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QUANTITATIVE DETERMINATION OF LOW CONCENTRATION HEXAVALENT CHROMIUM CR (VI) BY UV-VISIBLE SPECTROPHOTOMETER

Abdul Moiz Mohammed
Department of Basic Sciences, Preparatory Year, University of Ha'il,
P.O Box # 2440, Ha'il, Saudi Arabia
E-mail: mr.mamoiz@gmail.com

Abstract: Chromium exists in nature in various forms depending on its oxidation state, and are classified as more stable, stable and unstable. The most common Chromium found in materials is hexavalent chromium Cr(VI) which is found in soil, plants, animal tissue, water and food. Determination of Cr (VI) in the environmental materials is of importance. The large amount of Cr (VI) in plants, water, soil and food products may have health hazard like cancer, eye infection, skin problems, respiratory syndrome, kidney problems. UV-Visible spectrophotometer may be employed in the quantification of Cr (VI) in the materials. The paper presents the elemental analysis of Cr (VI) using different standard aqueous solutions and test solutions. It is also suggested that a standard 0.1 mg/L of dissolved Cr (VI) is to be maintained in materials to reduce health issues.

Index Terms: Ultraviolet, Visible, Spectrophotometer, Hexavalent, Chromium. Elemental Analysis.

I. Introduction

The elemental analysis of wide varied compounds found in the environment yields quantitative information of various elements in different chemical forms. The elemental analysis also explores the differences between homogenous and heterogeneous association of natural constituents either in oxidized states or in the form of coordinated anionic, neutral and cationic forms [1]. Chromium exists in various chemical forms with oxidation numbers from 0 to VI, and are classified in to most stable, stable and unstable form. The trivalent chromium Cr (III) and hexavalent chromium CR (VI) found in the environment are in stable form, while the former is considered most stable and later is considered to have toxic effect, where as Cr (IV) and Cr(V) are found in unstable form. Hexavalent Chromium Cr (VI) is metallic and are found in soil, plants, animals and rocks, and are widely used tanning of leathers, electroplating, purification and production of stainless steel and preserving wood [2].

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The spinel crystal structure of Chromite contains trivalent chromium, iron and small percentage of metal oxides such as magnesium and aluminum. Due to its stable structure it find many applications under high temperature. Many different analytical approaches were employed in the determination of Chromium in natural environment during last few decades [3].

II. Theoretical Aspect & Instrumentation

The quantitative analysis of hexavalent chromium using UV-Visible spectroscopy is derived from the Lambert-Beer Law, which relies on absorption of light energy by a defined thickness of medium. The basic principle and theory for the absorbance by the absorption medium is directly proportional to the thickness of the medium [4]. The basic principle of UV-Visible spectroscopy and theory on which the measurement is based was explained in detail [4 & 5]

III. Results

The most widely used method for quantitative analysis of Cr (VI) is the diphenycarbazide absorption method using UV-Visible Spectrophotometer. Due to recent development on spectrophotometer such as V-730 by Jasco with 50 mm path flow facilitates the determination of chromium with low absorption. Different standards aqueous solutions of concentration 0, 0.01, 0.02, 0.04, 0.05, 0.06, 0.08 and 1mg/L were used in the analysis, along with test aqueous solution of two concentration 0.005 and 0.01 mg/L of K_2Cr0_4 were used. The reaction reagent was the LR $-$ Cr^{6+} color kit for Cr (VI). The measurement were made in the UV-Visible range 700 to 400 nm with 1nm bandwidth and data interval 0.1 nm.

A calibration curve was obtained using standards with the concentrations mentioned above. The color of the standard solutions appeared to change to pink after the reaction with reaction reagent. Each standard was measured three times. The spectra showed peak at 543 nm.

