بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

MONA MAGHRABY

Faculty of Science
Chemistry Department

Performance evaluation of polyacrylonitrile-based polymeric composites as dual-function sorbents for some pollutants of interest to nuclear activities

A Thesis Submitted by

Moustafa Ali Moustafa Hamoud

M.Sc. chemistry (2014)

Assistant Lecturer

Nuclear Chemistry Department – Hot Laboratories Center

Atomic Energy Authority

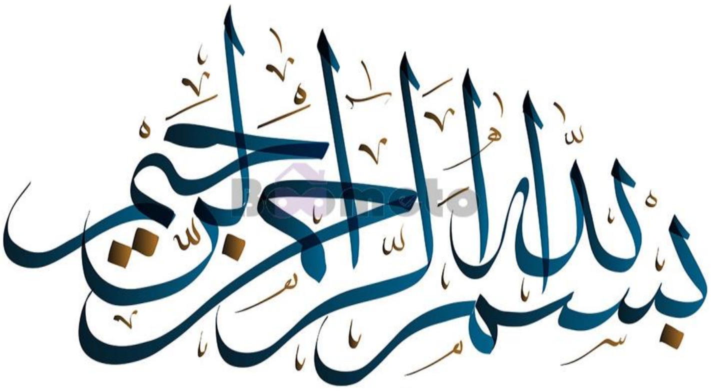
To

Chemistry Department-Faculty of Science-Ain Shams University

For

The degree of Ph.D of science in chemistry

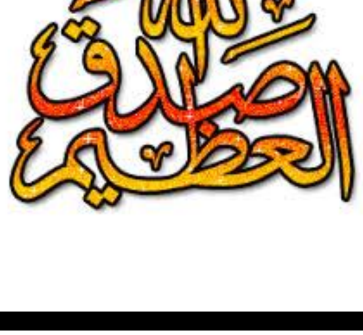
2020



قَالُوا سُبْحَانَكَ

لا عِلْمَ لَنَا إِلا مَا عَلَّمْتَنَا

إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ



Dedicated to

(The Soul of my Parents and Prof. Dr. Wafaa Sanad)

To

My Brothers, My Lovely Wife and My kids

All of those who Love me

Moustafa Ali Moustafa

Acknowledgment

First, I am deeply thankful to my God "**Allah**", by the grace of whom, the progress and success of this work was possible.

I would like to express my deep gratitude to **Prof. Dr. Ebtissam Ahmed Saad** prof. of Radio and Inrganic Chemistry, Faculty of Science, Ain Shams University; for his sponsorship and moral support of this work,.

I am greatly indebted to **"late" Prof. Dr. Wafaa Sanad,** Prof. of Radiochemistry, Nuclear Chemistry Department, Hot Laboratories Center, Atomic Energy Authority (EAEA); for her continuous supervision, and valuable discussions and I hope my God bless her soul.

I would like to express my sincere appreciation to **Prof. Dr. Karam Allan,** Prof. of Radiochemistry, Nuclear Chemistry Department, Hot Laboratories Center, Atomic Energy Authority (EAEA); for his continuous supervision, and valuable discussions.

I am greatly indebted to **Ass. prof. Dr. Mamdoh Refaat,** Ass. Prof. of Radiochemistry, Nuclear Chemistry Department, Hot Laboratories Center, Atomic Energy Authority (EAEA); for suggesting the topics of this thesis, planning of the experimental work, effective supervision, valuable discussions, sincere advices, and continuous encouragement during all phases of carrying this work.

Thanks are also expressed to **Prof. Mohamed Holiel** and **Prof. Refaat Ragheb,** Emeritus Profs., Nuclear Chemistry Department, Hot Laboratories Center, Atomic Energy Authority (EAEA); for their unlimited help during the experimental work.

The assistance and support of **all staff members** of the Nuclear Chemistry Department, notably of **Ass. prof. Dr. Saber Ibrahim Mohamed** are deeply appreciated.

Finally, I would like to express my deep thanks to **my family** for their unlimited support, and looking after me.

