

Spectral signature of Egyptian crude oils

Z F Ghatass¹, A W Nashed², I H Saleh¹ and M M Mohmed³

¹ *Department of Environmental Studies, Institute of Graduate Studies and Research,
163 Horrya Avenue, P.O. 832 Shatby, Alexandria, Egypt*

² *Department of Material Science, Institute of Graduate Studies and Research,
Alexandria University, Egypt*

³ *Department of Biophysics, Medical Research Institute, Alexandria University, Egypt*

Email: z_ghatass@yahoo.com

Abstract. Crude petroleum oils are complex mixtures of diverse hydrocarbons, in widely varying compositions, that originate from a variety of geological sources. Fluorescence emission spectra have been measured for two types of Egyptian crude petroleum oil, its light and heavy products over a broad range of excitation and emission wavelengths. Both types of crude oil products are characterized by spectral signatures with a differing topography: the number of fluorescent peaks, their coordinates (λ_{ex} , λ_{em}) on the plane of the three dimensions spectrum, and the shape of the bands formed by the contour line density, changeable in either direction. The refined light oil shows emission spectra at λ_{max} between 350 and 500 nm according to the excitation wavelength. The refined heavy oil shows very broad unstructured emission spectra with $\lambda_{max} > 400$ nm. As a group, they could certainly be distinguished from the light oil samples and most of the crude oil.

1. Introduction

Physical methods are now used widely in environmental science to analyze environmental data, estimate environmental impact of production and consumption, investigate the consequences of policy measures and help prepare government regulations [1]. Accurate quantitative analysis of the composition of the surface water, the soil or the atmosphere is crucial in our assessment of the quality of the environment and our judgment of the relative success of measures taken to reduce pollution. Fluorescence techniques represent one of the most powerful and promising tools for the monitoring of aquatic media [2-6]. Crude petroleum oils (CPO_s) are complex mixtures of diverse hydrocarbons, in widely varying compositions, that originate from a variety of geological sources [7-11]. The ultimate fate of the majority of this oil to a large extent remains an unresolved mystery. Accordingly, the final impact of this oil on the environment and mankind is an unsettling and anxious question [12]. The extensive pollution of the seas by oil has resulted in an increasing demand for an accurate teledetection system. The information that such a system should provide can be summarized as: is the water polluted with oil, and if it is, with what kind of oil? [13-19]. In this work, we demonstrate the total luminescent spectroscopy (using different wavelength for excitation) for representative fingerprint of different types of oil and its products.

2. Material and method

Two types of crude petroleum oil Samples (Balaaie and West Desert oil), its light (Triptane, Jet A₁ and Kerosene) and heavy (Balaaie and West Desert Solar) products were provided by Alexandria Petroleum Company. Fluorescence measurements of samples under study were carried out by using Spectrofluorometer LS 55 (Perkin Elmer). Excitation and emission slits were set to 10 nm width. All measurements were made using the real, non-degassed samples in quartz cell. Each sample was excited at different wavelengths and fluorescence emissions were recorded for each excitation.



3. Results

3.1. Fluorescence spectra of crude oil samples

The fluorescence spectra of crude oil samples were recorded. For example, Figure 1 shows the West Desert crude oil spectra, its shown that the broad unstructured emission spectra with maximum intensity at wavelength (λ_{max}) between 400 and 530 nm according to the excitation wavelength. Generally, emission intensity of crude oil increases with increasing of excitation wavelength up to 440 nm and its emission spectra shift to right with increasing excitation wavelength. Spectra of the two types of crude oil show a relatively small difference through the spectral range considered here. Thus under field conditions, the two crude oil samples would not be distinguished by means of their fluorescence emission spectra. As an example, Figure 2; show the corresponding three dimensions fingerprints and contour lines of West Desert crude oil. The contour lines of West Desert crude oil has two maximum emission peaks around an excitation - emission pair of (393, 450 nm) and (440, 500 nm), while the contour lines of Balaiiem crude oil has one maximum emission peak around excitation-emission pair of (410, 470 nm).

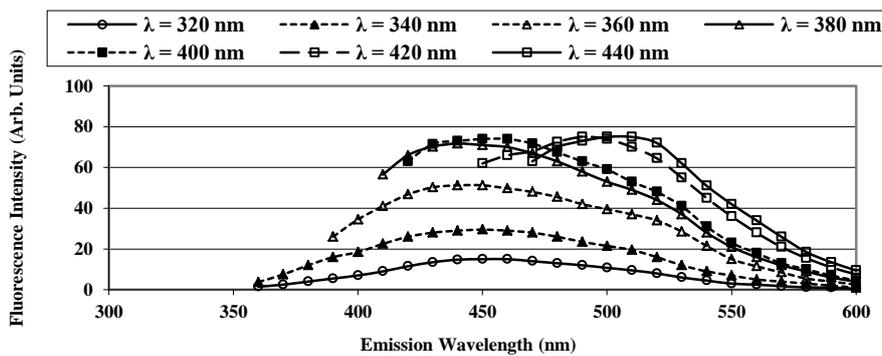


Figure 1. Fluorescence spectra of West Desert crude oil at different excitation wavelengths.