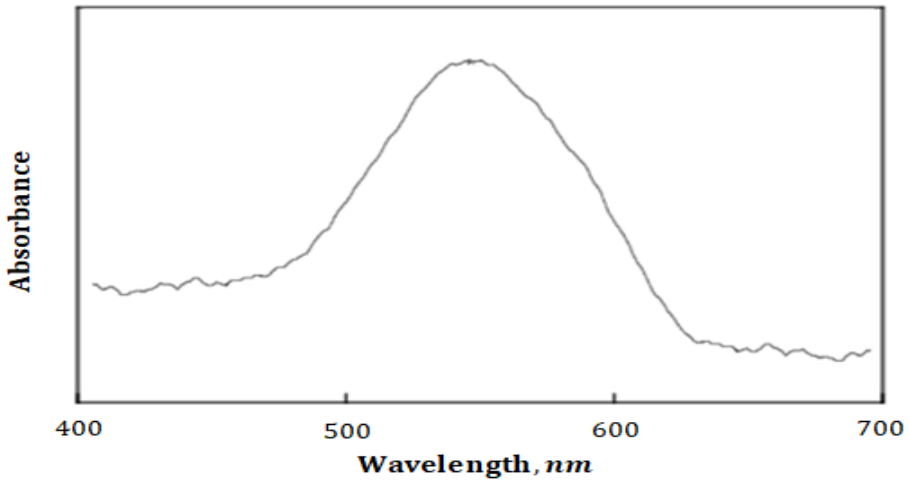

Fig.1. Spectrum of Cr (VI)

The baseline was considered between the absorbance values of 450 and 650 nm. The calibration curve showed high degree of linearity as shown in the calibration curve (Fig. 2).

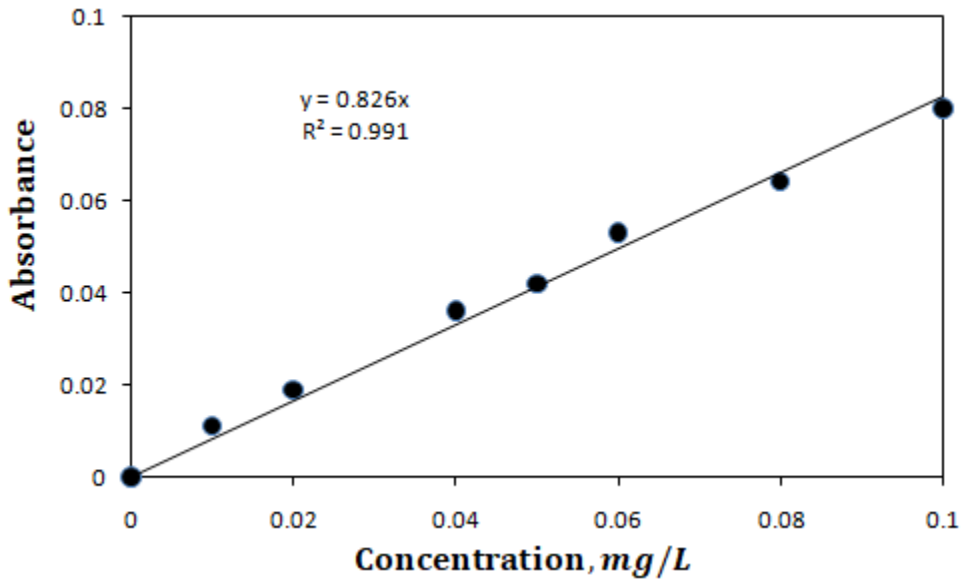

Fig.2. Calibration curve for Standard Aqueous Solutions

Two different solutions were prepared with Cr (VI) concentration 0.005 and 0.01 mg/L to test the obtained calibration curve. Measurements were made five times which are shown in table (1).

TABLE I: Quantitative Measurement

Test Solution	0.005 mg/L	0.01 mg/L
1	0.0052	0.0097
2	0.0041	0.0104
3	0.0045	0.0096
4	0.0048	0.0100
5	0.0051	0.0096
Average	0.0047	0.0099

IV. Discussion & Conclusions

Chromium Cr (VI) is available in metallic compounds and finds various applications in steel manufacturing, tanning of leather and textile industries. Cr (VI) many practical uses, but however they also possess harmful effects to human body resulting compounds causing cancer. In addition, have an effect on eye, skin, liver, kidney and respiratory system. Therefore, a standard percentage of dissolved Cr (VI) have to be maintained such as 0.1 mg/L. By employing UV-Visble spectrophotometer one can quantify the amount of Cr (VI) present in the soil, plants, animals and food products consumed by humans. The results presented in this paper may be useful for new researchers in the identification of Cr (VI) in compound and minerals available in nature and environment.

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