Fate of the Prestige oil and its residues in the water column

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1. Introduction

The fate of accidental spills to great depth in the open ocean is still unknown. There is a big ignorance in relation to the physical and chemical behaviour of spills in the ocean, specially when it is a complex chemical mixture as crude oil, and the processes involved in its dispersion in the water column. Nowadays, there is not any model that simulates the behaviour of petroleum in a depth higher than 1000 m and there is a lack of understanding of the physical properties that control the fate of a mixture of hydrocarbons under water (Yapa and Li, 1997).

Some environmental conditions, like density, due to salinity, temperature and pressure, can play a major role in the possible transformations of the original oil by means of dispersion and dissolution, in its way to the surface (Yapa and Li, 1997).

In order to asses the dissolution potential of the fuel oil in the different water masses overlaying the wreck, we have carried out laboratory experiments simulating density conditions of the sinking area.

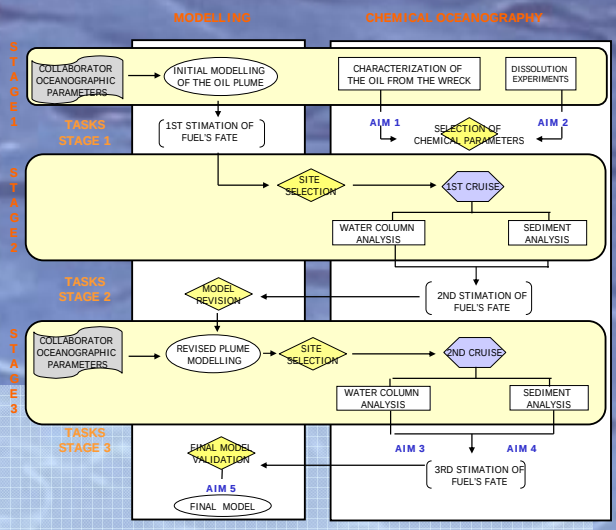


Figure 1. Chronological work plan of the FATEFUEL project.

2. The Sea Water Soluble Fraction (SWSF)

- More toxic for the biota than emulsioned or adsorbed fraction: bioaccumulation (Robotham and Gill, 1989)
- Enriched with low molecular weight PAHs and high molecular weight polar compounds (Ziolli and Jardim, 2002).
- Lack of standard procedure for its preparation
- Key factors that affect its composition (Ziolli and Jardim, 2002):

Salinity | **Temperature** | **pH** | **Oil composition** | **Mixing rate and time** | **Ratio fuel: water** | **Pressure**

3. Hydrodynamic characteristics of the sinking area

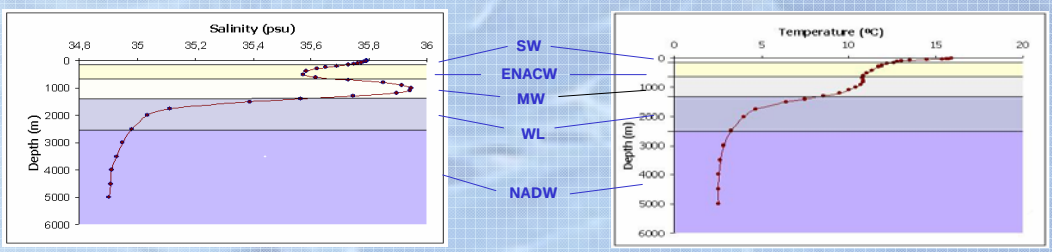


Figure 2 . Salinity and temperature of different water masses in the sinking area (HidroPrestige 0303 expedition, 2003).Salinity and temperature data have been obtained from World Ocean Atlas 2001.

Water masses

SW Superficial Water

ENACW Eastern North Atlantic Central Water

MW Mediterranean Water

WL Water from Labrador

NADW North Atlantic Deep Water

4. Experimental

PREPARATION

Seawater prefiltration → Fuel addition (1:500, v/v) → Ultrasonication (30 min) → Settling down (48 h)

	High temperature 20 ± 1 °C	Low temperature 3°C
High salinity 38 ppt	Experiment 1	Experiment 3
Low salinity 33 ppt	Experiment 2	Experiment4

Figure 3.Seawater dissolution treatments.

Figure 4 .The dissolution apparatus. Adapted from Ali and Mantoura,1995.

Sampling → Filtration (0,22 µm pore) → SI → LLE (DCM) → Concentration → GC/MS

ANALYSIS

LLE: Liquid-Liquid extraction SI: internal standard

5. Preliminary results

5.1.Compound identification and quantification

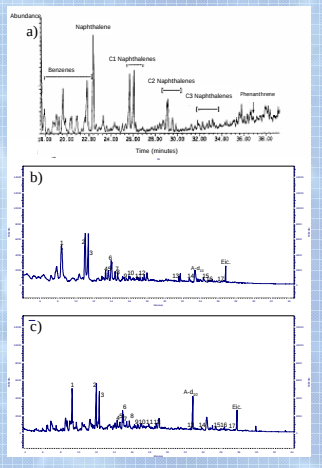
Figure 5. Comparison of magnetic stirring and ultrasonication methods.

a) GC/MS analysis of the total extract of seawater soluble fraction of Kuwaiti crude oil, prepared using magnetic stirring method (Ali and Mantoura, 1995).

b) GC/FID analysis of a sample prepared using magnetic stirring method (18 hours stirring, 48 hours settling down).

c) GC/FID analysis of a sample prepared using ultrasonication (30 minutes stirring, 48 hours settling down)

Main compounds: 1 Naphthalene;2-3 Methylnaphthalene ; 4 Ethylnaphthalene; 5-6-7-8 Dimethylnaphthalene; 9-10-11 Trimethylnaphthalene; 12 Fluorene; 13 Phenanthrene+Anthracene; 14 Carbazole; 15-16 Methylcarbazole; 17 Dimethylcarbazole; A-d10 deuterated Anthracene; Eic. Eicosane (ES).



5.2. Dissolution treatments

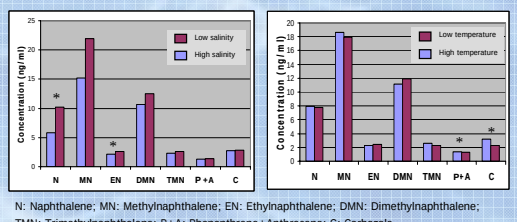


Figure 6. Influence of salinity and temperature in the dissolution of some compounds. (*) Statistically significant difference (ANOVA test, s<0,05)

N: Naphthalene; MN: Methylnaphthalene; EN: Ethylnaphthalene; DMN: Dimethylnaphthalene; TMN: Trimethylnaphthalene; P+A: Phenanthrene+Anthracene; C: Carbazole

6. Conclusions

- Ultrasonication is a fast, reliable and reproducible method to prepare the seawater soluble fraction.
- There is a differentiated dissolution of some fuel oil compounds in seawater, depending on the temperature and salinity conditions of this seawater.
- Results of ultrasonic method are comparable to magnetic stirring Methodology.

References

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