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PRODUCTION OF APOLAR REAGENTS FROM LOW-MOLECULAR POLYMER WASTE

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Abstract

The increasing accumulation of polymer waste requires innovative recycling strategies that enable the recovery of valuable chemical products. Low-molecular polymer waste (LMPW), often overlooked in conventional recycling, represents a promising feedstock for chemical valorization due to its reduced chain length and high reactivity[1-3]. This study presents an advanced thermochemical and catalytic approach for converting LMPW into apolar reagents, such as alkanes and olefins, suitable for industrial chemical applications. The process integrates controlled pyrolysis with heterogeneous catalysis to enhance selectivity toward non-polar hydrocarbons. Reaction mechanisms, chemical pathways, and technological parameters are analyzed in detail. The results demonstrate that optimized temperature control and catalyst selection significantly improve apolar product yields, offering a sustainable and scalable solution for polymer waste upcycling.

Keywords: Low-molecular polymer waste, apolar reagents, chemical recycling, catalytic pyrolysis, depolymerization, sustainable technology

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Introduction

The widespread use of synthetic polymers has resulted in a rapid increase in plastic waste, creating severe environmental and economic challenges. Traditional mechanical recycling methods are often inefficient for degraded or low-molecular polymer fractions, leading to down-cycling or disposal. Chemical recycling, in contrast, enables the transformation of polymer waste into valuable chemicals and reagents.

Low-molecular polymer waste (LMPW) originates from industrial polymer production residues, thermal degradation products, and post-consumer plastics. Due to shorter polymer chains and higher defect density, LMPW exhibits enhanced susceptibility to thermal and catalytic cracking[4]. This characteristic makes it an ideal candidate for producing **apolar reagents**, which are widely used as solvents, reaction media, and intermediates in organic synthesis and petrochemical industries.

Despite growing interest in polymer depolymerization, limited attention has been given to the targeted synthesis of apolar reagents from LMPW. This work aims to bridge that gap by combining chemical and technological approaches to develop an efficient and selective conversion process.

Low-molecular polymer waste based primarily on polyethylene and polypropylene oligomers was collected from industrial processing residues. The material was dried, mechanically ground, and subjected to solvent washing to remove polar contaminants, additives, and residual monomers. The average molecular weight was determined using gel permeation chromatography (GPC)[5-7].

Thermal depolymerization of LMPW proceeds through random scission of C–C bonds, generating alkyl radicals. These radicals undergo β-scission, hydrogen abstraction, and recombination reactions, leading to the formation of non-polar hydrocarbons:

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- Linear and branched alkanes
- α-olefins
- Paraffinic wax fractions

The absence of heteroatoms in polyolefin-based waste favors the formation of apolar products with minimal oxygenated by-products.

Heterogeneous catalysts such as zeolites (HZSM-5, HY) and silica–alumina systems were employed to control reaction pathways. Acidic active sites promote:

- Controlled chain cracking
- Isomerization of hydrocarbons
- Suppression of aromatization at moderate temperatures

Catalytic depolymerization significantly enhances selectivity toward desired apolar fractions compared to non-catalytic pyrolysis.

Technological Process Description. The process was carried out in a continuous fixed-bed pyrolysis reactor equipped with a temperature gradient control system. Nitrogen was used as an inert carrier gas to prevent oxidation.

Key technological parameters included:

- Temperature range: 350–500 °C
- Residence time: 10–30 minutes
- Catalyst-to-polymer ratio: 1:5

The temperature gradient allowed staged depolymerization, reducing secondary reactions and coke formation.

Reaction products were condensed and separated into gaseous, liquid, and solid fractions. The liquid apolar fraction was further distilled to isolate specific reagent ranges (C_5–C_{12} and C_{13}–C_{20}).

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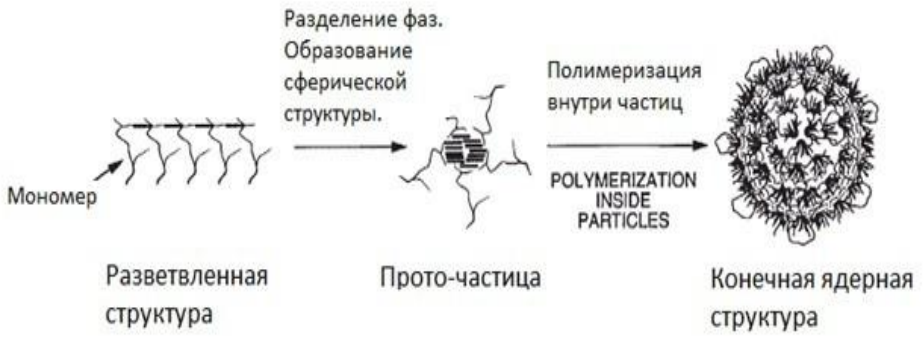

The optimized catalytic process yielded up to 70 % liquid hydrocarbons, with more than 85 % classified as apolar compounds. Gas chromatography analysis confirmed a predominance of alkanes and olefins, while FT-IR spectra showed minimal functional groups associated with polarity.

Compared to conventional thermal cracking, catalytic processing increased apolar reagent yield by approximately 30 %, demonstrating the effectiveness of combined chemical and technological optimization.

The study confirms that LMPW can serve as a valuable raw material for producing apolar reagents through controlled chemical recycling. The synergy between depolymerization chemistry and reactor technology plays a crucial role in achieving high selectivity and yield.

From a technological standpoint, the proposed process is compatible with existing petrochemical infrastructure and can be integrated into industrial recycling systems. Environmentally, it reduces polymer waste accumulation and dependence on fossil-based feedstocks, supporting circular economy principles.

A novel chemical-technological approach for producing apolar reagents from low-molecular polymer waste has been developed and evaluated. The process combines catalytic depolymerization with advanced reactor design to achieve

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high yields of non-polar hydrocarbons. This method provides a sustainable and economically viable pathway for polymer waste valorization and offers significant potential for industrial application.

References

1. Chen, H. et al. Chemical Upcycling of Plastic Waste, ChemSusChem, 2021.
2. Ragaert, K. et al. Mechanical and Chemical Recycling of Plastics, Waste Management, 2017.
3. Al-Salem, S. M. et al. Thermal and Catalytic Pyrolysis of Plastic Waste, J. Environ. Manage., 2017.
4. Lopez, G. et al. Pyrolysis of Plastic Wastes, Renewable and Sustainable Energy Reviews, 2018.
5. Artetxe, M. et al. Catalytic Cracking of Polyolefins, Energy Conversion and Management, 2020.
6. Miandad, R. et al. Catalysts in Plastic Waste Pyrolysis, Process Safety and Environmental Protection, 2019.
7. Kaminsky, W. Chemical Recycling of Plastics, Feedstock Recycling and Pyrolysis, Wiley, 2006.