Combating Oil Slicks

By A Husain

THE most sophisticated world technology with enormous investment has come into action to clean up the worst ever oil spill during the recent Gulf war.

The volatile fractions of the oil which constitute around 40 per cent of the oil, go through various processes of degradation, and thus about half the total quantity of oil is converted into tar balls which keep floating on the water surface.

A great deal of effort continues to go into various clean-up and control methods for removing the remains of oil and its products in the water. Of these mechanical and chemical methods are the most commonly employed.

The mechanical clean-up involves removal of oil or oiled debris by bulldozing or hosing with water under pressure. This technique is mostly employed in the intertidal zone.

Offshore oil spills rarely are suitable for mechanical clean-up, except by surface steamers or possibly the cropping of oiled kelps using mechanical aquatic weed cutters. Neither of these methods is very likely to have serious adverse effect on the environment. However, the problem becomes more serious in the intertidal zone, largely due to physical disruption of habitats.

Rocky coastlines present the least problem in terms of clean-up. Oiled rocky surfaces are cleaned most often either by flushing, steam cleaning and blasting or manual scraping.

None of these methods is likely to alter the substrate to any extent, and the main damage is limited to removal of fauna and flora. The biological recovery process may take several years, but nevertheless, recovery will occur. As the settling surfaces are usually not chemically or physically altered to any great extent in the clean-up process, the only limitations to recovery are biological ones.

The release of stranded and flushed oil into the water column may pose some problems. The problem becomes greater with the oiling of finer grained sediments such as cobble-boulder beaches or the fine silt sediments of lagoons and marshes. Because of the penetration of oil into such sediments, removal of oiled sediments often accompanies clean-up.

Excessive removal may result in the disturbance of physical and ecological equilibrium. Large-scale removal of beach sediments can often lead to retreat or back shore (cliff) erosion.

Pebble-cobble beaches present a particular problem in that the oil is likely to penetrate rapidly and deeply. Thus, if clean-up is at all advised, it should involve large-scale removal of the beach material with heavy machinery. Another physical consequence of excessive sediment removal is that of habitat alteration, which in turn leads to long-term ecological perturbations.

Clean-up of lagoons and coastal marsh systems such as salt marshes and mangrove swamps presents problems in that both the physical habitat and biological composition are easily damaged. In such cases, natural cleaning may frequently be the most effective, appropriate and the least damaging option. However, cosmetically it is the least appealing. Some progress is now being made in studies on replanting marsh vegetation and mangroves in oiled and cleaned sediments.

A serious problem with mechanical clean-up is the ultimate disposal of oiled debris, including oiled sea weeds, sediment and shoreline material. Thus an understanding of both the physical and ecological environments is necessary for the development of efficient effective and least damaging counter measures.

The use of chemicals to control and clean up oil spills is an alternative to mechanical removal of the oil, especially in the case of spills in offshore and polar regions. However, it is worth mentioning that the chemical methods dealing with tar balls are hazardous and can cause environmental problems. Therefore, it is a subject of concern and debate.

A wide range of chemical means have been tried on oil slicks. These include sinkants, gelling agents, herders, chemical dispersants and deemulsifiers. Of these, the last two have been the most widely used. Sinkants were used widely during the early days of pollution, for example during the Torrey Canyon Spill. Deemulsifiers are now used extensively in petroleum production systems, to some extent on "mausse" slicks and for transfer of collected oil to storage systems. Except for sinkants, use of these agents in the filed has been limited.

The use of chemical dispersants first gained international prominence following their use at the Torrey Canyon Spill, which remains controversial. The formulations, essentially mixtures of chemical surfactants and stabilizers in a carrier solvent, are especially designed to reduce the inter-facial tension between oil and water, and break up the oil slick into smaller droplets. These droplets can then be distributed into the water column by natural actions of surface and surface turbulence.

Much of the chemical dispersants' notoriety stems from the high toxicity of early formulations as well as improper application techniques used at the spill site. The high acute toxicity of such products was primarily due to the carrier solvents (aromatic hydrocarbons) and not the dispersant surfactants themselves.

