

## STATUS OF OIL POLLUTION ALONG THE INDIAN COAST

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The Arabian Sea and the Bay of Bengal have been estimated to annually receive around  $5 \times 10^6$  and  $4 \times 10^6$  t/y petroleum respectively from routine discharges from oil tankers and other ships plying the shipping lanes originating from the Middle East (Hinrichsen, 1990). This estimate appears to be exaggerated and needs re-examination since, the total input of oil to the World oceans is considered to be  $2.145 \times 10^6$  t/y (Clark, 1992). Consequently, tar balls and oily residue are a common sight on many beaches of countries including India, bordering the Indian Ocean. Further, damage to coral reefs of Andaman and Nicobar Island due to coating with oil residues has been reported (Sengupta *et al.*, 1995). With the consumption of petroleum products in India increasing from  $5.5 \times 10^7$  t during 1990-91 to  $8.8 \times 10^7$  t during 1997-98 and domestic production remaining

nearly stagnant at around  $3.3 \times 10^7$  t/y, it has become inevitable to increasingly import crude oil and its products thereby exposing the coastal segments to oil pollution (Zingde, 1999). Moreover, accelerated efforts in offshore oil prospecting in several areas of the continental shelf of India further enhance the vulnerability of the coastal zone to oil induced degradation.

Although tanker accidents and other accidental as well as intentional discharges of oil at sea are highly visible, the municipal and industrial wastewaters are considered as prominent local sources of hydrocarbons contributing to the contamination of the sea (NRC, 1985). Their entry to the sea is much less conspicuous because they are released in small concentrations though more or less continuously. In contrast with dramatic short-term effects of episodic large-scale releases, the impact of such continuous contamination of oil on biota is chronic.

### CONCENTRATIONS IN WATER

Several investigations have been conducted in the seas around India to evaluate the levels of petroleum hydrocarbons (PHc) in water. The available information is summarized in Table 1:

Table 1

Location	PHc ( $\mu\text{g/l}$ )	Standard	Reference
West coast of India	120 – 2440 0.6 – 41.6	Heavy furnace oil Arabian crude	Sengupta <i>et al.</i> , 1978 Fondekar and Alagarsamy, 1984
Central West coast of India	16.8 - 42.8	Saudi Arabian Crude	Fondekar <i>et al.</i> , 1980
Northern Indian Ocean	0.6 – 26.5	Saudi Arabian Crude	Sengupta <i>et al.</i> , 1980
Bay of Bengal	0.8 – 5.2	Saudi Arabian Crude	Sengupta <i>et al.</i> , 1980
Andaman Sea	28 – 83	Arabian crude	Topgi <i>et al.</i> , 1981
Bay of Bengal	1.1 – 67.7	Arabian crude	Topgi <i>et al.</i> , 1982
Bombay High, Mumbai	0.01 (av)	Chrysene	Ram and Kadam, 1991a
Ports along the West Coast of India	7.5 – 87.7	Saudi Arabian Mix crude	Kadam and Bhangale, 1992
Arabian Sea along the Indian Coast	1.8 – 8.7	Saudi Arabian Crude	Sengupta <i>et al.</i> , 1993
Mumbai coast, intertidal	0 – 93.5	Saudi Arabian Mix crude	Ingole <i>et al.</i> , 1995
Great Channel, Andaman	0.32 – 1.85	Saudi Arabian Crude	Sengupta <i>et al.</i> , 1995
Kakinada Bay	1.6 – 14.8	-	Sharma <i>et al.</i> , 1996
Visakhapatnam Harbour	11.5 – 123.8	-	
Visakhapatnam Harbour	108 (av)	-	Mohan and Prakash, 1998
Harbour area of Chennai	11 – 139	Arabian crude	Selvaraj <i>et al.</i> , 1999
South Maharashtra coast	1.7 – 3.7	Saudi Arabian Mix crude	Chouksey 2002
Around Mumbai	3.9 – 39.2	Saudi Arabian Mix crude	Chouksey 2002

