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Detection of Essential Trace Element of Chromium by Electroanalytical Methods

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Abstract :- A detailed study of essential ultra trace element of chromium present many of industrial waste lakes of western rajasthan. A convenient method of electroanalytical technique used for the essential trace element present in the industrial waste water as a polarography method for identification of essential trace element by using concentration of ppm to ppb. According to this method prepare solution of sodium chromate as a stock and identify electroanalytical potential by using as a supporting electrolyte 0.05 M HCl + 0.25 M NaCl give a sharp peak at $E_{1/2} = 0.91(V)$ and result compare with other electroanalytical instrument like UV-Vis Spectrophotometer, Atomic absorption spectroscopy

Keyword: Industrial waste, Voltametry, Supporting electrolyte, DPP (Differential Plus Polarography)

I. INTRODUCTION

Chromium is a element of the first transition series in the periodic table of the D block group. Its atomic number is 24 and atomic weight is 51.996 grams. Chromium first discovered by Varghlin in 1797. Chromium a hard element with a shiny brown color but break easily. Chromium a series of oxidation state -2 to -6 but the most stable and prevalent forms of chromium is +3 and +6. Chromium is a versatile transition metal widely recognized for its multi faced properties and significant industrial applications. Like chromium is mixed in steel, then steel does not rust easily, due to this utility it is used to make rust proof products. Chromium also found in various industrial process metallurgy, electro painting, textiles, tanneries in the form of industrial waste are hazardous effect of human, animal and also marine life. (1)

Metals are used in low concentration are essential for life but a high concentration they cause toxicity. Chromium taken by the human body in the form of several food a small concentrate are essential but excess quantity show side effect in the body.(2,3) chromium is also involved in lipid and protein metabolism in low concentration of human body. (4) much of the daily intake of chromium, typically about 100µg, is from foods, seafood's, mushrooms and egg yolk(4,5). In other the toxicity and environmental impact of chromium compound at high concentration in polluted water released from various industrial units. Now a day this polluted water contaminated like river, ponds, wells etc. in the present study, we first identified Chromium polluted water in many type of industrial units to released Chromium waste in several river, ponds and lakes then identify the concentration of chromium with electro-analytical methods and finally comparison with others analytical instruments.

II. INSTRUMENTATION

A microprocessor based pulse polarographic analyzer (Model CL-362) in combination with a drop-timer assembly, all of Elico Limited, Hyderabad, India, was used for voltammetric experiments. The CL-362 Pulse Polarographic Analyzer is capable of performing DC polarography, Differential pulse polarography and stripping voltammetry. The potential range of polarographic analyzer ±2048 mV. The scan rate can be varied from 2 to 10 mV/sec in fast mode and 1 to 2 mV/sec in slow mode. The current range is 1 to 1000 µA and the drop time can be controlled at 0.5, 1.0 and 2.0 sec. The charging current and IR compensation have range of 0 to 100%. 5mV to 100 mV pulses are available for DPP technique [6]. The instrumental settings for DC and DPP are shown in Table-1.

TABLE – 1
Instrumental parameters

S. No.	Parameter	DC Polarography	DPP
1.	Drop time	0.5 sec.	0.5 sec.
2.	Scan rate	10 mV/sec.	10 mV/sec.
3.	Charging current compensation	30%	30%
4.	Pulse amplitude	–	20 or 40 mV

A. UV-VIS Spectrophotometer

A UV vis spectrophotometer model no. (UV-1900-UV-VIS Spectrophotometer) Shimadzu Analytical PVT. LTD. Wavelength accuracy ± 0.05 nm at 02 peak 656.1 nm, ± 0.3 nm for entire range, Wavelength repeatability ± 0.1 nm wavelength slow rate About 14,500 nm/min & wavelength scanning 3,000 to 2 nm/min. The tungsten halogen deuterium lamp and wide range photomultiplier were used as the light source and detector, respectively.

B. pH Meter

The pH meter models of 5000 series (JENCO ELECTRONICS, LTD) are high performance, low cost, general purpose portable instrument for the measurement of pH, mV and temperature. The 5000 series offer different accuracies and resolutions for all levels of pH applications. The low end 5001 is for pH measurements only, with 0.05 pH resolution and 0.03 ϕ 1 digit pH accuracy. The high end model 5005 measures pH, mV and temperature to 0.01 pH, 1 mV and 0.1 with accuracies of 0.01 pH, 0.1% mV and 0.5 .The compact design of the 5000 series allow the instruments to be used in the field with a rugged carrying case, buffer solutions and it is internal battery as will as in the laboratory with a built-in tilt stand and UL/CSA approved AC acaptor. Analog output is provided for the models 5002, 5003 and 5005. A digital pH meter (Model – 5000) of Lab India, was used for pH measurements. A single fused glass and calomel electrode was employed. Before each measurement instrument was calibrated with standard buffer solutions.

C. Milli-Q A10 Water Purification System

Using an existing source of pure water as feed, the Milli-Q Advantage A10 system (2013 EMD Millipore Corporation, Billerica, MA, U.S.A.) delivers high-quality ultrapure water (resistivity value: 18.2 M Ω ·cm @ 25 °C; ≤ 5 ppb). Two separate components — the Milli-Q water production unit and the Q-POD® (Quality-Point-of Delivery) unit — provide an ultrapure water solution adapted to today’s laboratory environments.

III. EXPERIMENTAL

A. Cleaning and Conditioning of Lab Wares

For trace determination, contamination of the sample must be carefully avoided. Stringent cleaning of all glassware’s in sample preparation and of the cell components is necessary [7,8]. For this purpose, all glassware’s were soaked in 2M nitric acid for at least one week and washed several times with doubly distilled water prior to use [9]. Subsequent conditioning is also of paramount importance to avoid adsorption losses [10].

