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COMPARISON OF BORON PRESENCE IN THE BLEACHED CIGARETTE STUBS WASTE

Karthigeyen Ramachandran[1], Anis Sakinah Zainal Abidin[2] and Nanthini Balakrishnan[3]

[1,2]*Department of Petrochemical Engineering Polytechnic Tun Syed Nasir Syed Ismail*
[3]*Department of Mathematics, Faculty of Science University Putra Malaysia*

[1]*karthigeyen@ptsn.edu.my*
[2]*anis.sakinah@ptsn.edu.my*
[3]*nanthinibalakrishnan53@gmail.com*

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ABSTRACT

The high prevalence of smoking in Malaysia, particularly among men and adolescents, poses environmental concerns due to the toxic residues in cigarette stubs, including hazardous elements like boron or boric acid, which persist in the environment for extended periods. Therefore, this element could affect the water source and soil, eventually affecting human health. In order to reduce the effect of this element, bleaching process is recommended. Sodium hypochlorite (10%) with ratio 1:2 (sodium: water) was used in bleaching process with sample preparation, followed by analysis using Fourier Transform Infrared Spectroscopy (FTIR) and Energy Dispersive X-Ray (EDX). FTIR analysis showed that the peaks are nearly similar for all four types of sample data those taken 1 hours and 30 minutes post-bleaching, 2 hours 30 minutes post-bleaching, as well as those taken 3 hours 30 minutes post-bleaching and from already used or smoked materials, and no significant differences were observed, in contrast to what was seen in the EDX analysis. The provided data from EDX indicated that the percentage of boron decreased from 42.3% to 20.6% for sample 2 hours 30 minutes post-bleaching and 3 hours 30 minutes post-bleaching. The research on the chemical composition of cigarette stub waste, particularly focusing on boron, is of great significance due to its potential impact on the environment and human health. The study investigated the concentration levels of boron in cigarette stub waste, which could help in developing better waste management strategies to protect the environment.

1. Introduction

Cigarette smoking is a prevalent habit globally, leading to the accumulation of large quantities of stub waste. There is a significant problem with littering cigarette filters in Malaysia. According to a study by Mohd Hanafiah et al. (2019), cigarette butts are the most commonly littered item in the urban areas of Malaysia. This highlights the widespread presence of cigarette filter litter, and the need to address this environmental issue. These stubs, when improperly discarded, pose a threat to the environment and human health because of the potential release of harmful chemicals. However, recycling cigarette stubs has gained attention as a potential solution for reducing waste and mitigating environmental impacts. To implement effective recycling and waste management strategies, it is crucial to gain a comprehensive understanding of the chemical composition of recycled cigarette stubs waste. Cigarette filters have contributed to the growing problem of microplastic pollution. Research conducted by Zulkifli et al. (2020) found that discarded cigarette filters are a significant source of microplastics in Malaysia's urban areas. Microplastics pose risks to marine life and ecosystems, as they can be ingested by organisms and disrupt the food chain. Research conduct by Novotny (2009) found that cigarettes and cigarette filters collected in the International Coastal Cleanup for 1996–2007 shown Figure 1.

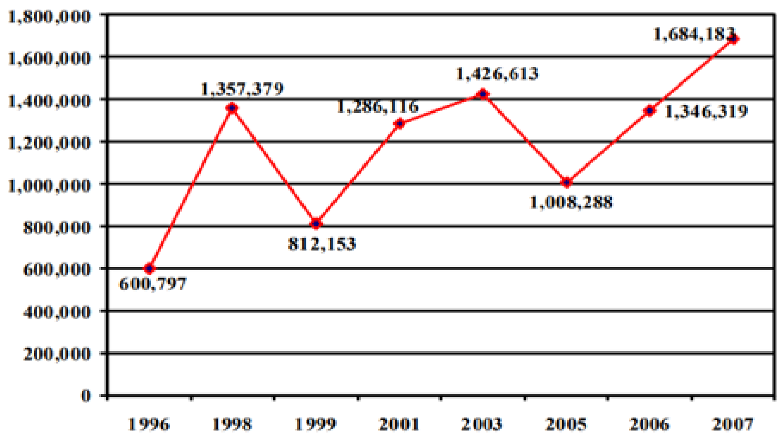

Figure 1: Cigarettes filters collected in the International Coastal Clean-up (Novotny, 2009)

