Environmental Science and Engineering

Dongfei Han
Mohammed J. K. Bashir *Editors*

Environmental Governance, Ecological Remediation and Sustainable Development

Selected Papers from 2023 3rd International Conference on Environmental Pollution and Governance (ICEPG 2023)

Springer

Environmental Science and Engineering

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Preface

Titled with *Environmental Science and Engineering* and available on latest research progress about environment and its relevant issues, this paper volume gathers a bunch of papers collected from 2023 3rd International Conference on Environmental Pollution and Governance (ICEPG 2023), held via hybrid form in Xiamen, China during October 27 to 29, 2023.

The Conference, attended by more than 160 delegates from around the globe, was presided over by Dr. Mian Liu, Xiamen University of Technology, China. In the keynote speech part, Prof. Feiyong Chen (Shandong Jianzhu University, China) highlighted the important role of ecological restoration in the comprehensive management of water environment in his report Water Environment Comprehensive Regulation and Ecological Restoration. With ecological concepts, methods, and technologies as the core, advanced technologies such as green road, ecological floating island, and ecological slope protection were comprehensively applied to create diversified ecological environment types, establish multi-level stable biological populations and structures, and achieve sustainable development of water environment. Apart from the keynote speeches, oral and poster presentation parts were also held and displayed by various scholars, leading to a warm atmosphere of academic discussion.

We received a number of submissions from the Conference. After rigorous review by related top experts and review rebuttal process, various excellent papers were accepted and included in this Proceedings. These papers cover various subjects of the Conference: Environmental Pollution Control Technology, Solid Waste Treatment and Recycling, Radioactive Contamination Control, Power Plant Water Treatment Technology, etc. The works of this volume can to some extend promote the development of environmental engineering, and thereby enhance scientific information interchange between scholars from top universities, research centers and high-tech enterprises working all around the world.

Featuring the most cutting-edge research directions and achievements related to environmental engineering, this Conference provided the most comprehensive research in related fields and a more comprehensive understanding of the latest results

of cross researches in the fields. Meanwhile, it also helped researchers and engineers understand the research frontier, as well as discover the solutions to potential problems.

We would like to acknowledge the authors for their contributions and the reviewers for their time to review the submissions rigorously. We are thankful to all the Committee members and advisors of this volume. Finally, this volume presents some of the latest researches in the fields related to environmental engineering and is believed to be beneficial to develop relevant subjects. We hope that it will serve as a reference for researchers and practitioners in academia and industry in related areas.

The Committee of ICEPG 2023

Suzhou, China — Dongfei Han
Kampar, Malaysia — Mohammed J. K. Bashir

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Part I
Microbiology and Soil Pollution Control

Chapter 1
Study on the Influence of Different Pretreatment Methods on Residual Sludge

Jiamei Wang, Tian Chai, Xin Chen, Xiaopei Lin, and Jing Zhang

Abstract With the continuous advancement of industrialization and urbanization in our country, the discharge rate of industrial wastewater and domestic sewage increases rapidly. A large quantity of activated sludge is produced in the process of sewage purification, and proper treatment of activated sludge has become a difficult problem. Based on this, this study compared the effects of four pretreatment methods and treatment conditions on the degree of sludge breakage, and selected the best pretreatment methods and conditions according to various indexes. The results showed that: When the pH of alkaline treatment was 12 and the treatment time was 3 h, the cracking degree of sludge was the best, the protein concentration reached 0.3113 mg/L, the TOC concentration reached 70.5 mg/L. When the pH of acid treatment is 2 and the treatment time is 2 h, the protein concentration is 0.2625 mg/L and the TOC concentration is 47.70 mg/L, and the cracking effect is the best. When the ultrasonic treatment time was 60 min, the protein concentration was 0.1125 mg/L, the TOC concentration was 23.2 mg/L, and the cracking effect of sludge was the best. When the heat treatment temperature is 90 °C, the heating time reaches 80 min, the protein concentration is 0.4000 mg/L, the TOC concentration is 9.63 mg/L, the

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sludge cracking effect is the best. According to the analysis of three-dimensional fluorescence spectrum, heat treatment is the best method to crack the degree of sludge, followed by alkali treatment, ultrasonic treatment and acid treatment.

Keywords Residual sludge · Pretreatment technology · Sludge cracking · Three-dimensional fluorescence

1.1 Introduction

1.1.1 Research Background

With the development of our country's social economy and the improvement of urbanization level, the sludge production in our country is constantly increasing. According to the data of E20 Environmental Research Institute, the initial calculation of China's municipal sludge production in 2021 is 55.52 million tons, an increase of 8.23% compared with 2020. Sludge as the main solid waste in the process of municipal sewage treatment has increased greatly, and the problem of sludge treatment has become an important problem in the process of sewage treatment. The main components of sludge are water, microorganisms and extracellular polymers (EPS), EPS is some polymer secreted by bacteria in vitro under certain environmental conditions, containing rich proteins, lipids, sugars, etc., its organic content is high, so sludge is a material as a substrate for anaerobic digestion. In order to digest and ferment the sludge more efficiently, it is necessary to crack the floc structure of the sludge and extract the EPS in the cell, so that the organic compounds in the cell can be more easily used in the fermentation process (Wolski 2020).