Sengupta *et al.*, (1978) reported very high and variable values of PHc along the oil tanker route and the Bombay High region. Exceptionally high levels of oil and grease (3.8 – 20.0 µg/l) have been recorded in the Dock waters of Mumbai Port (NEERI, 1985), while, Kadam and Bhargale (1992) found much lower levels of PHc (7.5 – 87.7 µg/l) in selected ports including the Mumbai Port, along the West coast of India. The high PHc concentration of 3348 µg/l was recorded in the coastal waters of Murud, near Mumbai, after a major oil spill in the Bombay High area that, under the prevailing tidal currents and winds, preferentially drifted towards the Murud coast (NIO, 1993). Sengupta *et al.*, (1995) reported levels of 0.32 – 1.85 µg/l in the surface water of the Great Channel (Andaman Sea), 15 d after the disaster of the Danish Tanker VLCC Maersk Navigator.

### ACCUMULATION IN SEDIMENT

The table 2 compiles the levels of PHc in marine sediments at some locations along the Indian coast

Table 2

Location	PHc (µg/g)	Standard	Reference
Central West coast of India	4.8 – 9.4 (dry wt)	Saudi Arabian Crude	Fondekar <i>et al.</i> , 1980
Arabian Sea along the Indian coast	4.4 – 12.4 6 – 5.8 (dry wt)	- Saudi Arabian Crude	Fondekar 1987 Sengupta <i>et al.</i> , 1993
Off West Coast of India	0.4 – 0.2	Chrysene	Ram and Kadam (1991a and b)
Mumbai High	0.01– 0.09 (wet wt)	Chrysene	Ram and Kadam (1991a and b)
Mumbai beaches	2.9 – 10.3 (wet wt)	Saudi Arabian Mix crude	Ingole <i>et al.</i> , 1995
Cochin estuary	249 – 570 (dry wt)	Bombay High crude	Nair <i>et al.</i> , 1995
Elliot Beach, Chennai	4 – 11,059	Saudi Arabian Mix crude	Selvaraj <i>et al.</i> , 1999
Off Bassein	2.2 (av; wet wt)	Saudi Arabian Mix crude	NIO 1999
Off Mumbai	1.2 (av; wet wt)	Saudi Arabian Mix crude	NIO 1999
Gujarat Coast	< 0.5 (av; wet wt)	Saudi Arabian Mix crude	NIO 1999
Gujarat Coast	ND – 20.7 (dry wt)	Saudi Arabian Mix crude	Chouksey 2002
Maharashtra coast	0.9 – 42.8 (dry wt)	Saudi Arabian Mix crude	Chouksey 2002

Table 3

Location	Species	PHc (mg/g)	Standard	Reference
Central-west coast of India	Plankton	19.5 – 83.3 (dry wt)	Saudi Arabian oil	Fondekar <i>et al.</i> , 1980
Arabian Sea along Indian coast	Zooplankton	10.0 – 107.5 4.5 – 144.7 (dry wt)	- -	Fondekar 1987 Sengupta <i>et al.</i> , 1993
Mumbai beaches	Mollusks	2.7 – 406 (dry wt)	Chrysene	Fernandes 1991
Northwest coast of India	Johnius glaucus	0.8 – 6.1 (wet wt)		
	Coilia dussumieri	1.0 – 9.6	Chrysene	Mehta <i>et al.</i> 1994
Visakhapatnam	Bivalve	186	Chrysene	Mehta <i>et al.</i> 1994
			-	Mohan and Prakash
Around Mumbai	Shellfish	1.8 – 10.8 (wet wt)	1998	
Mix crude			Saudi Arabian	Chouksey 2002

The above table indicates wide variations in the PHc levels in the sediment of the marine area of India with high level of contamination in the Cochin estuary (Nair *et al.*, 1995) perhaps due to large-scale port activities. High PHc content of the Elliot Beach was due to an oil spill that affected the area on 12 November 1995 (Selvaraj *et al.*, 1999). Rokade *et al.*, (1989) reported PHc level as un-saponifiable residue of 76 – 336 and 41 – 301 µg/g (wet wt) in Thane Creek and Bombay Harbour respectively.

