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Mini Review

In-place Disposal Strategies for Marine Plastic Waste and Debris, Instead of Landfill and Incineration

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ABSTRACT

Synthetic polymers offer many conveniences to modern life, but also pose a waste problem that is difficult to decompose. Over 90% of marine debris is plastic; because of its persistence, its impact on oceans, wildlife and people is increasing over time. This includes the degradation of marine environmental ecosystems, the obstruction of ships by garbage, the havoc of coastal and seabed debris on tourism and fishing, and the burden on coastal communities that depend on the ocean for their livelihoods. This research will realize on-site waste treatment, reduce transportation energy consumption, meet regional energy demands, and reduce carbon emissions from long-distance transportation. For coastal waste, river blockage, fishing port and scenic spot waste, there are immediate benefits of specific reduction and elimination. In addition, we can use the technology in this paper in the replacement of wind turbines, because the composition of the wind turbine blades is composite materials. This application can dispose of decommissioned blades on the spot, reduce transportation costs, and provide a reliable solution to replace the current problem that blades are difficult to recycle.

Keywords: Beach Cleaning; Renewable Fuels; Pyrolysis; Waste Management; Estuarine; Ocean Restoration.

INTRODUCTION

People have widely used petrochemical products in current daily life, improving the quality of life of modern humans. Among them, fossil fuels are natural resources that will be exhausted, including oil, coal and natural gas. After World War II, petroleum applications broke through the fuel stage and entered the field of synthetic plastics. Human life is increasingly inseparable from plastics, creating unprecedented prosperity for the petrochemical industry. Mainly plastic items are durable and lightweight. However, it is also derived that it is difficult to be decomposed by the natural environment after being discarded. In recent years, it has inspired the world to attach great importance to related issues [1]. Since the 1950s, people estimated that billions of tons of plastic have been produced worldwide. Incineration and landfill disposed of most waste plastics.

Although incineration can destroy waste plastics, the incineration process will emit toxic pollutants such as dioxins, acid gases and heavy metals. The heat energy and carbon dioxide released are the biggest cause of the greenhouse effect in the atmosphere [2]. While the latest factories use sophisticated dust collectors, dust collectors and filters to capture these emissions, most factories simply cannot do so [3].

Another method of disposal of plastic waste is landfill. Building landfills is a low-cost carbon capture and storage method [4]. Although waste plastic can eventually be broken down by nature into small pieces of plastic and reduce toxicity, the process is very slow. The plastic particles and toxic substances within the garbage in the landfill will wash and infiltrate with the rainwater, polluting rivers and groundwater. Toxic substances can also seep into the soil, causing soil pollution and affecting plant growth and crop yield. Micro plastics may be eaten by organisms or returned through the food chain to be absorbed by humans

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[5-7]. The chemical composition of plastics can cause new diseases in the human body, and even have catastrophic effects on future generations [8].

Therefore, converting waste plastics into renewable products or energy has become an economical treatment method that science attaches great importance to in recent years [9]. Although most waste plastics can be reused, they cannot fully implement due to economic and environmental factors. For example, the community is poor, the local industrial technology is backward, the cost of transporting waste to other places is high, and the government has no incentives or subsidies. The waste is still randomly piled up, buried, or incinerated, causing greater pollution, and the damage gradually affects the entire earth. Statistics show that 12.7 million tons of plastic waste cannot be properly disposed of into the sea every year, which is equivalent to dumping one truckload of waste into the sea every minute [10]. Sea debris first affects the coast and continues to pollute the ocean through ocean currents. By statistics, marine plastic pollution affected over 700 marine species [11]. Fifteen percent of endangered marine species, including all sea turtles, most whales, and other marine life, eat or become accidentally entangled by marine debris. Marine debris has become a global crisis, second only to climate change [12]. The United Nations launched a marine debris action plan and regional cooperation at the global and regional levels and called on leaders of industrial countries to take the lead in plastic reduction. This study focuses on the treatment of marine debris. Discuss the problems and limitations encountered, and how to use new technologies to overcome current obstacles.

WASTE REDUCTION AND DISPOSAL

Marine debris are serious problem

For ordinary consumers, throwing litter into the trash can and recyclable plastic into the recycling bin should fulfill the obligation to deal with garbage. For the garbage in other places, people also built appropriate garbage disposal sites in densely populated metropolitan areas or industrial areas for reuse, sanitary burial, or incineration.