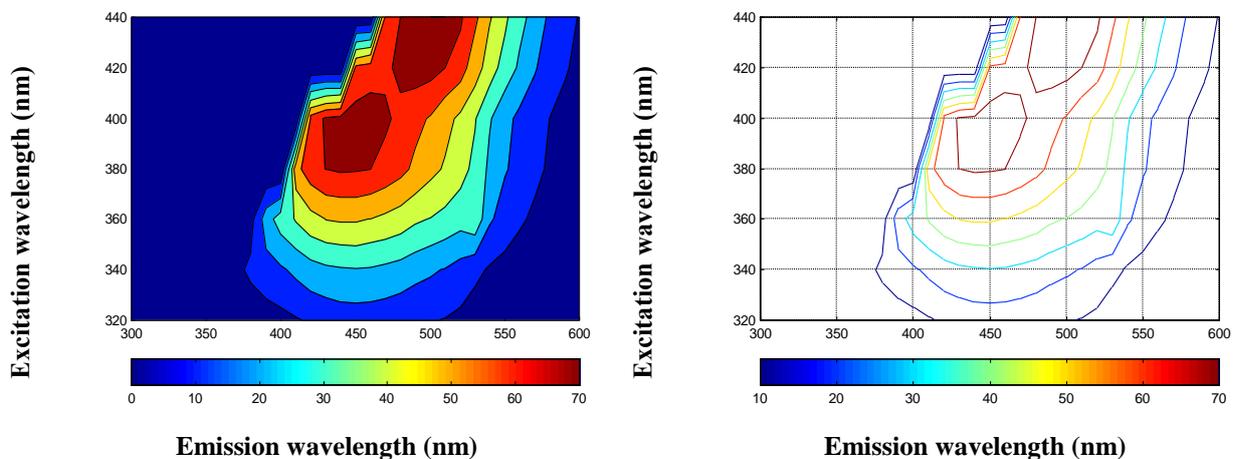


Figure 2. Three dimensions fingerprint and contour lines of West Desert crude oil.

3.2. Fluorescence spectra of oil products

3.2.1. *Light products.* The three dimensions fingerprints and contour lines of triptane, Jet A1, and kerosene were constructed. As an example Figure (3) shows the three dimensions fingerprints and contour lines of triptane. The contour lines of triptane has one maximum emission peak around (320, 390 nm), Jet A1 also has one maximum peak around (340, 370 nm), and kerosene has two maximum emission peaks around (320, 355 nm) and (347, 407 nm).

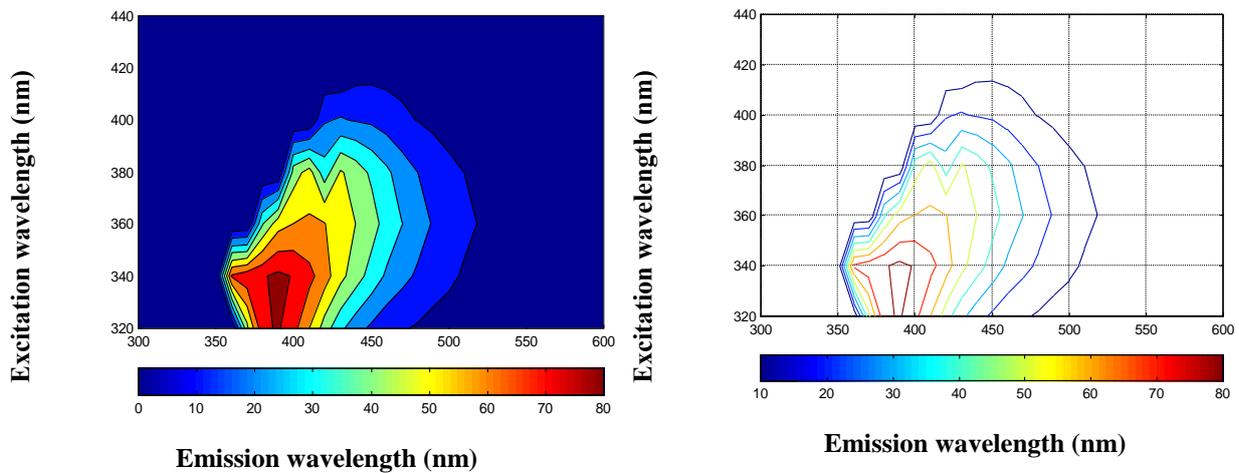


Figure 3. Three dimensions fingerprint and contour lines of Triptane.

3.2.2. *Heavy products.* The three dimensions fingerprints and contour lines for West Desert and Balaaim solar were constructed. Figure (4), shows the corresponding three dimensions fingerprints and contour lines of West Desert solar. The contour lines of West Desert solar has two maximum emission peaks around an excitation – emission pair of (400, 450 nm) and (440, 520 nm). The contour lines of Balaaiem solar, has two maximum emission peaks around (400, 457 nm) and (440, 505 nm).