Cigarette filter litter not only harms the environment but also poses health and aesthetic concerns. A study by Ismail et al. (2018) revealed that cigarette butts accounted for a significant portion of the litter found in public spaces, affecting the cleanliness and visual appeal of the surroundings. Furthermore, improper disposal of cigarette filters can lead to the release of toxic chemicals, thereby affecting air and water quality.Malaysia faces a substantial challenge in the littering of cigarette filters. A study conducted by Ismail et al. (2018) in the urban areas of Malaysia revealed that cigarette butts were the most frequently littered item. This demonstrates the widespread issue of cigarette filter litter in the Malaysia.

Several studies have highlighted the environmental impacts of improperly disposed cigarette stubs. For example, Novotny (2009) found that cigarette butts were the most commonly collected type of litter in coastal clean-ups, posing a threat to marine ecosystems. Chemical composition analysis of recycled cigarette stubs waste can provide empirical evidence regarding the presence of hazardous elements and compounds, such as heavy metals and toxic chemicals, which contribute to environmental pollution.

Analysis of the chemical composition can identify the specific toxic substances present in recycled cigarette stubs waste. For instance, Moerman et al. (2011) detected the presence of harmful compounds such as nicotine, polycyclic aromatic hydrocarbons (PAHs), and heavy metals in cigarette butts. Understanding the chemical composition can help to assess the potential health risks associated with exposure to recycled cigarette stubs waste. Improper disposal of cigarette stubs in soil can lead to contamination and affect soil quality. An empirical analysis of the chemical composition can reveal the presence of contaminants, such as boric acid, heavy metals (e.g., lead, cadmium), and organic compounds, which can adversely impact soil fertility and the surrounding ecosystem. A study by Cruz et al. (2020) found elevated levels of heavy metals in soil samples contaminated by discarded cigarette butts, indicating the need for effective waste management practices.

Figure 2: Composition of cigarettes. Ismail et al. (2018)

Research conduct by Ismail et al. (2018) found that cigarette stub waste contains various chemicals and composition that can be harmful to human health that shown in Figure 2. The chemical composition analysis of recycled cigarette stubs waste will reveal the presence of hazardous elements, toxic compounds, and contaminants, posing a significant environmental risk and potential health hazards.The analysis of chemical composition can shed light on the potential for water pollution caused by recycled cigarette stub waste. Boric acid, which is present in cigarette stubs, can adversely affect water sources. According to Li et al. (2018), boric acid can contaminate freshwater bodies and can affect aquatic organisms. Understanding chemical composition can help identify the extent of water pollution and guide appropriate measures for water resource protection.

A study from Girotti. (2015), sodium hypochlorite as a disinfectant and bleaching agent, particularly in the context of recycling cigarette stub waste. Analysis of the chemical composition of the waste after bleaching using sodium hypochlorite plays a crucial role in mitigating environmental risks and improving waste management practices. This enables the identification and quantification of chemical constituents, facilitating the development of effective strategies for handling, treating, and disposing of waste. The use of sodium hypochlorite for bleaching has been demonstrated to modify the chemical composition of waste and promote resource conservation within a circular economic framework. These findings also contribute to innovation in waste management, driving further research and development of improved treatment methods, alternative bleaching agents, and more efficient practices.

According to a study by Silverstein et al. (2014) Fourier Transform Infrared Spectroscopy (FTIR) is a powerful analytical technique used to identify the chemical functional groups in recycled cigarette stub waste and provides a detailed spectrum that represents the absorption patterns of different functional groups, allowing researchers to determine the types of chemical compounds and their structural characteristics in waste. FTIR can detect harmful compounds in recycled cigarette stub waste, such as the polycyclic aromatic hydrocarbons (PAHs) found in cigarette smoke. By analyzing the FTIR, researchers can confirm the presence of PAHs and assess their concentration levels, providing insights into potential health risks. Comparative studies using FTIR of different samples of recycled cigarette stub waste can identify variations in the chemical composition. FTIR can monitor and assess chemical changes during treatment processes to reduce the harmful components in waste. Analyzing FTIR before and after treatment helps to evaluate the effectiveness of treatment methods in modifying the chemical composition and reducing hazardous substances. In a study of Jain et al. (2016) using Fourier Transform Infrared Spectroscopy (FTIR) for the analysis, researchers can gain valuable insights into the chemical composition, identification of harmful compounds, comparative studies, and treatment effectiveness.

