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Recovery of Manganese from Dry Batteries

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ABSTRACT

Batteries contain cadmium, mercury, copper, zinc, lead, manganese, nickel and lithium, which may create a hazard when disposed incorrectly. The most important non metallurgical use of manganese is in the form of manganese dioxide, which is used as a depolarizer in dry cell batteries. Estimation of manganese content in the disposed dry battery samples has been determined by oxidation with excess standard potassium dichromate solution followed by titration with standard hydrogen peroxide solution. The effect of several variables like time variation, dichromate concentration was studied. It is observed that different volumes of battery sample solution are found to be in 1:1 correspondence with concentration of potassium dichromate solution .

INTRODUCTION

Reuse of the recovered materials from solid wastes is the other principal mode of energy conservations. There fore attention has been focused in the utilization of industrial wastes and low grade ores for the recovery of metals due to increased mining costs and depletion of mineral wealth. During the last decade a great increase in environmental awareness took place and legislation on wastes developed[1.] It is estimated that in India alone, about 115 million of urban population produces nearly 15 million tones of solid waste causing chronic pollution of land and water.[2,3]

Iron and steel are the most recycle materials used today. Recycling aluminum saves a tremendous energy; It takes 95% less energy to produce aluminum can to an existing one rather than from ore. Recent developments have allowed successful commercial introduction of rechargeable zinc alkaline and manganese dioxide batteries. But dry Lechlanche cell once discharched cannot be recharged again. Household batteries contribute many potentially hazardous compounds to the municipal solid waste stream, including zinc, lead, nickel, alkalines, manganese, carbon-zinc, mercuric oxide, zinc-air, silver oxide, and other types of button batteries. Higher levels of manganese are toxic and cause brain damage[2.] Very little or no information appeared in the literature on estimation of manganese[3] and its utilization for different analytical applications. Present study comprises oxidation of the disposed dry battery samples containing manganese in lower oxidation state to manganese (VII) by both titrametric as well as spectrophotometric methods. An attempt has been made by comparing the results obtained with those of oxidizing standard manganese (II) sulfate (known manganese content) under similar conditions.

EXPERIMENTAL SECTION

Materials and methods
Potassium dichromate solution (0.2N), Potassium permanganate (0.1N), Hydrogen peroxide solution, Mohr's salt solution (0.1N) and Manganese (II) sulphate stock solutions used were of Anal R grade purified by standard methods.

Equipment:
Spectrophotometer U.V visible spectrophotometer typeUV 260 (Shimadzu) was used for the determination of manganese content in the samples.

Dissolution of battery samples
House hold disposed dry batteries from different suppliers were collected. 5.0 gms of the finely ground battery sample is accurately weighed in a porcelain dish. It is heated strongly with 20-30 ml 60% perchloric acid. After complete dissolution is was made up to 250ml (stock solution).To an aliquot of this solution, 15.0 ml of 0.05N potassium dichromate solution (in excess) is added. The above solution is diluted with 50 ml of deionized water and is added with 5.0 ml of 1:1 sulphuric acid solution. It is then titrated immediately with a standard solution (0.0276N) of hydrogen peroxide until the colour changes from purple to colourless.The unreacted potassium dichromate solution is then titrated against a standard (0.03891 N) Mohr's salt solution, using Diphenyl amine as indicator. From these two titre values, the volume of potassium dichromate solution required for the oxidation of manganese present and hence the amount in the sample solution is determined. The validity of the method has been tested by both persulphate as well as periodate methods[5, 7] for determination of manganese has also been attempted following spectrophotometric method.

RESULTS AND DISCUSSION

The results obtained on the determination of manganese from disposed dry batteries are presented .The dissolution of the samples in various acids (i.e. hydrochloric, sulphuric and nitric acid) indicate that 60% perchloric acid was found to be more effective than in other acids employed in the study.

