

Technology Newsletter

Plastic Depolymerization and Upcycling (DEPOLUP)

(This newsletter contains short information about technical news items, recently published and expired patents)

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Table of Contents

1. Pyrolysis/Depolymerization of Waste Plastic:	2
Business/Technical News	2
Patents Published between 1-30 th -September-2023:	4
1. Synthesis/Use of Catalyst for Pyrolysis of Waste Plastic:.....	4
2. Device/System/Method for Pyrolysis of Waste Plastic:	5
3. Pyrolysis of Waste Plastic:	6
2. Waste Plastic Segregation/Sorting:	7
Business/Technical News:.....	7
Patents Published between 1-30 th -September-2023:	8
3. Conversion/ Recycling of Waste Plastic:.....	9
Business/Technical News:.....	9
Patents Published between 1-30 th -September-2023:	10
4. Global Plastic Recycling Market Research Report.....	13
5. Expired/Lapsed/Withdrawn/Abandoned Patents:.....	15

1. Pyrolysis/Depolymerization of Waste Plastic: Business/Technical News

Waste Plastic Pyrolysis Plant: A Sustainable Solution for the Plastic Disposal Crisis

Publication date: 07-09-2023

This is article from Beston Group, they are professional manufacturer of waste pyrolysis plant, charcoal making machine, egg tray machine, etc.

Plastic pyrolysis plants herald a ground breaking approach to plastic waste management. Pyrolysis, a thermal degradation process in the absence of oxygen, transforms plastic waste into valuable products. Unlike mechanical recycling, pyrolysis can efficiently handle mixed plastics, opening up new avenues for waste management. Within state-of-the-art pyrolysis plant facilities, plastics are subjected to high temperatures, typically above 500°C, causing them to break down into a mixture of smaller hydrocarbon molecules. This process generates pyrolysis oil, a versatile substance with the potential for various applications.

Reference: <https://www.linkedin.com/pulse/waste-plastic-pyrolysis-plant-sustainable-solution-disposal> (Date of access: 16-10-2023)

Converting waste into valuable building blocks for the industry

Publication date: 07-09-2023

With a grant of 3.8 million euro, from the ‘Netherlands Enterprise Agency (RVO), the project Renewable Building Blocks from Complex and Wet Waste Streams (ReBBlocCS), is dedicated to recover valuable chemicals from ‘complex’ waste streams. Boelo Schuur, UT Professor of Separation Technology, is involved in coordinating the project. Schuur picks up a plastic part from the pile. ‘Recycling plastic pieces like this can be a challenge, because there are so many different kinds of plastic, each with their own composition’. To make recycling possible, together with research partners, agency aim to develop an optimal separation recipe for these plastics, based on chemical technologies, like pyrolysis or liquid extraction.’

Reference: <https://www.utoday.nl/science/73213/convertng-waste-into-valuable-building-blocks-for-the-industry> (Date of access: 18-10-2023)

Table salt could be the secret ingredient for better chemical recycling

Published date: 08-09-2023

Researchers from Michigan State University, US have shown that table salt outperforms other expensive catalysts being explored for the chemical recycling of polyolefin polymers, which account for 60% of plastic waste. The research shows that sodium chloride could provide a safe, inexpensive and reusable way to make plastics more recyclable. The team also showed that table salt and other catalysts could be used in the recycling of metallized plastic films like those used in potato chip bags which are currently not recyclable.

Reference: <https://www.sciencedaily.com/releases/2023/09/230908170858.htm> (Date of access: 10-10-2023)

Pyrolysis–catalysis upcycling of waste plastic using a multilayer stainless-steel catalyst toward a circular economy

Published date: 11-09-2023

This study proposes a simple method using a stainless-steel 316 (SS 316) catalyst that can easily be reused. It was found that the carbon and hydrogen atom recovery efficiencies reach up to 86% and 70% and the catalyst exhibits excellent regeneration performances. Researchers from University of California shows approach towards higher economic benefits and smaller environmental footprints than conventional incineration. Here, researchers have performed a simple pyrolysis-catalysis deconstruction of waste plastic via a monolithic multilayer stainless-steel mesh catalyst to produce

multi-walled carbon nanotubes (MWCNTs) and H₂, which are important carbon material and energy carrier to achieve sustainable development. Results revealed that the C and H recovery efficiencies were as high as 86% and 70%, respectively. This catalyst can efficiently convert aromatics to MWCNTs by the vapor–solid–solid mechanism and demonstrate good universality in processing different kinds of waste plastics.

