

**TREATMENT OF INDUSTRIAL WASTE WATER  
CONTAMINATED BY AROMATIC NITRO  
COMPOUNDS**

**Submitted By**

**Sarwat Shaioon Mohamed Allam**

B.Sc. of Science (/Chemistry), Faculty of Science, Ain Shams University,  
1996

A Thesis Submitted in Partial Fulfillment  
*Of*  
The Requirement for the Master Degree  
*In*  
Environmental Sciences

Department of Environmental Basic Sciences  
Institute of Environmental Studies and Research  
Ain Shams University

**2020**

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**This thesis was discussed and approved by:**

The Committee

Signature

**1-Prof. Dr. Taha Abd El Azzem Mohamed Abd El-Razek**

Prof. of Environmental Chemistry, Department of Basic Sciences  
Institute of Environmental Studies & Research  
Ain Shams University

**2-Prof. Dr. Eissa El Sayed Hekal**

Prof. of Physical Chemistry and Building Materials  
Faculty of Science  
Ain Shams University

**3-Prof. Dr. Noha Samir Donia**

Prof. of Hydraulics & Vice Dean of Institute of Environmental  
Studies & Research for Environment & Community  
Ain Shams University

**4-Dr. Ysery Ali Abd El-Aziz Yosef**

Associate Prof. of Chemical Engineering  
Atomic energy authority

**5- Dr. Ashraf Abdou Ismail**

Associate Prof. of Inorganic Chemistry  
Center for Scientific and Technological Excellence  
Ministry of Military Production  
President of Golf Water Solutions and Service (GWSS)

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Associate Professor (Inorganic Chemistry), Science &Technology center of Excellence (STCE), Ministry of Military Production

Chairman of Gulf water solutions and Services company (GWSS).

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## **ABSTRACT**

### **Treatment of Industrial Waste Water Contaminated by Aromatic Nitro Compounds**

The disposal of waste water (red water) that produced during the production of TNT in environmental acceptable manner possesses serious difficulties. For many years this red water were disposed of by the method open burning but the method is not acceptable today owing to the effect of particulates, nitrogen oxide and other harmful products which pollute the air. Some other methods of incineration are available which overcome part of these difficulties, but they are very costly. Using adsorption followed by advanced oxidation processes (AOPs) are the most feasible technologies for red water treatment. In the present work, two types of carbon were used for treatment separately and simultaneously. Bone charcoal (BC) is prepared from animal bones and activated carbon (AC) prepared from Rice Husk. Operational parameters in each step were tested and optimized. The adsorption isotherms of TNT red water at a wavelength 200 nm by (BC) and (AC) have been evaluated. Then, treatment of red water by mixing (BC) and (AC) were assessed, followed by advanced oxidation with ultraviolet and hydrogen peroxide. As a measure of extent of treatment, we use the % removal at wavelength 200 nm, also we measure the total organic carbon (TOC), and chemical oxygen demand (COD) before and after treatment. The removal was favored at low pH, with maximum removal (90%) at pH = 2 for BC while for AC the maximum removal (95%) at pH = 10. After the treatment of red water by adsorption on mixing carbons (BC + AC) followed by AOPs, the removal is 95%, total organic carbon is (95%) and chemical oxygen demand is (97%). According to preceding results the red water after treatment by the recommended method in this work is suitable for discharge safely.

## AIM OF THE WORK

The aim of this work includes the following:

- 1- Preparation of various activated carbons from locally available agro-residues. The study also focuses on physicochemical characterization of these activated carbons. Finally, application of the best activated carbon with advanced oxidation process (AOP) in the treatment of liquid waste of a TNT manufacturing plant in Abu-Zaabal company for specialty chemicals.
- 2- The removal of nitro-aromatic compounds which represent the major industrial waste water concentration in the TNT manufacturing.

In this concern, the proposed research program is directed to investigate the following:

First: Removal of nitro-organic compounds by applying the adsorption technique using activated carbon (AC) and bone charcoal (BC) separately and simultaneously.