However, not all waste has resources for proper management. From fishing ports, small factories, tourist attractions, or vicious dumping by unscrupulous operators, they cannot effectively manage many disposable plastic products. Finally, these wastes enter the water cycle system and percolate the coastal and ocean. The ocean is the most terminal receiving field for all kinds of pollution in the entire hydrosphere environment, and it is difficult to trace the source of pollution and prove it. Although each piece of garbage was once produced, sold, or owned by someone, no one handles the pollution after entering the sea, forming complex non-point source pollution. This makes it impossible for marine debris to be effectively managed and properly curb [13].

The coastline is extremely long; the terrain is rugged and varied, and the biodiversity is rich. Although marine waste can be entrusted to professional marine companies to remove it, the cost is high and the amount of treatment is limited. At present, relying on manual beach cleaning is still the most efficient cleaning method, with the lowest ecological impact [14]. If there are enormous wastes that the workforce cannot move, use large machines or ships to assist in the removal. However, governments around the world still lack a systematic coastal cleanup budget coordination and effectiveness tracking mechanism. Most coastal management units make additional cleanups during special events such as heavy rainstorms or large accumulations of marine debris, and do not allocate funds for regular coastal cleanups. Coupled with the difficulty of manpower and mobilization, the effectiveness of workforce beach cleaning is very limited.

We can't deal with coastal litter, let alone marine litter. Garbage that wind and waves have not brought ashore has gathered with the exchange of ocean currents, forming a super "garbage sea" in the three oceans [15]. Since there is no national unit to govern, this type of marine waste is almost unattended, allowing the pollution to continue to expand.

Mobile equipment is the solution for marine debris

Large-scale waste treatment plants have the advantages of various procedures, large processing capacities, and professional facilities to reduce secondary pollution. They use physical, chemical, or biological treatment methods to rapidly decompose waste to meet the requirements of reduction, stability, safety, and resource utilization. However, the high construction costs, the need for a large amount of waste supply to maintain efficient operations, increased industrial safety risks, and protests from local people all make the installation conditions of centralized waste plants extremely strict [16]. After construction, the plant will receive all kinds of mixed waste, and collecting and sorting wastes will consume a lot of workforce, time, and carbon emissions from transportation.

Therefore 90% of marine debris is plastic, it is light, low in density, wide in distribution, and far away from centralized waste treatment plants (Figure 1). How to collect marine waste and transport it to a suitable waste treatment plant, there is still no concrete and effective solution. The method of "clearing marine debris" differs completely from the method of "collecting garbage" on land. Besides the high cost of manpower and garbage transportation, cleaning the coast and seabed has to overcome various difficult environmental conditions, and avoid damaging the ecology [17]. In the event of strong winds or enormous waves, the executive unit must stop the cleaning operation because of safety considerations. It makes extremely difficult to estimate the planning schedule and delay costs.

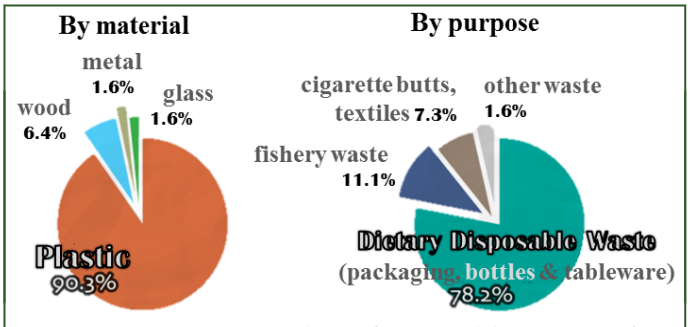

Figure 1: Composition analysis of marine debris. Source from the society of wilderness, Taiwan.

Therefore, use Geographic Information System (GIS) to locate operations and allocate resources to draw up waste disposal plans. Develop a detailed database combined with artificial intelligence to monitor waste sources and predict waste volumes [18]. The formulation of these strategies is an essential step in eradicating ecological dangers in marine ecosystems caused by humans [19].

Then, in order to solve the long and narrow coastline and excessively scattered waste, mobile processing modules became the direction of thinking [20]. The waste treatment equipment is zoomed out and can be placed in a standard 20-foot container, which is called the LowTemperature Pyrolysis Device (LTPD) host. The LTPD host realizes that "where the garbage is, it will drag there the equipment", which not only saves the cost of garbage transportation but also achieves the goal of "zero carbon footprint". It can combine garbage collection with a large inhaler, which is configured on dune buggy and power boats. The temporary storage box is full of garbage and can be fed to the host for disposal, as shown in Figure 2. After unloading, the vehicle or ship can continue to collect waste, which can be repeated. Therefore, the processing range and efficiency are better than pure workforce. Coupled with the small size of the host, the modular design is easy to integrate, so only a small amount of manpower is required to operate on site, which reduces the operating cost of personnel. Plastic waste comes from petrochemicals and can be pyrolysis into renewable fuels [20]. They used fuel in internal combustion engines to continuously provide energy to LTPD host, dune buggy and power boats. Achieve sustainable goals.