Energy Dispersive X-Ray (EDX) analysis enables the identification and quantification of elements present in recycled cigarette stub waste. According to a study by Goldstein et al. (2017) EDX detects characteristic X-ray emissions to determine the types and concentrations of elements present, including heavy metals or trace elements. EDX analysis aids in evaluating contaminants within the waste material. Hossain et al. (2019) EDX analysis helps understand the physical characteristics, potential sources of waste, and behavior of elements. EDX can monitor changes in the chemical composition of recycled cigarette stubs waste during the treatment processes.

Research have use certain consecutive processes and stages of processing in order to achieve the objective, accordingly the steps required to analysis on the chemical composition of the cigarette stubs waste. Boric acid, a toxic substance, has a chemical composition that exhibits a high peak in the analysis. It is commonly found in tobacco, and consumption of boric acid can result in acute or chronic poisoning. For instance, acute poisoning can occur when individuals ingest roach-killing products that contain powdered boric acid. According to the study of Linskens et al. (2014), boric acid is considered a caustic chemical that can harm tissues upon contact. Individuals who are frequently exposed to boric acid may experience chronic toxicity.

2.0 Materials and methods

2.1 Collecting and Cleaning Process

The cigarette stubs waste were gathered randomly around pedestrian areas, sidewalks and everywhere passed by the public. Then, proper segregation from other waste materials was ensured. This helped maintain the purity of the waste material and facilitated the subsequent bleaching process. The waste material needed to be removed and separated from the cigarette filter, which was also known as plug wrap paper and tipping paper located at the end of the waste cigarette butt. The waste material was cleaned by washing it using tap water to remove light dirt, such as small dust.

2.2 Bleaching and Drying Process

Sodium hypochlorite (usually in the form of a bleach) was diluted with water to obtain the desired concentration. Cigarette stubs were placed in a container or vessel and immersed in the prepared sodium hypochlorite solution. The bleaching process was used with sodium hypochlorite (10%) with a ratio of 1:2 (sodium: water) for sample preparation. For efficient treatment, it is essential to ensure that the waste material is fully submerged. The duration of immersion can vary, but preliminary tests should be conducted to determine the optimal contact time. The waste material should be agitated or mixed in a sodium hypochlorite solution to enhance the contact between the chemical and the waste. This promotes bleaching and aids in the removal of impurities and contaminants. A study of Rayung. (2014) mention that after bleaching, clean the waste material with tap water and allowed to completely dry the waste material in oven for 30 minutes and 110˚C. Ensure that the sample is properly dried and free of contaminants or external particles. Four types of sample have been bleached and dried for testing.

2.3 Analysis using FTIR & EDX

The dried samples were prepared for FTIR analysis. A small amount of the waste material sample was placed onto an FTIR sample holder, such as a potassium bromide (KBr) pellet or an attenuated total reflection (ATR) crystal. FTIR analysis was performed using a spectrometer equipped with an appropriate FTIR accessory, such as a transmission or attenuated total reflection (ATR) module. The FTIR spectra of the samples were collected over a suitable wavelength range such as the mid-infrared region. The FTIR spectra were analyzed to identify the functional groups, chemical bonds, and compounds present in the recycled cigarette stub waste. Next,the sample was prepared for EDX analysis also by mounting it on a suitable cigratte stubs waste.The sample holder was placed in an EDX analyzer.The operating conditions of the EDX system, such as the acceleration voltage and beam current, were adjusted based on the characteristics of the sample and desired analysis.EDX analysis was performed by scanning the sample surface with an electron beam and detecting the characteristic X-rays emitted by the elements present.Acquire EDX spectra and analyze the data to determine the elemental composition and identify specific elements or contaminants in the cigarette stubs waste.Four types of samples have been test for FTIR and EDX :

