

## Source identification of a tar residue from Mumbai beach

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Received 10 November 1995; revised 26 April 1996

A tar residue from Mumbai beach was matched with the suspected source sample from a tanker using UV, IR and GLC techniques. Negligible differences in several ratios of UV absorbances and ratios of infrared transmittances of the samples as well as their superimposable GLC fingerprint patterns indicated that the beach tar might have originated from the tanker.

It was reported that a tanker "Puppy-P" collided with a cargo vessel on 28<sup>th</sup> June 1989 in Arabian Sea 1200 km off Indian coast spilling 5000 t furnace oil. The damaged tanker when entered the coastal waters 33 km off Mumbai on 4<sup>th</sup> July 1989 further spilled a small quantity of oil. On following days heavy tar deposition was noticed along Mumbai coast from Worli to Colaba. Therefore, attempts were made to match a beach sample (BS) with the suspected source sample i.e. tanker sample (TS) using some analytical techniques.

BS was collected on 6<sup>th</sup> July 1989 and the extraneous material such as sand was removed manually from it. TS was supplied by Mercantile Marine Department, Mumbai. Beach sample (BS, 2.6 g) was dissolved in CH<sub>2</sub>Cl<sub>2</sub> (50 ml), dried over anhydrous Na<sub>2</sub>SO<sub>4</sub> and filtered. The solvent was evaporated from the filtrate to obtain a semisolid residue, bp $\geq$ 115°C, yield 1.1 g (42%). TS (3.2 g) was also processed following the same procedure to get a brown semisolid residue, bp $\geq$ 117°C, yield 3.1 g (97%). The samples were scanned on Perkin Elmer Lambda 5 UV/VIS spectrophotometer for UV spectra (190-300 nm). Infrared (IR) spectra of the samples were scanned in the range 4000-600 cm<sup>-1</sup> as thin liquid films in NaCl discs on infrared spectrophotometer (Perkin Elmer 983 G). Gas liquid chromatography (GLC) of the samples was performed<sup>1</sup> on Perkin Elmer Sigma 2000 gas chromatograph using a FSOT column (length 40 m, internal diam 0.25 mm) with methyl silicon liquid phase (Perkin Elmer, Part No. 0092348) and a flame ionisation detector (FID). Nitrogen (100 ml min<sup>-1</sup>) with inlet split ratio of 1:70 was used as the carrier gas. Column temperature was programmed (100°-

300°C) at the heating rate of 10°C min<sup>-1</sup>. The detector and the injector temperatures were maintained at 350°C.

A preliminary study for identity of the samples was done<sup>2</sup> comparing ratios of UV absorbances (RUA) obtained at 240 and 256 nm wavelengths which correspond to alkenes, cycloalkenes and hydrocarbons containing more than one ethylenic double bond, and one and two ring aromatic hydrocarbons respectively<sup>3</sup>. They were 1.73 and 1.77 for BS and TS respectively indicating resemblance in composition of the unsaturated

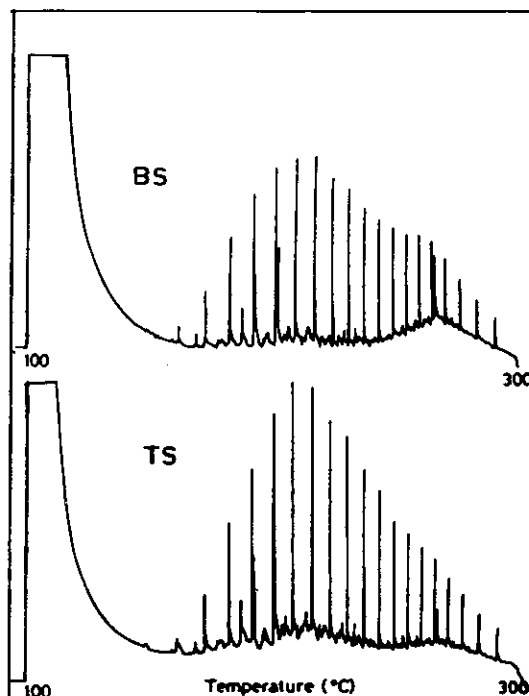


Fig. 1—GLC fingerprint patterns of beach sample (BS) and tanker sample (TS)

Table 1—Comparison of ratios of IR transmittances (RIT) of beach sample (BS) and tanker sample (TS)

| Wavenumber<br>(cm <sup>-1</sup> ) | Ratio |      | Difference |
|-----------------------------------|-------|------|------------|
|                                   | BS    | TS   |            |
| 720/1375                          | 1.09  | 1.07 | 0.02       |
| 1600/1375                         | 1.14  | 1.14 | 0.00       |
| 1600/720                          | 1.04  | 1.07 | -0.03      |
| 810/1375                          | 1.22  | 1.19 | 0.03       |
| 810/720                           | 1.11  | 1.12 | -0.01      |

hydrocarbons. Ratios of IR transmittances (RIT) at several wavenumbers<sup>4</sup> chosen on the basis of general hydrocarbon nature of oil samples were calculated from IR spectra of the samples (Table 1). Negligible differences in corresponding ratios of the two samples (Table 1) and their superimposable spectra patterns indicated good analogy between them<sup>5,6</sup>. In this study signals at 3050 cm<sup>-1</sup> were insignificant for both the samples<sup>3</sup>. Gas liquid chromatograms (GLC) of the samples (Fig. 1) were the characteristic patterns which consist of sharply resolved peaks representing straight chain saturated aliphatic hydrocarbons (paraffins) and an envelope of unresolved complex mixture (UCM) along the baseline<sup>7-9</sup>. The envelope revealed presence of naphthenes or alicyclic hydrocarbons where some or all the carbon atoms are arranged in a ring and aromatic hydrocarbons present in trace quantities.

The typical patterns known as "fingerprint patterns" which generally originate from a crude residue were observed to be the superimposable patterns<sup>5,7,8</sup>.

The data indicate that BS has resemblance with TS and BS might have originated from TS i.e. cargo of the tanker.

Authors are thankful to Dr M D Zingde for valuable suggestions.

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