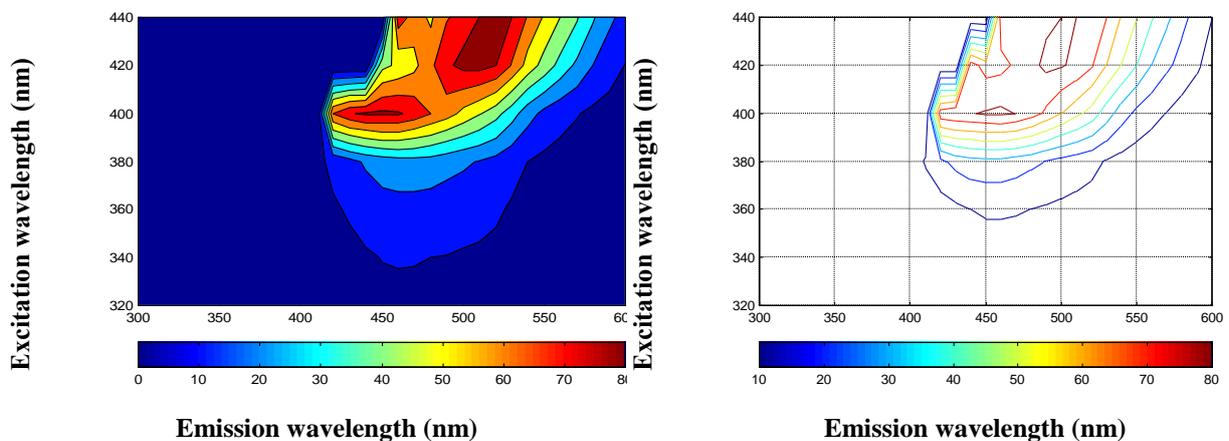


Figure 4. Three dimensions fingerprint and contour lines of West Desert solar.

4. Discussion

In the present work, the various crude oil, light and heavy products are characterized by spectral signatures with a differing topography: the number of fluorescent peaks, their coordinates (λ_{ex} , λ_{em}) on the plane of the three dimensions spectrum, and the shape of the bands formed by the contour line density, changeable in either direction. By counting the coinciding coordinates of peaks, it is possible to differentiate between the various samples as shown in Table (1).

Table 1. Catalog list of maximum coordinates (λ_{ex} , λ_{em}) on three dimensions diagrams

No.	Matter	(λ_{ex} , λ_{em}); (nm)
1	West Desert crude oil	(393; 450) and (440; 500)
2	Balaaiem crude oil	(410; 470 nm)
3	Triptane	(320; 390)
4	Jet A ₁	(340; 370)
5	Kerosene	(320; 355) and (347; 407)
6	West Desert solar	(400; 450) and (440; 520)
7	Balaaiem solar	(400; 457) and (440; 505)

References

- [1] Boeker E and Grondelle RV 1995 *Environmental Physics* (New York: John Wiley)
- [2] Camagni P, Colombo G, Koechler C, Pedrini A, Omenetto N and Rossi G 1988 *IEEE Transactions on Geoscience and Remote Sensing* GE **26** 22
- [3] Dudelzak AE, Babichenko SM, Poryvkina LV and Saar KJ 1991 *Appl. Opt.* **30** 453
- [4] John P and Soutar I 1976 *J. Anal. Chem.* **48** 520
- [5] Visser H 1979 *Appl. Opt.* **18** 1746
- [6] Lloyd J F 1974 *Analyst* **99** 729
- [7] Ryder A G, Glynn T J and Feely M 2003 *Proc. SPIE – Int. Soc. Opt. Eng* **76** 1188
- [8] Hegazi E, Hamdan A and Mastromarino J 2005 *The Arab. J. for Sci. and Eng.* **30 B** 3
- [9] Patra D, Sireesha K L and Mishra A K 2001 *Ind. J. Chem. A.* **40A** 374
- [10] Patra D and Mishra A K 2001 *Appl. Spectrosc.* **55** 338
- [11] Patra D and Mishra A K 2002 *Anal. Chim. Acta.* **454** 209
- [12] Kung R V and Itzkan I 1976 *Appl. Opt.* **15** 409
- [13] Visser H 1979 *Appl. Opt.* **18** 1746
- [14] Vodacek A and Philpot WD 1987 *Rem. Sens. Envir.* **21** 83
- [15] Measures R M 1984 *Laser Remote Sensing* (New York: John Wiley)
- [16] Hoge F E and Swift R N 1988 *Appl. Opt.* **27** 3969
- [17] Fadeev V 1992 *SPIE, Conf. Laser study of macroscopic bio-system* 410
- [18] Rayner D M and Szabo A G 1978 *Appl. Opt.* **17** 1624
- [19] Camagni P, Colombo A, Koechler C, Omenetto N and Rossi G 1991 *Appl. Opt.* **30** 26