1) Fiber material has been smoked
2) Fiber material that is bleached using sodium hypochlorite within a period of 1 hour 30 minutes
3) Fiber material that is bleached using sodium hypochlorite within a period of 2 hour 30 minutes
4) Fiber material that is bleached using sodium hypochlorite within a period of 3 hour 30 minutes

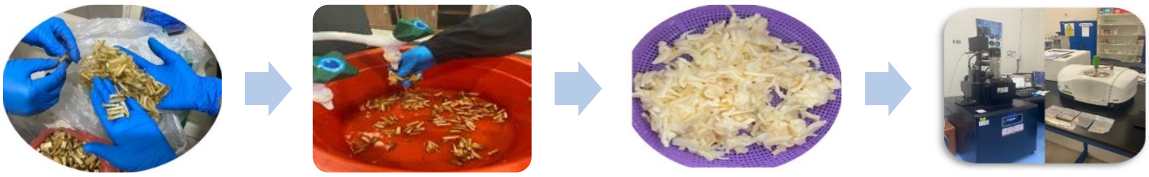

Figure 3: Process of analysing the chemical composition

Process of analysing the chemical composition shown in Figure 3.FTIR and EDX data were to identify the functional groups, compounds, and elements present in the waste material.Quantitatively analyze the EDX data percentage, to determine the relative abundances of the specific components. The impact of the bleaching process using sodium hypochlorite on the chemical composition of the cigarette stub waste was determined by the FTIR and EDX results before and after the treatment.

3.0 Results & Discussion

Analysis of the chemical composition reveals valuable information about the various compounds, elements, and functional groups present in cigarette stubs waste. By employing techniques such as Fourier Transform Infrared Spectroscopy (FTIR) and Energy Dispersive X-Ray spectroscopy (EDX), the specific components of the waste material can be identified and characterized.

3.1 FTIR Analysis

FTIR analysis can provide valuable insights into the presence of boric acid in bleached cigarette stub waste. By examining the obtained FTIR spectra, the characteristic peaks associated with the boron-oxygen bond or boron-containing functional groups can be identified. These peaks indicated the presence of boric acid in the waste material. This analysis can further reveal the relative intensity or changes in these peaks, providing information on the concentration or effectiveness of the bleaching process in modifying the amount of boric acid in the waste material.