B. Sampling and Sample Storage

Water samples were collected in cleaned polyethylene containers which were kept filled with 0.1M hydrochloric acid until the time of sample collection [11].

C. DC Polarographic Studies

The present study was undertaken in view of the fact that choice of a medium for polarographic investigation in case of chromium is limited due to its very negative reduction potential. Among different supporting electrolytes for the study of Cr(IV) at dropping Mercury electrode.

TABLE 2- Electroreduction of Cr(IV) in different complexing media Cr(VI) = 1.0 x 10⁻⁴M

S. No.	Medium	-E _{1/2} (V)	i _d (μA)
1.	0.05M HCl + 0.25M NaCl	0.91	5.92
2.	0.01M Thioacetamide in 0.1M KCl	0.85	1.61
3.	0.01M Sodium chloride in 0.1M KSCN	1.32	1.30
4.	0.01M Citric Acid in 0.1M KCl	1.01	1.05

According to the table different supporting medium used and finally 0.05 M HCl + 0.25 M NaCl select as a supporting electrolyte for reduction of chromium(IV) A DC polarogram of Cr(IV) Shown by Fig. 01.

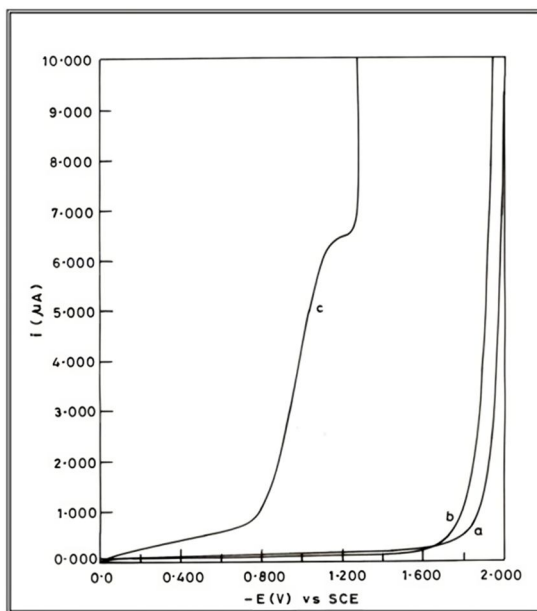


Fig. 01 DC polarogram Of Cr(IV)

Observation of peak following by :-

- 1) Blank solution of 0.05 M HCl
- 2) Blank solution of 0.05 M HCl in 0.25 NaCl
- 3) 1.0×10^{-4} M Cr(VI) in 0.05M HCl in 0.25 NaCl

D. Differential Pulse Polarographic Studies

IN other DPP peak of chromium(IV) by using supporting electrolyte of 0.05 M Hydrochloric acid + 0.25 M sodium chloride showed a sharp DP peak at a potential of 0.82 V as shown in Fig. 02.

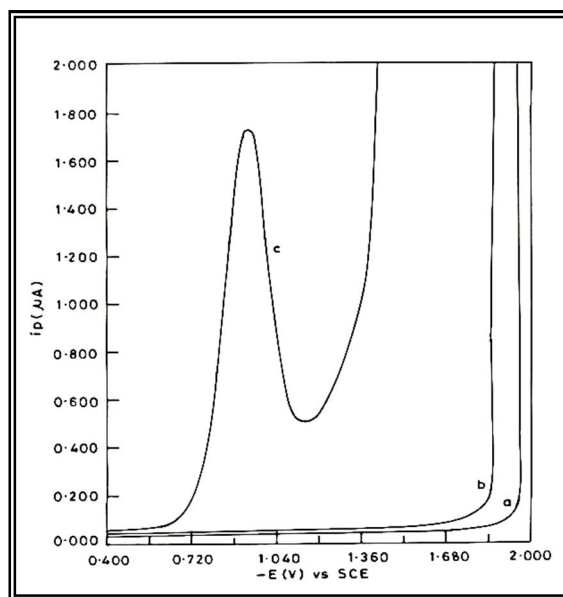


Fig. 02 DP polarogram of Cr(IV)

Observation of peak a,b,c following by :-

- Blank solution of 0.05 M HCl
- Blank solution of 0.05 M HCl in 0.25M NaCl
- Cr(VI) in 0.05 M HCl in 0.25M NaCl

1) Comparison

Many of the industrial waste samples of different rivers in western rajsthan can be compared with other analytical instrumentation method. Then validity of the DPP measurements was further established by comparing the results with UV-vis spectrophotometric method. Table 2 contains the comparative data.

E. DPP and UV-vis Spectrophotometric Determination of Chromium(IV)

S. No.	Sample	Cr (IV) Concn. (PPM)		
		Added	DPP	UV-vis
1.	Jojari River	1.0	0.97	0.98
2.	Jawai River	1.0	0.98	0.95
3.	Khari River	2.0	1.98	1.96
4.	Luni River	2.0	1.92	1.97

IV. CONCLUSION

The detailed electrochemical investigations of Cr(VI) in medium of HCl / NaCl has provided optimum analytical conditions for its ultra trace determination by DPP technique. the proposed method will be of low cost to other instrumental techniques reported for determination of chromium such as spectrophotometry [12–17], spectrofluorometry [18], AAS [19–22], capillary electrophoresis [23], flow injection analysis [24–27] X-ray fluorescence [28] and NAA [29] methods commonly reported in the estimation of Chromium.

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