balls, though lighter than water does not only stay at the water surface but storms, uptake by organisms and adsorption by clay and allied minerals sink the tar to the bottom. Because of their ubiquitous nature, they can also be transported by wave action to the shore.

Solution to the environmental problems caused by oil spillage requires a socially aware explorationist that is mindful of the impact that negligence or carelessness on his part will cause the environment, the oil company and society at large. Since anthropogenic inputs are the primary causes of enhanced level of crude oil in the water, precautionary measures must be taken to eliminate or reduce equipment failure and human error to the barest minimum.

Recently efforts at solving the problems inherent from oil spillage involves the cleaning up of oil spillages through the establishment of Clean Nigeria Associates (CNA), Nigerian Environmental Society, Women Environmental Action Group and the formation of the Federal Environmental Protection Agency. Though a laudable act, it is always better to protect than to administer cure. The question is: If there are environmental and safety departments or policies on environmental safety in our oil companies, how efficient and reliable are these departments in the performance of their duty? How long does oil pipelines stay before they are changed realising that they are constantly being subjected to corrosion and over-pressure. Is there any effective and routine checking of hoses, control valves and proper functioning of the equipment to avoid equipment failure?

There is need for the oil companies to generate environmental consciousness among their technical staff. Such measures should include regular seminars and workshops to stress the effect of crude oil on the environment and its associated economic losses. Effective supervision of each production step until the oil is finally deposited in the storage tanks should be a routine affair. It must be realised that once oil is on the water it becomes difficult and expensive operation to remove it, since oil spreads rapidly from the point of accidental release into the immediate environment.

On the other hand, the public must be scientifically enlightened on the merits and demerits of an oil-base economy such as ours, through environmental education jointly organised by Nigerian National Petroleum Corporation (N.N.P.C) and Federal Environmental Protection Agency (FEPA).

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