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بسم الله الرحمن الرحيم

مركز الشبكات وتكنولوجيا المعلومات

قسم التوثيق الإلكتروني



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جامعة عين شمس

التوثيق الإلكتروني والميكرو فيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
على هذه الأقراص المدمجة قد أعدت دون أية تغييرات



RECOVERY OF SOME ELEMENTS FROM SOLID WASTES PRODUCED FROM FUEL COMBUSTION IN POWER PLANTS

Submitted By

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B.Sc. Science, Faculty of Science, Mansoura University, 1985

Diploma of Environmental Sciences, Faculty of Graduate Studies and
Environmental Research, Ain Shams University, 2009

Master of Environmental Sciences, Faculty of Graduate Studies and
Environmental Research, Ain Shams University, 2015

A thesis Submitted in Partial Fulfillment

Of

The Requirements for the Doctor of Philosophy Degree

In

Environmental Sciences

Department of Environmental Basic Sciences

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ABSTRACT

This thesis composed of two sections, the first is laser characterization of furnace bottom residue (FBR) while the second addressed methods of metal recovery especially vanadium and nickel.

First section: The goal of this section was to investigate the existence of heavy elements locally found in nine different samples of fuel power plant residues and to pay attention to the mining industry towards exploration recycling of these reserves. An optimized fast detection system based on an orthogonal double-pulse laser-induced plasma spectroscopy (ODPLIPS) system for quantitative analysis of valuable heavy metals like vanadium (V) and nickel (Ni) content in fuel power plant residue (PPR) was successfully developed. Those metals were taken from the PPR as a solid waste residue for industrial recycling. The investigated composition analysis by employing the calibration of the LIPS scheme is established on the registered collection spectra of the plasma flare generated by the laser beam in air pressure. We prepared standard matrices in a known concentration in the PPR sample to draw the standard calibration curves for each element, as well as by utilizing a tactic based on the intense lines emission of the elements of interest as quantitative analysis. These heavy elements that exist in the PPR were exactly identified using the energy dispersive X-ray (EDX) and an orthogonal double-pulse-LIPS (ODPLIPS) systems. By using the ODPLIPS excitation technique, the intensity of both spectral lines Ni(II) 221.65 and V(II) 294.45 nm were enhanced by nearly 4 and 5 times, respectively at laser pulse energy (LPE) ratio ($E2/E1 = 3$) as compared to the SP signal that could help^{the} analytical performance of the LIPS system in terms of increasing sensitivity and reducing self-absorption effects for PPR pellets. Several experimental parameters of ODPLIPS geometry like the periodic interval between the data acquisition and the excitation pulse laser (ICCD gate delay, $t_d = 200$ ns), the LPE ratio ($E2 = 3$ times $E1$) and the inter-pulse separation between the couple laser pulses ($\Delta t = 800$ ns) have been optimized to improve the SNR and sensitivity of our detection system and to achieve the best detection limit. The calibration curves were employed to quantify the Ni and V concentration that exists in the PPR samples. Furthermore, the LIPS outcome accuracy in evaluating the V and Ni concentration in PPR was validated using an inductively coupled plasma-optical emission spectrometry (ICP-OES) system. The predicted LIPS out- comes were found in complete harmony with the ICP-OES outcomes. The predictable limit of

detection of our ODPLIPS system for V and Ni heavy metals was observed to be about 12.58, and 14.75 mg/kg, respectively. The proposed protocols elucidated that the brilliant profit of ODPLIPS for identifying valuable V and Ni metals present in the PPR sample and for examining the quality and purity of recovering metal manufactures.

Second section: Solid waste residue generated in power stations that use heavy oil as the source of fuel poses a threat to the environment due to the presence of some heavy metals. At the same time, these metals include vanadium and nickel can be recovered and recycled. In this work vanadium and nickel were recovered from solid waste residue (Furnace bottom sediments FBS) collected from the bottom of steam boiler. Four samples were selected and collected from different boilers. Solid samples were grinded to convert them to powdered form and sieved in 200 μm . The grinded samples were used for recovery. The recovery of vanadium and nickel was conducted in two stages. A first stage was acidification of the grinded (FBS) using 30 % sulfuric acid (dissolution of FBS) followed by alkali metal precipitation. The second stage is similar to first stage on the remaining solids from first stage. Determination of vanadium and nickel were conducted by two techniques, (EDX) and (ICP technique). The effect of some operational parameters (liquid/solid, leaching, temperature, mixing time, acid and alkali concentrations) on the recovery of V and Ni was investigated. Conditions of precipitation of V and Ni from alkali solutions were established. The effect of different amount of ammonium hydroxide/ammonium chloride which gives deferent pH value from (2 to 10) at different temperatures (25, 40, 60, and 80) $^{\circ}\text{C}$ were investigated. The maximum recovery of vanadium reached 96.3% at (pH 3.5), Nickel recovery was 95.8% at (pH 9.5) for reaction time 4 h.

Keywords

LIPS • Recycling metals, Power plant residue, ICP, Furnace bottom sediments, Solid waste, Heavy fuel oil, Vanadium, Nickel

List of Abbreviations

Al	:	Aluminum
ASTM	:	American Standard Methods
EDX	:	Energy dispersive X-ray
FBS	:	Furnace bottom sediments
Fe	:	Iron
FGD	:	Flue gas desulfurization
ICP	:	Inductive coupled plasma
ICP-OES	:	Inductively coupled plasma-optical emission Spectrometry system.
LPE	:	Laser pulse energy
Na	:	Sodium
Ni	:	Nickel
ODP	:	Orthogonal double-pulse
ODPLIPS	:	Orthogonal double-pulse laser-induced plasma spectroscopy
S	:	Sulfur
Si	:	Silicon
td	:	Time delay
TGA	:	Thermo gravimetric analysis
V	:	Vanadium
Zn	:	Zink

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