Several modifications have been brought out in this regard to reduce the toxicity level and to develop specific formulations. Also no evidence of damage due to the use of dispersants has been reported from the places where they were used commonly in oil slick control.

More studies are required on this aspect of oil pollution. However, it is quite significant that the use of chemical dispersants simply represents the introduction of yet another contaminant into the marine environment.

It is not man alone who acts on the oil slicks to contain them. Nature too plays a role, with the petroleum introduced into the marine environment going through various stages of physical, chemical and biological transformations during its transport by advective and spreading processes.

Advection and spreading begin immediately after introduction of petroleum into the ocean and cause a rapid increase in the exposure area of the oil to subsequent "weathering" processes. These include evaporation, dissolution, vertical dispersion, emulsification and sedimentation.

Evaporation is responsible for loss of one-third to two-thirds of an oil spill mass in a period of few hours or a day. This causes considerable changes in the chemical composition and physical properties of the oil.

The rate of loss through evaporation from a given volume of oil depends on the area exposed, the oil phase component vapour pressure, the oil air mass coefficient and the possible presence of diffusive barriers such as water-in-oil emulsion or a "slick" on the oil surface.

The rate of evaporation from a thick, cold slick under calm conditions is be slower than from a thin, warm slick under stormy conditions. Hydrocarbons may evaporate from true solution in surface water quite rapidly, often with half lives of an hour or less. In the case of high molecular weight hydrocarbons of low solubility, most may be in colloidal or accommodated form and are not immediately available for evaporation.

Dissolved hydrocarbon concentrations are particularly important because of their potential toxic effects on biological systems. Most of the dissolved hydrocarbons are the more soluble, low molecular weight aromatics such as benzene, toluene and xylenes.

As the oil evaporates, these hydrocarbons are removed : Thus the oil solubility drops and the dissolution rate falls to a negligible value. The most soluble hydrocarbons, which are also the most volatile, are likely to be preferentially removed by evaporation.

The lifetime of an oil slick on an ocean surface is often controlled by the dispersion or vertical transport of small particles of oil or oil-in-water emulsions into the water column.

Dispersion also results in exposure of subsurface marine organisms to particulate and dissolved oil. These organisms, in turn, may mediate the sedimentation of some of the oil through incorporation into fecal pellets.

Breaking or surface turbulence waves probably cause the oil to be driven into the water column, thus forming a swarm of oil droplets. The larger particles rise and coalesce with the slick, while the smaller oil droplets are conveyed with water eddies vertically downward to become permanently incorporated into the water column. These smaller droplets, which do not rise to the surface, and their associated water medium are referred to as an oil-in-water emulsion.

Heavier crudes with high viscosities are in general found to form more stable emulsions and the presence of asphaltenes and higher molecular weight waves have been found to be positively correlated with mousse stability. The products of photochemical and microbial oxidation have also been identified as having an important role as stabilising agents. In several instances, mousse could only be formed with photochemically or microbially weathered oils which were also subject to evaporation or dissolution processes.

About 25 per cent of the oil spill evaporates, in the gaseous state, are oxidised photochemically by hydroxyl radicals and other oxygen species in a few hours or a day to carbon monoxide, carbon dioxide, oxyenated organics and "secondary" aerosols. Photochemical oxidation of some of the petroleum components can be induced by sunlight.

