# کارگاه‌های آموزشی مرکز اطلاعات علمی


## آموزش نرم‌افزار Word برای پژوهشگران


## روش تحقیق کمی


## آموزش مهارت‌های کاربردی در تدوین و چاپ مقالات ISI

# Chemical Characterization of Plasma Medium by Optical Emission Spectroscopy

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## Introduction

Optical emission spectroscopy (OES) is a very useful technique to obtain information about the nature of plasma, such as the chemical compositions and species of the plasma, density of the plasma, electron temperature and ion/electron energy distributions. For the first time, the promoting effect, i.e., mechanism and chemical characterization, of $Ar/CH_4/C_2H_6$ plasma medium as auxiliary working gases on heavy oil residue cracking where in the range of $C_6$ – $C_{>40}$ long hydrocarbon chains, is inspected by OES [1, 2].

## Methods

The spectrum of Dielectric Barrier Discharge (DBD) plasma and production of radicals were analyzed by an Avantest (avaspec-3648) spectrum analyzer [1]. The observable spectral range was 200-1050 nm. In designed tests, the applied voltage was gradually increased and in all experiments the working gas flow rate was kept constant. In $Ar+CH_4$ and $Ar+C_2H_6$ cases because of energetic electrons, many reactions can take place in the reactor. However, it is important to increases the energy of the electrons and intensity of H, CH, and $H_2$ selective peaks in the plasma spectrum in order to improve the production rate of light valuable hydrocarbons and also inhibit to produce heavy valueless chains.

## Results and Discussion

The $CH_4/C_2H_6$ gases were effectively dissociated by electron and argon metastable atom impacts in the Penning discharge model, creating sufficient $CH_x$ radicals [3]. In Figure 1 (a, b) the increase of CH (314.3 nm) and Hα (656.3 nm) intensity for rising applied voltages is indicated. The lines of $C_2$ and $H_2$ are also visualized in the spectrum. As this figure shows excited and ionized argon peaks which present the presence of energetic electrons that provide the energy of the cracking bonds. Therefore, many radicals produce in the plasma medium which can join to other radicals. In absence of methane and ethane, these radicals

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joined to each other and may produce heavy hydrocarbons. The $H_\alpha$ line is visually observed at 656.3nm, while the other lines of the Balmer system, $H_\beta$ line and $H_\gamma$ line are detected, but their intensities are too weak to be distinguished from the noise signal. As a result, the collision probability between the electron and CH is low, which leads to an infrequent CH radical population generated in the plasma. C-H bands are generated in plasma where carbon and hydrogen are sufficiently present. The absence of the $CH_2$ line in the spectra is most likely because the $CH_2$ radical has an extremely short lifetime to be probed. With higher applied voltage, the ionization probability and the intensity related to the electron energy are increased.

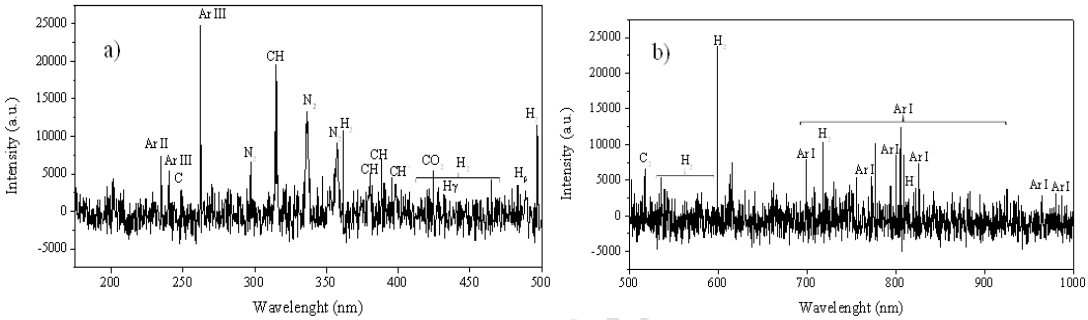


Fig 1. The optical emission spectrum in DBD plasma medium from (a) 100 nm to 500 nm (b) 500 nm to 1000 nm.

## Conclusions

OES is employed as a control tool during the process to manage reaction conditions and to enable time and spatial monitoring of the plasma. Any parameters which firstly: increase the energy of the electrons (such as applied voltage), secondly: increase the intensity of the H, CH and $H_2$ peaks in spectrum of plasma (presence of methane and ethane as working gas and their flow rate), increase the production rate of the light valuable hydrocarbons and also prevent the production of heavy valueless chains.

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## References

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