### BIOACCUMULATION

Except for a few reports given in the table 3, not much information is available on the levels of PHc in marine organisms along the Indian coast :

These results indicate that the levels vary considerably and no trends are discernible.

## DISTRIBUTION OF TAR BALLS

Oil residue in the form of tar balls is commonly observed along the Indian beaches. These were first reported by Nair *et al.*, (1972). Since then many studies have been conducted on deposits of oil residues on the beaches around India (Dwivedi and Parulekar, 1974; Dhargalkar *et al.*, 1977; Oostdam, 1984; Kadam, 1988; Ramamurthy, 1991; Sengupta *et al.*, 1995; Kadam and Rokade, 1996). A total of 1000 and 750 t of tar ball deposition was estimated on the West coast of India during 1975 and 1976 respectively (Dhargalkar *et al.*, 1977; GESAMP, 1993; Glasby and Roonwal, 1995). Ramamurthy (1991) suggested that about 6,000 to 7,000 t of tar residues were generated annually along the West coast of India. The available information on tar deposition along coasts of India is compiled in table 4:

Dwivedi and Parulekar (1974) observed that the tar deposition on beaches varied considerably with highest deposition of 4,480g/m<sup>2</sup> on the beach at Sinquerim, Goa in pre-monsoon season. Density of deposition of 247.1 and 28.5 g/m<sup>2</sup> on High Tide Line (HTL) and Mid Tide Line (MTL) respectively has been reported along the Ratnagiri coast while, the density was high (759 g/m<sup>2</sup>) at HTL at Deogarh beach during July 1972. Tar deposition was higher along the west coast than the east coast and the tar deposits were more during monsoon and pre-monsoon seasons. However, Dhargalkar *et al.*, (1977) failed to notice any deposition along the Ratnagiri beach during 1975 and 1976. Reddy and Singbal (1973) collected some tar like materials from selected beaches along the East and the West coasts of India and analysed them for water, sand, oil, total S, asphaltene, waxes, V and Ni. Based on the results these workers inferred that the source material of tar they sampled was Aghajari

crude oil. Kadam (1988) investigated tar pellets from the Veraval beach (Gujarat) during 1984 to identify suspected source on the basis of IR spectra, GLC fingerprint patterns and wax and asphaltene contents.

Sengupta *et al.*, (1995) assessed the fate and immediate as well as long term impacts of oil spilled after an accident of Maersk Navigator (January 1993), on marine environment in the Great Channel (South Andaman Sea). Kadam and Rokade (1996) collected tar residue from Mumbai beach after collision of a cargo vessel "Puppy-P" in July 1989 and based on the ratios of UV absorbances and IR transmittances as well as their GLC fingerprint patterns concluded that the spill from the vessel was the probable source of the beach residue.

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Table 4

Location	PHc (g/m <sup>2</sup> )	Reference
Goa beaches	3.2 – 375.0	Nair <i>et al.</i> , 1972
East coast of India	5.9 – 138.7	Dwivedi and Parulekar 1974
West coast of India	1.9 – 4480.0	Dwivedi and Parulekar 1974
West coast of India	0.5 – 32.8	Oostdam 1984
West coast of India	0.03 – 3.5 (pelagic tar)	Sengupta 1991
Gujarat coast	0.7 – 2375.0	Dwivedi <i>et al.</i> , 1974
Arabian sea along the Indian coast	0 – 0.005 (floating tar)	Sengupta <i>et al.</i> , 1993
Andaman Sea	Nil	Sengupta <i>et al.</i> , 1995
Central West coast of India	0.01 – 3.5	NIO 1996
Mandwa beach, near Mumbai	1.2 – 2230	Chouksey 2002
Uran beach, near Mumbai	22.5 – 1187.5	Chouksey 2002

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