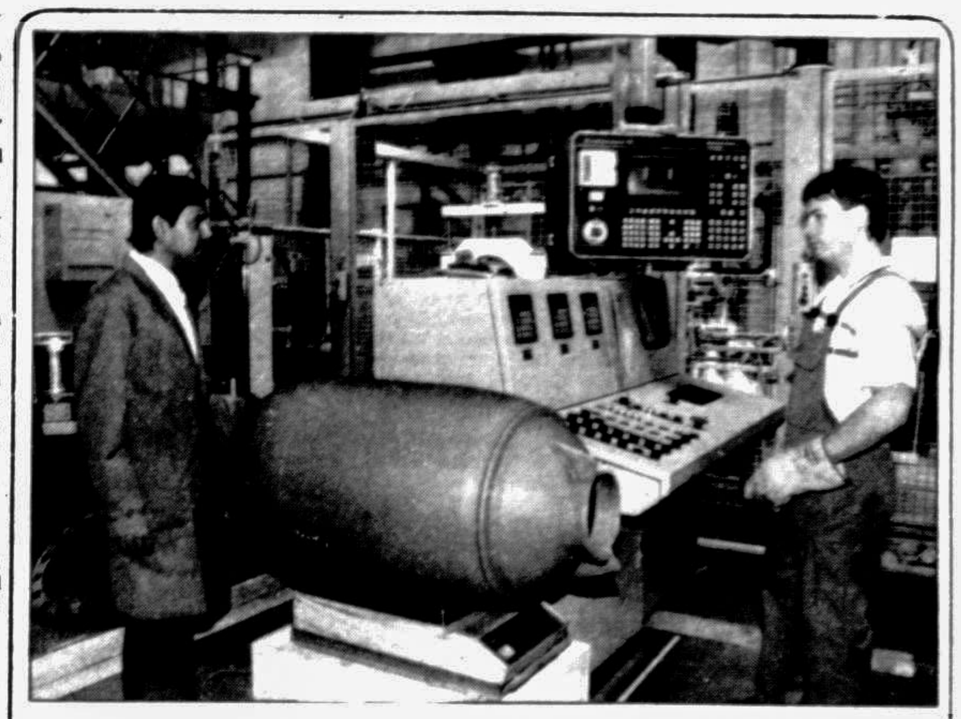
Dark or auto-oxidation may also occur, producing hydrocarbon fractions and reaction products which are introduced into the atmosphere, slick and tar lumps on the surface of the ocean, dissolved and particulate hydrocarbon materials in the water column and similar components in the sediments.

While physical and chemical processes are occurring, biological processes also act on the different fractions of the original petroleum in various ways. These include degradation of petroleum by micro-organisms to carbon dioxide or organic components in intermediate oxidative stages, uptake by larger organisms and subsequent metabolism, storage or discharge.

The biodegradation of petroleum is one of the principal mechanisms for removal of petroleum from the marine environment.

The various compounds differ widely in terms of their biodegradability. Thus alkanes, alkenes and the simple or monoaromatics are biodegraded quite readily, but tars and resins are virtually impervious to biological attack.

The pathways used for biodegradation of petroleum tend to fall into two distinct approaches : That used by bacteria and that by the eukaryotic invertebrate and vertebrate systems. Micro-organisms (bacteria, yeasts and fungi) are important in the degradation of petroleum on surface films, slicks, the water column and sediments. Phytoplankton may degrade hydrocarbons in the water column, followed by excretion of what is apparently unmodified oil in the feces. Benthic invertebrates such as polychaetes, which normally play an important part in the oxidation and recycling of sediment organic matter, also have a significant role in the degradation of sediment-bound oil.



Bangladesh Engineer Specialises in Plastics in Germany

BONN: "As far as plastics technology is concerned, the Germans are undoubtedly the best in the world", stated Md. Ghulam Rabbani, a mechanical engineer from Bangladesh in a reference to the training programme he was undergoing in Germany under the auspices of the Carl Duisberg Society (CDG) in a bed to catch up with the most modern techniques prevalent in the industry and act as a "multiplier" back home, reports INP.

Rabbani, who holds a Bachelor of Science degree from the Bangladesh University of Engineering and Technology, Dhaka, has several years of experience at Dhaka's Plastics Technology Centre — a former United Nations project and now run by the Bangladesh government — in his 16-month assignment in Germany.

Flagged off by a 5-month German language programme at Dortmund and Saarbrucken, the 34-year old mechanical engineer got his first look into the evolving world of plastics technology at Suddeutsche Kunststoff Zentrum (SKZ) in Wurzburg where he spent three months early in the year mapping out an individual programme in the industry.

The Bangladesh engineer is presently engaged in receiving intensive training in blow-moulding machines and in the processing of blow-moulded products at Battenfeld Fischer Balsformtechnik Gmbh in Troisdorf near Bonn.