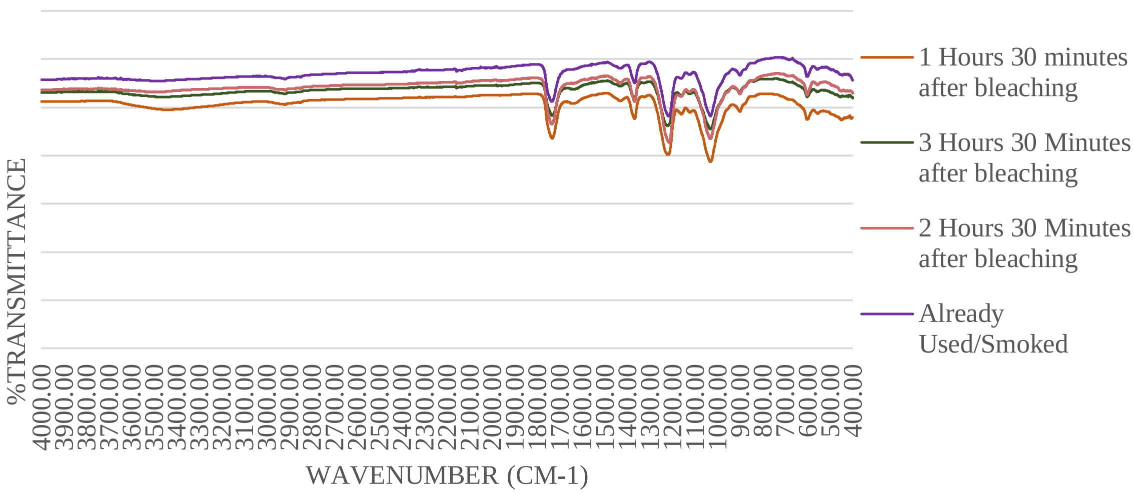

Figure 4: Fourier Transform Infrared Spectroscopy Result

The Figure 4 illustrates four types of sample data analysis using Fourier Transform Infrared Spectroscopy (FTIR). The highest and most intense peaks represent smoked or used cigarettes. Absorption peaks in the fingerprint region (typically 600-1500 cm^-1) correspond to stretching and bending vibrations of CH and CH2 groups, indicating the presence of aliphatic hydrocarbons. Absorption bands around 1700-1750 cm^-1 are characteristic of carbonyl functional groups (C=O), which may indicate the presence of compounds such as ketones, aldehydes, or carboxylic acids. Absorption bands around 1500-1600 cm^-1 suggest the presence of nitro functional groups (-NO2), commonly found in compounds such as nitroaromatics. Following this, we soaked the fiber material in a chemical mixture for 3 h and 30 min using the bleaching method and followed by 2 h and 30 min, with the last data point representing soaking times of 1 h and 30 min. When examining the graph, it was found that FTIR analysis showed that the peaks are nearly similar for all types of sample data, and no significant differences were observed, in contrast to what was seen in the EDX analysis.There is a peak indicating at each of the data that identify presence of boron-oxide-carbon, a chemical component found in the ether group.

3.2 EDX Analysis

Therefore, EDX analysis complements FTIR analysis by providing quantitative information about the elemental composition, specifically the concentration of boron. By detecting characteristic X-rays emitted by the elements, EDX analysis can identify the presence of boron in bleached cigarette stub waste. The results of the analysis indicate the initial concentration of boron before the bleaching process as well as any changes in concentration following the treatment. A reduction in the percentage of boron detected in the waste material after bleaching suggests the efficacy of the treatment in reducing the presence of boric acid or boron. Table 1 illustrates five different types of data analysis using Energy Dispersive X-Ray (EDX).

By examining the material fiber that has undergone smoking, the data obtained from EDX analysis revealed that boron (B) exhibited the highest percentage among the hazard elements detected. It is important to note that when the concentration of boron reaches its maximum, it can potentially have an impact on human health. After subjecting the fiber materials to bleaching using a mixture of sodium hypochlorite and water for 1 h and 30, 2 h and 30 min, and 3 h and 30 followed by drying in a universal oven, the analyzed data revealed interesting findings. Interestingly, the most abundant chemical element observed in the data was boron, which is also reflected in the corresponding table 1.

Table 1: Energy Dispersive X-Ray Result

Atom (Symbol)	Before Bleaching Wt.%	σ	After Bleaching (1hr 30min) Wt.%	σ	After Bleaching (2hrs 30min) Wt.%	σ	After Bleachin g (3hrs 30min) Wt.%	σ
Carbon, C	54.5	3.5	57.6	1.5	61.6	1.8	65.7	1.9
Boron, B	42.3	3.7	33.8	2.8	20.6	2.3	20.6	2.5
Oxygen, O	2.9	0.2	12.4	0.5	17.5	0.5	22.9	0.8
Potassium, P	0.1	0	0	0	0	0	0	0
Calcium, Ca	0.1	0	0	0	0	0	0	0

Upon analyzing the EDX data, it was found that various atoms, including Carbon, Oxygen, Boron, Potassium, and Calcium, were present. The EDX percentage results effectively demonstrated the proportion of atoms remaining in the fiber material. The Boron atom dropping by 8.5% from 42.3% to 33.8% for 1 h and 30. For instance, carbon exhibited a significant increase. Conversely, the Boron atom content experienced a sharp decline, dropping by 21.7% from 42.3% to 20.6% for 2 h and 30 bleaching process. For the 3 h and 30 bleaching process the boron atoms still remain same in for of percentages compare to 2hr and 30 mins. On the other hand, oxygen increased and both calcium and potassium levels experienced a marginal decrease of 0.1%. The results indicate that bleaching resulted in a substantial decrease in the presence of boron atoms. This successfully identify the chemical composition and reducing the boron content in the fiber material. Furthermore, the bleaching agent increased the proportions of oxygen and carbon. This can be attributed to the reaction of the sodium hypochlorite bleaching chemical, which promotes an increase in the oxygen and carbon content. Figure 5 shown the cigarette stubs waste that before(a) and after(b) bleaching process.