Fig. 1. Effect of dichromate concentration on oxidation of Manganese

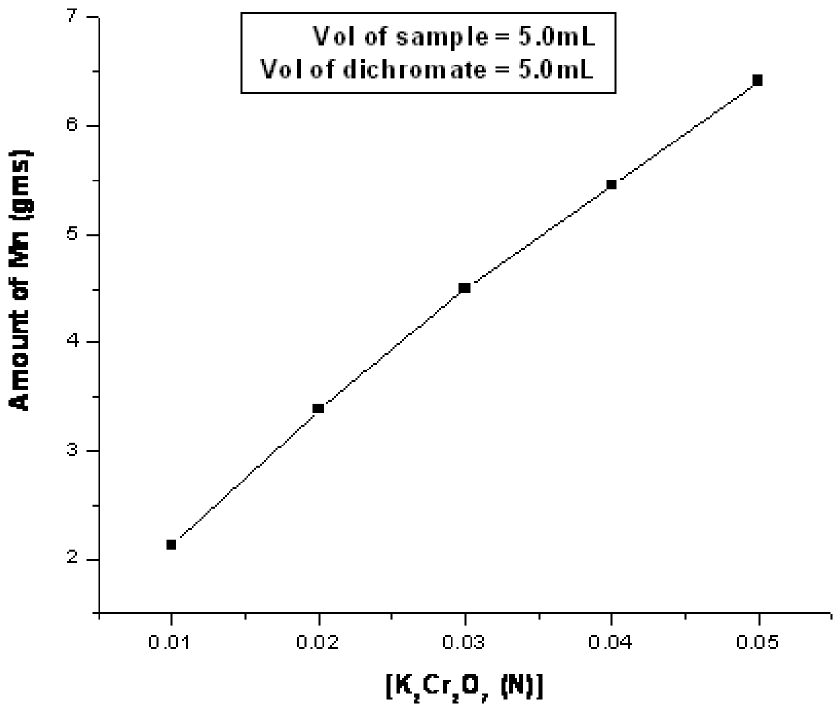

Table -1. Time variation for oxidation of manganese content

Volume sample =5.0 ml *Vol. of dichromate soln. = 5.0 ml*

S.No	Time variation (min)	Volume of Hydrogen peroxide consumed (ml)	Mohr's salt soln. consumed (ml)	Amount of Mn found (gms)
1	2	0.3	2.8	5.1324
2	4	0.5	2.5	5.5631
3	6	0.6	2.3	5.8652
4	8	0.6	2.0	6.2763
5	10	0.8	1.9	6.4155

Table -2 . Amount of Manganese in various samples

S. No	Volume of sample taken (ml)	Volume of Dichromate solution added (ml)	Volume of Hydrogen peroxide consumed (ml)	Mohr's salt soln. consumed (ml)	Amount of Mn found (gms)
1	2.5	2.5	0.3	1.0	6.2322
2	5.0	5.0	0.8	1.9	6.4155
3	7.5	7.5	1.1	2.8	6.3544
4	10.0	10.0	1.4	4.2	6.0489
5	12.5	12.5	1.8	4.4	6.5988
6	15.0	15.0	2.0	5.8	6.3544

Time variation:

The effect of time required for the oxidation of manganese has been studied by taking an aliquot (5 ml) to which 30 ml H_3PO_4 and 10 ml water is added at different intervals of time-2 min, 5 min, and 10 min time periods. The results indicate that a maximum time of 10 minutes is sufficient for complete oxidation beyond which it is independent of time (Table-1).

Table – 3. Determination of Manganese in battery samples

Amount of battery sample taken in gms	Amount of Mn found in gms (periodate method)	Amount of Mn found in gms (persulphate method)
0.5	0.1201	0.115
1.0	0.1164	0.109
1.5	0.1435	0.156
2.0	0.2779	0.275
2.5	0.3705	0.3685

Effect of dichromate concentration:

To study the effect of concentration of dichromate solution upon oxidation of manganese in the samples, an aliquot (5.0 ml) of the sample is oxidized with different concentrations containing equal proportions of dichromate solutions (Fig.!).It is also noticed that further increase in concentration of dichromate solution (beyond 0.05 N) resulted in irregular titre values corresponding to different amounts.

The above findings are confirmed by spectrophotometric studies.
The study comprises oxidation of the battery samples containing manganese in lower oxidation state to manganese (VII) (I) by potassium periodate hot acid and (ii) by persulphate along with special reagents .The total manganese content in the samples analyzed were compared with those samples analyzed were compared with those values obtained by oxidizing standard manganese (II) sulfate (known manganese content) under similar conditions . So the values obtained in the present study may be considered suitable for the recovery of manganese.

It was also observed that the oxidation of manganese content in the samples achieved improved results with periodate than with persulphate.

CONCLUSION

It can be concluded that separation and determination of manganese in dry batteries was achieved efficiently in presence of perchloric acid . The procedure adopted for manganese recovery was successfully compared with spectrophotometric studies.

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