'Killer Bees' Get a Bad Press

Scientists are trying to convince the American public that the African bee is not really a killer but a victim of a form of character assassination. Mario de Cautin of IPS reports.

AFRICAN bees have got a bad press in America, and apiarists are out to set the record straight.

The bees were first imported from Africa by a Brazilian bee breeder, but were accidentally set free. They have now spread throughout South America and some swarms have worked their way up to the Mexican-U.S. border.

Mexican entomologist Miguel Gonzalez Nanno says the African bees have actually increased honey production and says the "killer" label is unfair because there are other more venomous animals like vipers and scorpions.

He traces the history of the African bees and says the term 'killer bees' was a form of "political revenge" taken by the former military regime in Brazil against the University of Sao Paulo's Prof Warwick Kerr, a renowned biologist, geneticist and entomologist.

In 1952, Kerr imported 140 queen bees from Tanzania to cross them with another variety that was more productive and more resistant to diseases. In 1957, a beekeeper removed the double protection of an experimental apiary, setting 26 colonies of African bees free.

In 1964, when the insect started multiplying in Brazil but had not yet spread to the rest of Latin America, the regime of Gen Humberto Castelo Branco began using the term 'killer bees' extensively.

The reason was simple, explains entomology professor Robert Mores of New York's Cornell University, who is an expert on African bees and Kerr's co-worker in Sao Paulo.

Kerr had criticised the junta and clashed with the military governor of Sao Paulo. He was detained twice for protesting the torture of an nun and aggression against striking railway workers.

Dangerous reptiles maim and kill more people in Brazil every year. But reporters backing the dictatorship hyped poison insect bites, blaming them on killer bees and on Kerr even though many victims were actually stung by wasps.

Every year, about 24,000 people die from viper bites in Africa's western coast while 30,000 are bitten in Mexico, and an average of 130 cases are fatal. Some 100,000 Mexicans are stung by scorpions annually, 940 of whom die as a result.

There are no confirmed figures on deaths caused by African bees since their arrival in Latin America 34 years ago, but the number of people fatally stung by them was much less than those who died from scorpion bites.

Reports on the number of victims of African bees in Mexico vary.

The Mexican Institute of Social Security says 13 people died since the bees arrived in the country in 1986 to March 1991, but experts from the agriculture ministry reported 40 cases.

"This contradiction shows it is very difficult to prove if these people died from bites of African or European bees, which are equally poisonous," says Gonzalez Nanno.

A young, healthy person can take 30 to 100 bites before losing consciousness, while a malnourished child, an allergic adolescent or an old person with heart or respiratory problems could die from half a dozen bites.

Both types of bees attack only when disturbed, but the difference lies in their response. European bees attack in groups of 20 to 30, chasing the victim for about 50 metres and causing irritation that lasts two to three hours.

African bees, on the other hand, attack in swarms of 1,000 to 2,000. Sometimes an entire colony of 50,000 bees chases the victim up to 400 metres, and the sting lasts up to 24 hours.

Gonzalez Nanno said the African bee has genetically developed a strong defence mechanism against people and animals that destroy their hives to get honey.

African bees have invaded 23 of Mexico's 31 states, and the first swarm of 'killer bees' appeared in the US state of Texas in October 1990.

Watchout ! The Microbots are Coming

by C. Chitti Pantulu

ARMIES of microchip robots with inbuilt guidance and control systems will soon takeover from cumbersome and expensive, conventional robots in factories across the world.

Scientists in several western countries are racing against time to develop this special class of 'gnat-robots' which could probably contain a primitive insect-like intelligence of their own to avoid obstacles and hazards.

While this might appear like science fiction, recent successes in micromachining technology promise to make microrobots a reality in the near future.

Scientists at MIT's Artificial Intelligence Laboratory are reported to be planning such singlechip and other kinds of miniature robots which no longer conform to the traditional idea of a robot.