Publications

From chapter III of this thesis, the following publication is extracted:

Journal of Radioanalytical and Nuclear Chemistry (2020) 324:647–661
https://doi.org/10.1007/s10967-020-07098-5

Synthesis of PAN/ferrocyanide composite incorporated with cetrimonium bromide and its employment as a bifunctional adsorbent for coremoval of Cs^+ and $HCrO_4^-$ from aqueous solutions

Moustafa A. Hamoud[1] · Karam F. Allan[1] · Wafaa A. Sanad[1] · Ebtissam A. Saad[2] · Mamdoh R. Mahmoud[1]

Received: 24 November 2019 / Published online: 17 March 2020

Abstract

Polyacrylonitrile/ferrocyanide composite incorporated with cetrimonium bromide (PFICB) was synthesized and evaluated as a novel bifunctional adsorbent for coremoval of Cs^+ and $HCrO_4^-$. Results of the reaction time effect showed that adsorption of Cs^+ and $HCrO_4^-$ onto PFICB were rapid processes. The effect of the solution pH in the range 2.5–10 revealed that PFICB had the ability to simultaneously remove Cs^+ and $HCrO_4^-$. The maximum adsorption capacity of PFICB was found to be 41.79 mg/g for Cs^+ and 19.39 mg/g for $HCrO_4^-$. These values were compared with those reported in literature using other adsorbents.

Keywords Ferrocyanide · Cesium · Chromate · Polyacrylonitrile · Adsorption · Coremoval

Introduction

Chemical precipitation, solvent extraction, membrane separation, adsorption and foam separation are the traditional methods applied for removal of radioactive materials from aqueous solutions [1–5]. Nevertheless, utilization of these methods is challenged by the occurrence of cationic and anionic radio-toxicants in radioactive liquid wastes where multi-treatment processes and/or multi-steps are required which is undesirable particularly from the economic point of view. A one-step treatment process is therefore necessary to avoid such drawbacks. Herein, researchers' efforts in our laboratory have been directed in the last years to find appropriate one-step processes for treatment of radioactive liquid wastes contaminated with cationic and anionic radionuclides. Results of these studies showed the potentiality to simultaneously remove $^{60}Co^{2+}$ and $HCrO_4^-$ [6], $^{63}Ni^{2+}$ and $^{51}CrO_4^{2-}$ [7] and $^{137}Cs^+$ and $^{99}TcO_4^-$ [8]. Besides, $As^{3+}/SO4^{2-}$ [9], Tl^+/Cl^- [10], $Cu^{2+}/HCRO_4^-$ [11], $Cd^{2+}/HAsO_4^{2-}$ [12], Cu^{2+}/SO_4^{2-} [13], Pb^{2+}/NO_3^- [14], $As^{3+}/HAsO_4^-$ [15] and Cd^{2+}/CN^- [16] binary systems have been studied in literature. However, simultaneous removal of cationic and anionic species in these publications is governed by the utilization of multi-step treatment processes. Regarding these published papers, it can be seen that simultaneous removal of $^{134}Cs^+$ and $HCrO_4^-$, which are the concerned species in the current study, has not been studied yet. Cesium radionuclides are found in radioactive liquid wastes owing to their applications in many fields such as radiochemistry, medicine, mineral processing, industry and food irradiation [17, 18]. Owing to its solubility and similarity to other alkali elements (e.g. K^+ and Na^+), cesium ion easily absorbs by plants. If ingested, it creates an internal hazard particularly to the reproductive system [19]. Radioisotope production and radiochemistry research laboratories can be responsible for the existence of hexavalent chromium radionuclide (^{51}Cr(VI)) in radioactive liquid wastes. Besides its radiotoxicity, hexavalent chromium exhibits a chemical toxicity when presents in aqueous solutions at concentrations higher than the admissible ones as it has been reported to be mutagenic and carcinogenic in human [20]. Therefore, such contaminants must be removed from aqueous solutions before being discharged into the environment.

Among the abovementioned treatment processes, adsorption process is extensively applied for removal of

✉ Mamdoh R. Mahmoud
mamdoh.refaat@eaea.org.eg

1 Nuclear Chemistry Department, Hot Laboratories Center, Atomic Energy Authority, P.O. Box 13759, Inshas, Cairo, Egypt

2 Chemistry Department, Faculty of Science, Ain Shams University, Cairo, Egypt

Contents

CHAPTER II: Experimental

CHAPTER III

Synthesis of PAN/ferrocyanide composite incorporated with cetrimonium bromide and its employment as a bifunctional adsorbent for coremoval of Cs^{+} and $HCrO_4^{-}$ from aqueous solutions

CHAPTER IV

Efficient removal of radiocobalt and manganese from their binary aqueous solutions by batch adsorption process using PAN/CB/KCuHCF composite

List of Tables

List of Figures