Figure 2: Schematic diagram of mobile equipment for disposing marine debris.

Disposal of decommissioned wind turbine blades

Rising demand for composites globally, leading to significant legacy issues in manufacturing and end-of-life. The heterogeneity of composite materials, such as carbon fiber composite bicycle frames and wind turbine blades, is the primary challenge for recycling [21]. Carbon fiber or glass fiber made most of the current wind turbine blades. The blades of old wind turbines can be as long as half a football field and the blades of new 15MW wind turbines are longer than a 100-meter runway.

Decommissioning blades is first a problem of disassembly and transportation, especially the handling of blades is a very difficult and big challenge. If mobile equipment is used to process it near the wind turbine, it will save huge freight costs and reduce the carbon footprint. In addition, because the blades are difficult to recycle and reuse, most of them are disposed of after crushing [22]. In the European Union, stricter legislation on landfills, increases in landfill taxes, and loss of valuable materials are driving the need to develop composite recycling technologies. However, recycling environmental benefits may not be optimized because of the lack of high-completeness environmental datasets. These considerations include mechanical, High Pressure Crushing (HVF), and chemical recycling methods [23].

DISCUSSION

Fan blades with an average lifespan of 20 years have gradually entered the wave of decommissioning. In Taiwan, the first land-based wind turbine is expected to be decommissioned in 2023, and up to 900 wind turbine blades will need to be replaced in the future. And the fan blades that have expired may not be stacked or buried because the carbon fiber and glass fiber in the blade will emit pollution [24]. Glass fiber reinforced plastic is a thermosetting plastic composed of glass fibers and polymer compounds. Composites are nearly impossible to separate for recycling, and so is carbon fiber.

Microwave pyrolysis works with thermoset plastics [25]. Thus, a microwave pyrolysis unit heats faster, is cleaner, easier to operate, is easily miniaturized for modular applications, allows reactors to operate at lower temperatures, and achieves higher energy conversion efficiency [26]. Therefore, through microwave pyrolysis technology, the Glass Fiber Reinforced Plastic (GFRP) with large volume, low density, and lightweight is converted into solid carbide with small volume and high density. Just like small stone do not produce dust, it is convenient to take out and deal with separately, and will not cause environmental pollution. The LTPD host technology uses microwave pyrolysis, which can apply to the disposal of fan blades.

CONCLUSIONS

The small and modular mobile equipment is easy to consign and can dispose of sea drifts that have wide distribution areas, are low-density, and light-weight along the coastline, especially plastic bottles, Styrofoam, and waste wood. It can also carry the equipment on board to process waste that is on board and salvaged from the sea. The equipment can go deep into remote areas such as blocked rivers, scenic spots, etc., to dispose of waste on-site. It can reduce the increased carbon emissions caused by the long-distance transportation of waste to stationary factories for treatment. If the waste contains organic components, it can be pyrolysis into renewable fuel, which can be for its internal combustion engine. This can achieve multiple purposes, such as reducing waste, reducing environmental impact, and solving power shortage energy needs. This article

discusses the exact and workable solutions, in line with the direction of sustainable development. It can not only reduce the amount of waste, and reduce environmental pollution, but also achieve the purpose of a circular economy. If the scale is expanded, it can also solve the problem of excessive plastic waste on land and in the ocean. It will also be of great help to countries that rely almost entirely on imports of energy.