Second: using the advanced oxidation process (AOP) as a promising technique to remediating nitro-organic, compounds which are not adsorbed on the carbon surface in the first stage.

Third: factors affecting both techniques adsorption and AOP such as: equilibrium time, adsorbent mass and pH for adsorption process, amount of oxidant  $H_2O_2$  and exposure time for AOP process.

Finally, design recommended procedures for the integrated treatment process of TNT red water and thus the treated water can be discharged safely.

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## Abbreviations

RHAC	Rice Husk Activated carbon
AOPs	Advanced oxidation processes
BC	Bone charcoal
BOD	Biological oxygen demand
COD	Chemical oxygen demand
DNB	Dinitrobenzene
DNT	Dinitrotoluene
DOD	The United States Department of Defense
DS	Dissolved solids
EPA	Environmental protection Agency
FTIR	Forward transmittance infrared
GAC	Granular activated carbon
HLR	Hydraulic loading rates
NDIR	Non-dispersive infrared detector
Rh	Rice husk
SS	Suspended solids
STP	Standard temperature and pressure
TAT	Triaminotoluene
TDS	Total Dissolved solids
TNB	Trinitrobenzenene
TNT	Trinitrotoluene
TOC	Total organic carbon
TSS	Total suspended solids
UVO	UV oxidation

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## **1-INTRODUCTION**

### **1.1. Industrial pollutants**

One of the landmarks of advanced civilization is its concern for the disposal of its society's waste products in a safe and environmentally acceptable manner. Water pollution problem has intensified through the ages in response to the increased growth and concentration of population and industrial centers. Often, the problems have been viewed as inevitable consequences of community development and sometimes even have been accepted as evidence of affluence and progress. The efforts of removing man-made pollutants from the natural environment have been unable to keep pace with the increasing amounts of waste materials resulting from municipal and industrial effluents. For many years, a prime motivation in the controlling pollution stream was to protect the public from the waterborne diseases and to prevent the upset of biological balance in the aquatic life.

#### **1.1.1. Industrial wastewater:**

Refer to the industrial production process of wastewater discharge, including process water, machinery and equipment cooling water, flue gas washing water, equipment and site washing water (Kalderisa et al., 2008).

Industrial wastewater in addition to indirect cooling water and then also known as industrial sewerage is the main target of industrial wastewater treatment (Yost et al., 2007).

According to the main components of pollutants in wastewater it can be divided into acidic wastewater, alkaline wastewater, phenol wastewater, cadmium-containing wastewater, chromium-containing

wastewater, zinc-containing wastewater, and mercury-containing wastewater, fluoride wastewater, containing organic phosphorus wastewater, and including radioactive waste water (Flokstra et al., 2008).

### **1.1.2. Red water:**

It is the wastewater resulting from washing and purification of TNT processes and it is commonly referred to as TNT red water (Chen et al., 2007), and currently, red water is classified by the U.S. Environmental protection Agency (EPA) as a resource conservation recovery act (RCRA)-regulated hazardous waste (K047) based on its reactivity (Burrito-Rodrigues et al., 2008).

Due to the severe toxicity and doubtful carcinogenicity of 2, 4-DNT, 2, 6-DNT and 2, 4, 6-TNT, they should be removed from the wastewater before it is released into the environment (Maloney et al., 2008). This work presents the characterization of wastewater from Abu Zaabal Company for Specialty Chemicals TNT production plant using the analytical techniques of mass spectroscopy, chromatography, toxicity assays and other physical–chemical analyses.

### **1.1.3. Environmental problem:**

The disposal of wastewater (red water) that produced during the production of TNT in an environmental acceptable manner possesses serious difficulties. For many years this red water were disposed of by the method open burning but the method is not acceptable today owing to the emission of particulates, nitrogen oxides and other harmful products which pollute the air. Some other methods of incineration are available which overcome part of these difficulties, but they are very costly.