These microbots are just one possibility that micromachining technology has thrown open. More uses are being discovered by the day for micromachined devices which promise to revolutionise fields as varied as medicine to everyday use domestic appliances and auto-airconditioners.

Interest in micromachining in the past few years has highlighted on development of processes which can be applied to make tools, sensors, manipulators and robots on a microscale. The attempt has been to develop micro-systems that can do what large-scale electromechanical systems cannot do as well or as cheaply.

For micromachining, high precision silicon processing technology has been found to be the most suitable as it is amenable to the mass production methods of IC assembly lines.

Once again, for similar reasons of numbers, chemical etching is prefered for sculpting this silicon into the desired shapes.

While the first generation micromachined devices include structures which are sculpted on the silicon base itself, the second generation micromachines are produced by surface machining involving selective etching to form free-standing micro-structures.

The next generation of micromachined devices, scientists feel, would combine integrated systems of microelectronics and mechanical components.

In the bulk micromachining of silicon, a three dimensional structure is formed combining photographic pattern definition, etching and bonding.

The basic dimensional limits of micromechanical structures, which range from the size of a biological system to the atomic level, has been a subject of much speculation.

Presently, finished elements of approximately one micron have been achieved in laboratories. Using photolithography, researchers can go down to 0.5 or 1 micron exposure sizes to make a gear that is 10 microns wide with 2 microns wide teeth.

The most common micromachined devices today are found in commercially available ink-jet printers which use micro-nozzles that allow rapid and accurate placement of ink droplets on paper to form alphabets. This technology was developed by IBM. Similar nozzles are also used to bend gas molecules in nuclear reactors.

At the same time, efforts are on to make a tiny gas chromotograph, the heart of which is composed entirely of finely etched grooves and channels on a single chip, for measuring gas emissions at hazardous waste sites.

Conventional gas chromotograph equipment is fairly large. Micromachining technology now makes it possible to have gas chromotograph machines much smaller than a briefcase.

However, the most significant contribution of micromachining could be to the medical sciences. The technology promises to make possible a low airflow sensor which can measure differential pressures from either 0 to 0.2 or 0 to 2 inches of water full scale, and air flow rates as low as 1 cm cube per minute. This equipment is being tried out in medical respiratory — related functions and commercial building controls. These airflow sensors are also being talked of for future use in automotive airconditioners.

There is also talk of micromachined devices such as a pair of microminiature scissors and buzz saws for delicate microsurgery such as scraping away fatty deposits from arteries which can revolutionise treatment of heart ailments. Microminiature electronic pills that can be implanted in humans and animals to dispense a precise amount of medication are the other possibilities.

A micromachined insulin pump with a sensor to detect glucose levels promises to provide much needed succor to diabetics.

However, what is more significant is that scientists at University of Michigan are reported to be developing micro-probes for the human brain to study selective brain cells. This throws up immense possibilities for epilepsy patients who can be implanted with these probes.

One the other hand, with micromachining developing further, there is now scope for domestic appliances such as VCRs and tape recorders to become smaller.

In 1988, scientists are reported to have demonstrated a 'bare bones' electrostatic micromotor about 0.003 inches in diameter with teeth about the size of red blood cells.

As components shrink, many forces, such as centrifugal forces, become less troublesome. However, other aspects such as air drag and friction are still taxing researchers. Air, which causes no concern in an ordinary motor, attains the of properties of molases to a motor of 60 micron size. It will have to overcome this viscous drag to move fast. Problems like this are still to be studied.

Development of such motors is what has made the dream of 'gnat robots' achievable. Scientists are hopeful that they will be able to develop all tools needed to build a microbot. Motors or other actuators, encoders to tell position, force sensors, m to arms and gears and systen to route power and signals in and out of these robots are some of the aspects which will have to be perfected.

However, even after developing these systems, one problem still remains. How to interface these microsystems with the macroworld? Needless to say, scientists are hard at work to overcome this problem too.

Mr. C. Chitti Pantulu is a PTI Reporter based in New Delhi

Move to Return Human Remains to Places of Origin

A body of knowledge lies in the vaults of Britain's museums and medical colleges — in fact, thousands of bodies. They are human remains procured for the study of racial science over three centuries.