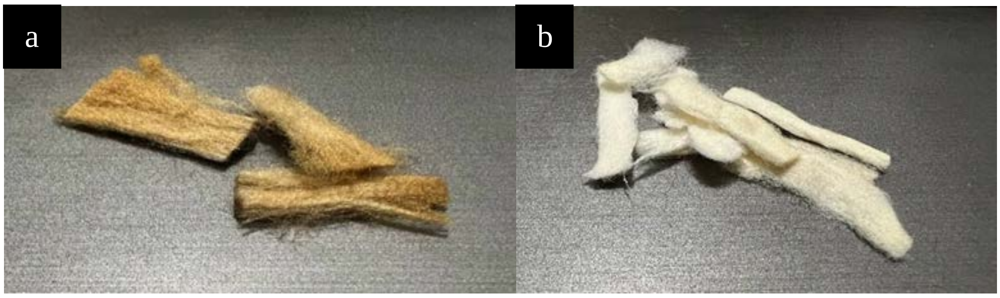

Figure 5: Cigarette stubs waste before(a) and after(b) bleaching process

Overall, these findings highlight the effectiveness of the bleaching process in altering the chemical composition of the fiber material. The reduction in boron atoms, coupled with the increase in oxygen and carbon, signifies the successful modification of the material using the employed bleaching method. The findings from both FTIR and EDX analyses provided insights into the chemical composition of boron in the waste of recycled cigarette stubs. The presence of characteristic peaks in the FTIR spectra and EDX analysis indicated the presence of boron as an element in cigarette stubs. The changes in the concentration of boron before and after the bleaching process can provide valuable information on the effectiveness of the treatment. The results suggest that the bleaching process using sodium hypochlorite has the potential to modify the chemical composition of cigarette stub waste, including the reduction of boron. This reduction is desirable because boric acid can pose environmental risks and affect water sources and soil, ultimately impacting human health. The successful reduction of boric acid through bleaching indicates a positive outcome in terms of waste management and environmental protection.

It is important to note that the specific findings and discussion will depend on the actual results obtained from the FTIR and EDX analyses conducted on bleached cigarette stub waste. The discussion should be tailored to the specific concentrations of boron detected as well as any changes observed before and after the bleaching process. Further interpretation and analysis of the data, along with reference to relevant literature and recommendation, will help provide a more comprehensive understanding of the implications of the presence or reduction of boron in the waste of bleached cigarette stubs.

4.0 Conclusion

In conclusion, the issue of boron in the analysis of the chemical composition of recycled cigarette stub waste is significant due to its potential environmental and health implications. Boric acid is known to be present in cigarette stubs and can pose risks when not properly managed or disposed. The FTIR and EDX analyses confirmed the presence of boron in the recycled cigarette stub waste. This aligns with the expected argument of the study, which aimed to determine the chemical composition of the waste material, specifically focusing on boron compounds aligning with the expected objective of the study. The characteristic peaks observed in both the FTIR spectra and EDX analysis provided clear evidence of the presence of boron. These findings support the expected argument that boron compounds would be present in the waste material. The study evaluated the effectiveness of a bleaching process using sodium hypochlorite in modifying the chemical composition of cigarette stub waste. The changes in boron concentration before and after the bleaching process suggest that the treatment has the potential to reduce the presence of boron in the waste material. This argument emphasizes the importance of identifying and quantifying the concentration of boric acid to assess its potential impacts on water sources, soil, and human health.The analysis using techniques such as FTIR and EDX confirmed the presence of boric acid within the treated cigarette stub waste. FTIR analysis revealed characteristic peaks associated with boron-oxygen bonds or boron-containing functional groups, indicating the presence of boric acid. EDX analysis provided quantitative information on the concentration of boron, confirming its presence as an element in the waste material.The research findings revealed the concentration levels of boron in the waste of bleached cigarette stubs.

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