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Invited Review

Oil sorbents from plastic wastes and polymers: A review

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HIGHLIGHTS

- Polymers such as polypropylene, polyethylene, polystyrene, etc. are major components of municipal solid waste.
- This review is the first of its kind reporting and compiling various methods of producing oil sorbents from plastics.
- One method of combating plastic wastes as well as oil spill is through the use of sorbents.
- Producing oil sorbents from plastic wastes and polymers can also fulfill waste management purposes.
- Synthesis methods and characterization of oil sorbents have been reviewed from virgin polymers as well as plastic wastes.

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ABSTRACT

A large volume of the waste produced across the world is composed of polymers from plastic wastes such as polyethylene (HDPE or LDPE), polypropylene (PP), and polyethylene terephthalate (PET) amongst others. For years, environmentalists have been looking for various ways to overcome the problems of such large quantities of plastic wastes being disposed of into landfill sites. On the other hand, the usage of synthetic polymers as oil sorbents in particular, polyolefins, including polypropylene (PP) and polyethylene (PE) have been reported. In recent years, the idea of using plastic wastes as the feed for the production of oil sorbents has gained momentum. However, the studies undertaking such feasibility are rather scattered. This review paper is the first of its kind reporting, compiling and reviewing these various processes. The production of an oil sorbent from plastic wastes is being seen to be satisfactorily achievable through a variety of methods Nevertheless, much work needs to be done regarding further investigation of the numerous parameters influencing production yields and sorbent qualities. For example, differences in results are seen due to varying operating conditions, experimental setups, and virgin or waste plastics being used as feeds. The field of producing oil sorbents from plastic wastes is still very open for further research, and seems to be a promising route for both waste reduction, and the synthesis of value-added products such as oil sorbents. In this review, the research related to the production of various oil sorbents based on plastics (plastic waste and virgin polymer) has been discussed. Further oil sorbent efficiency in terms of oil sorption capacity has been described.

Contents

1. Introduction 425
2. Ways of combating oil spills 426
   2.1. Burning 426
   2.2. Booms and skimmers 426
   2.3. Chemical dispersants 426
   2.4. Sorbents 426

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3. Desired properties of oil sorbents made from plastics 426
3.1. Good mutual solubility 426
3.2. High surface area (and/or high surface to thickness ratio) 426
3.3. Porous structure 426
3.4. Penetration into network structure (swelling) 426
3.5. Low degree of cross linking 426
4. Fabrication strategies of oil sorbents from plastic wastes 426
4.1. Chemical conversion 426
4.2. Grafting 427
4.3. Gamma radiation 427
4.4. Mechanical method 427
4.5. Porous films 427
4.5.1. Dry-Stretch process 427
4.5.2. Particle stretch process 428
4.5.3. Wet process 428
4.6. Aerogels 431
5. Sorbents based on plastics types 431
5.1. Polyurethane oil sorbents 431
5.2. Polystyrene oil sorbents 433
5.3. Polyethylene and polypropylene based oil sorbents 433
5.4. Methacrylate polymers (polyacrylates or acrylics) oil sorbents 434
5.5. Oil sorbents based on miscellaneous polymers 434
6. Future prospects 435
References 435

1. Introduction

Plastic products opened a new era in industrial history ever since synthetic polymers were first introduced into industrial scale production in the 1940s [1]. Booming research and utilization of plastic products considerably and profoundly changed the structure of material research and application. This originated from the fascinating character of plastics including high resistance to corrosion, high flexibility to process applications and low manufacturing cost. Apart from their wide use in decoration, electronics industry and construction applications [2], they are extensively used as shopping bags, bottles, and pipes. Due to their extensive scale of production, the waste generated by plastic is also alarming. There are many species that are directly affected by plastic wastes. Seabirds are amongst the most vulnerable creature and are observed to consume floating plastics [3]. Another problem associated with plastic waste is related to the screening or presence of different grades of plastic waste. Plastics need greater processing in order to be recycled than glass or metal. They must often be of nearly identical composition to become mixed efficiently. When different grades of plastics are melted together they tend to separate and resist being reformed. Even plastic of the same type creates problems. This information reveals that beneath the convenient use of plastic products, one should be consciously aware about the challenges of white pollution and the accompanying environmental issues created by plastic waste. Hence there is a need to utilize plastic waste effectively. The classification of plastic waste is a good start to understand and start to solve the waste problem. Table 1 shows the classification of plastic waste [4,5].

Current methods for the disposal of plastic wastes include landfill, incineration (burning to ashes), plastic recycling, and energy production. At present, the high cost of producing electricity from wastes prohibits this route [6]. Traditionally due to the increasing growth of plastic solid waste (PSW), and so far landfill or incineration have the most utilized application for post-consumer plastic treatment [7,8]. Landfilling will eventually be phased out due to the scarcity of space and its ever increasing cost [4]. Likewise, incineration generates emissions of toxic fumes and fly ash that require further disposal [9]. Among the industrial utilizations of plastic waste, pyrolysis is one of the favorable approaches. Wallis et al. studied the thermal degradation of HDPE in a reactive extruder to obtain oily products with future potential to refine fuels [10]. The production of alkane gases from the pyrolysis of HDPE using a fluidized bed reactor was also studied [11]. Furthermore in order to obtain valuable products, appropriate catalysts can be applied to improve the thermal degradation efficiency of waste plastic. The application of waste plastic to produce porous carbon is another option for reclaiming of PSW (plastic solid waste) since porous carbons investigated in research perform considerably more impressively than commercially available activated carbon [12], however the yields are low (less than 20%) due to large volatilization and the burn-off effect under vacuum condition. This is accompanied with the high energy intensive process which restricts the widespread application of plastic waste pyrolysis [4].

Recycling is a promising way to utilize plastic waste as it provides benefits of waste minimization, reduction of carbon dioxide emissions and value added products [6]. It is believed that the application of plastic waste is focused on its elimination in a low-cost approach rather than its beneficial, value-added reuse. Due to the importance of cleaning of oil spills, many reviews have been written in recent years about advanced sorbent materials [13–15]. However, this review paper is the first of its kind reporting, compiling and reviewing the various methods of producing oil sorbents from plastics. This includes studies utilizing plastic waste as well as virgin polymers that are components of plastics materials. In this review, we are concerned with oil sorbents mainly for oils from petroleum sources.

Table 1
Classification of Plastic Wastes

Polymer	% Plastic Waste
LDPE/LLDPE	20.6
PP	20
HDPE	17.4
PET	11.7
PS	10.9
PVC	10.9
PU	2.7
Others	9.8

LLDPE Linear low density polyethylene
LDPE low density polyethylene