Therefore, in order to make more efficient use of the organic matter in the sludge, it is necessary to pretreat the sludge, and transform the complex organic components in the sludge into small molecular substances with simple structure and easy degradation through physical, chemical and biological methods (Nguyen et al. 2021; Pan et al. 2019), so that the organic matter is dissolved in the liquid phase, which is convenient for subsequent research and utilization.

1.1.2 Main Research Contents

This study carried out experiments by acid treatment, alkali treatment, ultrasonic treatment and heat treatment, combined with water quality indicators to explore the pretreatment ability, and combined with three-dimensional fluorescence for characterization and analysis. The main content is divided into two parts.

In the first part, the cracking ability of the four pretreatment methods to the stable structure of sludge was explored, and the best control parameters of each pretreatment method were determined according to the TOC and protein indexes.

In the second part, combined with the three-dimensional fluorescence spectrum analysis, the response size of the three-dimensional fluorescence spectrum is used to reflect the changes of sludge composition more directly. Meanwhile, the four pretreatment methods are compared, and the best pretreatment method is determined according to the changes of each response region.

1.2 Experimental Materials and Methods

1.2.1 Experimental Material

The sludge used in this experiment was all taken from the secondary sedimentation tank of an anhydrous treatment plant in Jimei District, Xiamen City. The daily sewage treated by the treatment plant was 6×10^4 m^3, mainly using A^2/O process, and mainly treating the domestic water of residents in Jimei District. After the sludge sample is retrieved, it is directly transported to the laboratory for culture treatment.

1.2.2 Detection Method

All the water samples involved in the relevant parameters of this experiment should be centrifuged for 10 min at the condition of 5000 r/min, and then filtered through the 0.45mm microporous filter, and the filtrate at this time was taken for the determination of relevant indicators. Due to the instability of the sludge, all the experiments were repeated three times under the same conditions, and the data results of this experiment were the average of the three repeated measurements.

Protein detection method. Two sets of 10 ml centrifugal tubes were used. 2 ml of EPS and 2.8 ml of lowry reagent 1 were added into the set of tubes. 2 ml of EPS and 2.8 of ml lowry reagent 2 were added to the second set of tubes. After full mixing, they were left for 10 min at room temperature. 2.0 ml of ultra-pure water was used as blank sample according to the same color rendering operation. Then, 0.4 ml of Folin-phenol reagent was added into the two sets of centrifuge tubes. After dosing, they were left at room temperature for 30 min and readings were obtained at 750 nm. Group 1 was denoted as A_1, group 2 as A_2, absorbance of protein in sample was denoted as $A_{protein}$.

$$A_{Protein} = 1.25 \times (A_1 - A_2) \tag{1.1}$$

Three-dimensional fluorescence spectroscopy (3D-EEM). Three-dimensional fluorescence spectrometer, excitation source is 150 W ozone-free xenon lamp. The parameters are set as follows: The excitation wavelength (Ex) ranges from 200–600 nm, and the interval is 2 nm; The emission wavelength (Em) is fixed at 200–800 nm, the interval is 2 nm, the slit is 5 nm, and the scanning speed is 1200 nm·min^{-1}. Using ultra-pure water as a blank, Raman scattering and first and second order Rayleigh scattering are deducted, and internal rate correction is performed.

1.3 Effect of Pretreatment Technology on Sludge Composition and Content

In this section, different pretreatment conditions of the four pretreatment methods were discussed and clarified based on the physicochemical index parameter TOC and the typical concentration of released organic matter (protein), and the optimal pretreatment conditions of each pretreatment method were explored.

1.3.1 Effect of Heat Treatment on Sludge

Heat treatment is a hydrolysis technology widely used in wet organic waste and biosolids, and has been used in engineering practice. However, the energy consumption of heat treatment is high, so the selection of treatment temperature of sludge heat treatment is particularly critical (Liu and Zhang 2022).

When the treatment time is controlled as 80 min and the treatment temperature is 60 °C, 70 °C, 80 °C, 90 °C and 100 °C respectively, as shown in Fig. 1.1a, the concentration of protein released in the reaction system is 0.2238, 0.3425, 0.3338, 0.4000 and 0.3538 mg/L, among which, The protein concentration reached the highest at 90 °C. As shown in Fig. 1.1b, TOC concentrations released in the reaction system were 4.48, 5.36, 9.36, 9.63 and 6.01mg/L, respectively. With the increase of heating temperature, the TOC concentration of the system increased first and then decreased, and reached the maximum TOC release potential at 90 min.

1.3.2 Effect of Ultrasonic Treatment on Sludge

Ultrasonic pretreatment technology mainly relies on cavitation to produce strong oxidizing free radicals and decomposition of volatile hydrophobic substances in sludge with rising temperature (Zhong-hua et al. 2020). Due to its characteristics of high energy consumption, the main parameter affecting ultrasonic treatment is processing time.