



## Analysis of Naphtha

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### 1 Introduction

The analysis of highly volatile solvents is difficult by ICP-OES because the sample is volatilized before entering the plasma, which can easily overload the plasma. One solution is to dilute the sample in a less volatile solvent, but the limits of detection are deteriorated by the factor of dilution. In this Application Note, we present results on the direct analysis of naphtha using a special ultrasonic nebulizer.

### 2 Principle

#### 2.1 Technique used

The elemental analysis of solutions was undertaken by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). The sample is nebulized then transferred to an argon plasma. It is decomposed, atomized and ionized whereby the atoms and ions are excited. We measure the intensity of the light emitted when the atoms or ions return to lower levels of energy. Each element emits light at characteristic wavelengths and these lines can be used for quantitative analysis after a calibration.

#### 2.2 Wavelength choice

The choice of the wavelength in a given matrix can be made using the "profile" function, or by using Win-IMAGE, which is rapid semi-quantitative analysis mode using multiple wavelengths. The principle is the same in either case: record the scans of analytes at low concentration, and of the matrix. By superimposing the spectra, we see possible interferences.

#### 2.3 Limits of detection estimation

The limits of detection are calculated using the following formula:

$$\text{LOD} = k \times \text{BEC} \times \text{RSD}_0$$

With:

LOD = limits of detection,

$k = 3$  for the normal 3-sigma values,

BEC = Background equivalent concentration,

$\text{RSD}_0$  = relative standard deviation of the blank.

To calculate the LOD, a calibration curve is constructed using two points, 0 ppm and 5 ppm, or some concentration where the calibration is linear; this gives the BEC. The  $\text{RSD}_0$  is evaluated by running the blank ten times.

### 3 Sample Preparation

Samples were analyzed directly using an ultrasonic nebulizer with a desolvator.

### 4 Instrument specification

The work was done on a JY ULTIMA. The specifications of this instrument are listed below in Tables 1 and 2.

**Table 1: Specification of spectrometer**

Parameters	Specifications
Mounting	Czerny Turner
Focal length	1m
Nitrogen purge	Yes
Variable resolution	Yes
Grating number of grooves	2400 gr/mm
Order	2nd order

**Table 2: Specification of RF Generator**

Parameters	Specifications
Type of generator	Solid state
Observation	Radial
Frequency	40.68 MHz
Control of gas flowrate	by computer
Control of pump flow	by computer
Cooling	air

## 5 Operating conditions

The operating conditions are listed in Table 3 below.

**Table 3: Operating conditions**

Parameter	Condition
RF Generator power	1450 W
Plasma gas flowrate	16 L/min
Auxiliary gas flowrate	0.6 L/min
Sheath gas flowrate	0.2 L/min
Nebulizer flowrate	2.1bars, 0.61 ml/min
Sample uptake	0.5 mL/min
Type of nebulizer	Meinhard
Type of spray chamber	Scott
Argon humidifier	No
Injector tube diameter	3.0 mm

The operating conditions of the Ultrasonic Nebulizer are given below.

### For the nebulizer:

Heater temperature	140°C
Cooler temperature	-12°C

### For the membrane:

Heater temperature	160°C
Argon flow rate	2.03 L/min

## 6 Wavelength selection and analytical conditions

For each element, the line with the highest sensitivity was used, as there were no particular problems with interferences. For all elements, the conditions were the same except for alkali elements.

**Table 4: Analytical conditions**

Elements	Slits (μm)	Analysis mode	Integration time (sec)
Standard	20 x 15	Direct peaking	8
Alkali	20 x 15	Gaussian	1

## 7 Discussion

### 7.1 Limits of Detection

The limits of detection have been calculated using the formula in paragraph 2.3.

**Table 5: Limits of Detection**

Element	Wavelength (nm)	LOD (μg/L)
Ag	328.068	0.2
Al	396.152	3.9
B	249.773	1.4
Ba	455.403	0.1
Ca	317.933	7.8
Cd	228.802	1.1
Cr	267.716	0.8
Cu	324.754	0.4
Fe	259.940	2.6
K	766.490	38.6
Mg	279.553	0.2
Mn	257.610	0.5
Mo	202.030	3.1
Na	589.592	5.1
Ni	231.604	5.1
Pb	220.353	18.9
Si	251.610	18.6
Sn	189.989	14.5
Ti	334.941	0.9
V	311.071	0.6
Zn	213.856	1.3



## 7.2 Results

The results of the analysis of a samples spiked with 20 µg/L are given in Table 6.

**Table 6: Results for a spiked sample (20 µg/l)**

Element	Concentration
Ag	17
Al	24
B	19
Ba	25
Ca	19
Cd	16
Cr	22
Cu	17
Fe	21
Mg	19
Mn	16
Mo	13
Na	24
Ni	18
Ti	24
V	21
Zn	18

## 8 Summary

When wanting to achieve the best detection limits possible, dilution is undesirable. The results presented in this Application Note show that JY spectrometers, using an ultrasonic nebulizer with a membrane desolvator, perform the analysis of a highly volatile solvent very well.



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