REFERENCES

1. Thompson RC, Moore CJ, Vom Saal FS, Swan SH. Plastics, the environment and human health: current consensus and future trends. Philos Trans R Soc Lond B Biol Sci. 2009; 364(1526): 2153-2166.
2. Shen M, Huang W, Chen M, Song B, Zeng G, Zhang Y. (Micro) plastic crisis: un-ignorable contribution to global greenhouse gas emissions and climate change. J Clean Prod. 2020; 254, 120138.
3. Chen HL, Nath TK, Chong S, Foo V, Gibbins C, Lechner AM. The plastic waste problem in Malaysia: management, recycling and disposal of local and global plastic waste. SN Appl Sci. 2021; 3: 1-15.
4. Lou XF, Nair J. The impact of landfilling and composting on greenhouse gas emissions–a review. Bio Technol. 2009; 100(16): 3792-3798.
5. Chae Y, An YJ. Current research trends on plastic pollution and ecological impacts on the soil ecosystem: A review. Environ Pollut. 2018; 240: 387-395.
6. Hodson ME, Duffus-Hodson CA, Clark A, Prendergast-Miller MT, Thorpe KL. Plastic bag derived-microplastics as a vector for metal exposure in terrestrial invertebrates. Environ Sci Technol. 2017; 51(8): 4714-4721.
7. Huerta LE, Mendoza VJ, Ku QV, Chi JDLA, Sanchezdel CL, Chi C, et al. Field evidence for transfer of plastic debris along a terrestrial food chain. Sci Rep. 2017; 7(1): 14071.
8. Wang YL, Lee YH, Chiu IJ, Lin YF, Chiu HW. Potent impact of plastic nanomaterials and micromaterials on the food chain and human health. Int J Mol Sci. 2020; 21(5): 1727.
9. Lange JP. Managing plastic waste-sorting, recycling, disposal, and product redesign. ACS Sustain Chem Eng. 2021; 9(47): 15722-15738.
10. Agamuthu P, Mehran SB, Norkhairah A, Norkhairiyah A. Marine debris: A review of impacts and global initiatives. Waste Manag Res. 2019; 37(10): 987-1002.
11. Gall SC, Thompson RC. The impact of debris on marine life. Mar Pollut Bull. 2015; 92(1-2): 170-179.
12. Cowan E, Tiller R. What shall we do with a sea of plastics? A systematic literature review on how to pave the road toward a global comprehensive plastic governance agreement. Front Mar Sci. 2021; 8: 798534.
13. Alpizar F, Carlsson F, Lanza G, Carney B, Daniels RC, Jaime M, et al. A framework for selecting and designing policies to reduce marine plastic pollution in developing countries. Environ Sci Policy. 2020; 109: 25-35.
14. Zielinski S, Botero CM, Yanes A. To clean or not to clean? A critical review of beach cleaning methods and impacts. Mar Pollut Bull. 2019;139: 390-401.
15. Karakuş O. Can We" Sense" the Call of The Ocean? Current Advances in Remote Sensing Computational Imaging for Marine Debris Monitoring. arXiv preprint arXiv:2210. 2022; 06090.
16. Hacking N, Flynn A. Protesting against neoliberal and illiberal governmentalities: A comparative analysis of waste governance in the UK and China. Polit Geogr. 2018; 63: 31-42.
17. Madricardo F, Ghezzo M, Nesto N, Mc Kiver W J, Faussone GC, Fiorin R, et al. How to deal with seafloor marine litter: an overview of the state-of-the-art and future perspectives. Front Mar Sci. 2020; 7: 505134.
18. Moy K, Neilson B, Chung A, Meadows A, Castrence M, Ambagis S, et al. Mapping coastal marine debris using aerial imagery and spatial analysis. Mar Pollut Bull. 2018; 132: 52-59.
19. Hung YC, Chen LY. Using Intelligent Clustering to Implement Geometric Computation for Electoral Districting. ISPRS Int J Geo-inf. 2019; 8(9): 369.
20. Hung YC, Ho CH, Chen LY, Ma SC, Liu TI, Shen YC. Using a Low-Temperature Pyrolysis Device for Polymeric Waste to Implement a Distributed Energy System. Sustainability. 2023: 15(2): 1580.
21. Joustra J, Flipsen B, Balkenende R. Structural reuse of high end composite products: A design case study on wind turbine blades. Resour Conserv Recycl. 2021; 167: 105393.
22. Majewski P, Florin N, Jit J, Stewart RA. End-of-life policy considerations for wind turbine blades. Renewable Sustainable Energy Rev. 2022; 164: 112538.
23. Korniejenko K, Kozub B, Bąk A, Balamurugan P, Uthayakumar M, Furtos G. Tackling the circular economy challenges—Composites recycling: Used tyres, wind turbine blades, and solar panels. J Compos Sci. 2021; 5(9): 243.
24. Rani M, Choudhary P, Krishnan V, Zafar S. A review on recycling and reuse methods for carbon fiber/glass fiber composites waste from wind turbine blades. Compos B Eng. 2021; 215: 108768.
25. Yang W, Kim KH, Lee J. Upcycling of decommissioned wind turbine blades through pyrolysis: A review. J Clean Prod. 2022; 134292.
26. Garcia-Nunez JA, Pelaez-Samaniego MR, Garcia-Perez ME, Fonts I, Abrego J, Westerhof RJM. Historical developments of pyrolysis reactors: a review. Energy & Fuels. 2017; 31(6): 5751-5775.