Other than a few ancient English, Scottish, Irish and Welsh remains, most came from former colonies during the years of the British Empire.

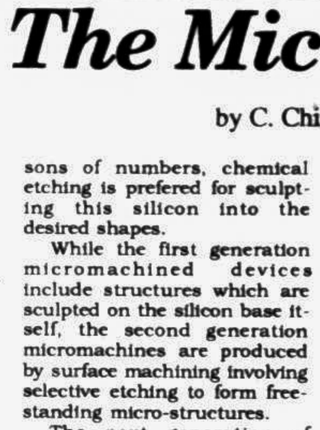
Some remains are still being used — most recently for DNA molecular research — but movements are growing in some Commonwealth countries to have them returned. Those seeking to repatriate the remains seem certain to face a stiff challenge.

Anatomists are resisting demands from indigenous communities in Commonwealth countries for the remains since they fear a landslide of such claims from other groups.

Said Dr Paul Turnbull, a historian at the James Cook Museum in Queensland, Australia, who has studied the methods by which anatomists acquired human material : "The big problem now is that scientists have seen that by extracting DNA, they can do interesting work into scientific variations (of racial development).

"Their fear is that this new, and what seems to be a very fruitful powerline of scientific research, is going to stop".

CHARLES DARWIN
His theory spurred Victorian anatomists to study skulls



TRUGANNINI
The last Tasmanian. Museum skeleton is mounted like an ape

In Britain, Labour Party MP Bernie Grant and other politicians are promoting the idea of reclaiming the remains and returning them to their homelands as a step towards righting the wrong of plundering that went on for years of colonial occupation.

The comparison of various racial groups and the search for human origin began in the 18th Century. English surgeon John Hunter amassed 17,000 human specimens before his death in 1793. People would talk of the "Big Kettle" he used to boil down human heads to get to the skull.

The study of human skulls, craniometry, emerged as a science in its own right by the 1840s, and European museums sought to acquire their own human collections. By the 1860s, when Charles Darwin's theory of evolution was in vogue, English anatomists formed their own society dedicated to the investigation of the "zoological diversity" of the races.

Said Turnbull : "Scientists wanted to obtain a clear picture of intellectual and physical differences between the world's peoples, and this entailed the procurement of specimens."

Prominent institutions and individuals began to treat the various corners of the British Empire as hunting grounds for specimens of an exotic type.

"All of the teaching hospitals at that time enjoyed close links with medical practitioners, government surgeons and navy and army surgeons who had been trained through that college, so that material of an interesting nature — as far as racial science was concerned — would come back to the institution in which these people were trained," said Turnbull. Material would be sent back to Britain by doctors, surgeons and interested individuals posted in the colonies.

Scientists of the time had simple notions of racial types : "They wanted to isolate and explain, as accurately as possible, racial differences, to establish distinct racial boundaries."

These differences would, it was hoped, answer questions such as where populations came from, by matching up their characteristics with those of other groups. "For example," says Turnbull, "did the American Indians come from Asia? If they did, what part of Asia?" It was hoped that it would be possible to reconstruct the past movements of populations across the globe.

The collections in Britain fall into two categories. First, the large amounts collected by the medical institutions which had links with colonial medical officers. These were used for research. The other type were those given to museums purely for display and teaching purposes.

By placing human remains on public display in a colonial context, these much smaller collections probably had a bigger role in creating the concept of recial stereotyping.

The display of human beings from particular races in museums, along with staged photographs taken at the time, tended to portray non-Europeans as curiosities.

Witness the display of Truganninni, the so-called "last Tasmanian", in a museum in Australia. Says Paul Turnbull :

"If you look at the way the skeleton is actually set up you will find that it was mounted in such a way that there is emphasis on the 'primitive' characteristics : the way the skeleton is mounted emphasises a sort of leaning over, and the forearms are out as one might expect of a large ape while walking. The assumption being that the Tasmanian is such a low type of humanity that it bore greater resemblence to the higher order of apes than the European did."