Reference: <https://www.pnas.org/doi/10.1073/pnas.2305078120> (Date of access: 10-10-2023)

An Indonesian customer successfully ordered a set of 15TPD waste plastic pyrolysis machine from DOING

Publication date: 14-09-2023

An Indonesian customer ordered a set of 15TPD waste plastic pyrolysis machine from DOING HOLDINGS CO., LTD. DOING has many successful project cases and has received praise from many customers, which attracts Indonesian customer towards this deal. 1) DOING pyrolysis reactor adopts the unique welding method and steel plate, and is a one-piece design, which can withstand high pressure and temperature to avoid cracking. 2) DOING pyrolysis machine is equipped with some safety devices: Oil-water separator (avoid the backflow of the oil gas), Water seal (avoid the backflow of tail gas) and Vacuum device (fully extract oil gas from reactor to avoid flash explosion), which all provide safety guarantee for machine operation. The Indonesian customer reached friendly cooperation with DOING and ordered a set of 15TPD waste plastic pyrolysis machine, which can process over 5000 tons of waste plastics per year and obtain 1500 tons of fuel oil at least (take the plastic with the lowest oil rate-30% as an example). The obtained fuel oil has wide applications. In addition to the steel factory, it also can be used in the cement factory, brick factory, glass factory, boiler heating, heavy oil generators, etc.

Reference: https://www.plastictooilmachine.com/News/DOING_News/Indonesian_customer_ordered_waste_plastic_pyrolysis_machine_308.html (Date of access: 19-10-2023)

Flashy process derives both graphene and hydrogen from waste plastic

Published date: 18-09-2023

Researchers at Rice University have now found a way to harvest hydrogen from plastic waste using a low-emissions method that could more than pay for itself. The researchers exposed plastic waste samples to rapid flash Joule heating for about four seconds, bringing the temperature up to 3100K. This process vaporizes the hydrogen present in the plastics, leaving behind graphene. Using funding from the US Army Corps of Engineers, the Tour lab acquired the necessary equipment to characterize the vaporized contents.

Reference: <https://www.materialstoday.com/polymers-soft-materials/news/flashy-graphene-and-hydrogen-waste-plastic/> (Date of access: 16-10-2023)

How is pyrolysis plant useful in waste management?

Publication date: 26-09-2023

DOING pyrolysis plants decomposes waste tires/plastics/aluminum plastic/oil sludge/coal tar oil into oil gas, non-condensable gas, and carbon black through high-temperature heating. Oil gas is condensed into liquid oil through a cooling system, which can be sold to steel and cement plants for industrial fuel heating; In addition, for non-condensable gases, which can be directly used to heat the reactor, saving fuel costs for equipment operation. And carbon black can be directly pressed and burned, with a calorific value equivalent to six or seven thousand calories of coal; Alternatively, refined grinding powder can be used as raw material in rubber products. By extracting value from what was once considered waste, pyrolysis plants support a circular economy and mitigate resource depletion.

Reference: http://www.bestpyrolysisplant.com/News/Industry_News/how_is_pyrolysis_plant_in_waste_management_345.html (Date of access: 19-10-2023)

Vacuum pyrolysis depolymerization of waste polystyrene foam into high-purity styrene using a spirit lamp flame for convenient chemical recycling.

Published date: 27-09-2023

Waste polystyrene (PS) foam causes significant damage to marine ecosystems due to its toxic decomposition products. However, effective recycling methods for waste PS foam have not yet been developed. With the aim of establishing an efficient chemical recycling process for waste PS, this study presents a simple and convenient method for recovering high-purity styrene from waste PS foam by vacuum pyrolysis depolymerization. The vacuum pyrolysis of waste PS foam was performed in a Pyrex tube, ignited using a spirit lamp flame for 20 min, resulting in a recovery of 98%-purity styrene in a 55% yield. The yield was further increased to 67% by conducting the pyrolysis in the presence of molecular sieves, which prevented side reactions such as backbiting and radical coupling. Additionally, increasing the temperature enhanced the styrene yield. This vacuum pyrolysis depolymerization process for chemical recycling requires no temperature controller or monomer fractionation. It can be applied to various waste plastics with carbon-carbon backbones, thus offering a promising solution for reducing plastic waste. Furthermore, the closed loop system, which includes monomer recovery without the need for purification and its reuse for reproducing the original products, also contributes to a reduction in natural fossil fuel consumption.

Reference: <https://pubs.rsc.org/en/content/articlelanding/2023/su/d3su00207a>

(Date of access: 16-10-2023)

Patents Published between 1-30th-September-2023:

1. Synthesis/Use of Catalyst for Pyrolysis of Waste Plastic:

Sr. No.	Publication Number Publication Date	Title	Assignee/Applicant(s)
1	CN116694349A 2023-09-05	A catalytic cracking device for waste plastic and waste rubber	Qingdao Huicheng Environmental Protection Technology Group Co Ltd, China University of Petroleum, CN
2	CN116731739A 2023-09-12	Method for treating waste plastics and waste active adsorbent materials at the same time	Shanghai Qiangong Nenglyu Technology Co. Ltd., CN
3	EP3844247B1 2023-09-13	A method for catalytic conversion of waste plastic into liquid fuel	Reliance Industries Limited, IN
4	CN116747898A 2023-09-15	Heteroatom zeolite molecular sieve catalyst with sheet shape for catalyzing polyolefin plastic cracking	Zhejiang University, CN
5	WO2023176813A1 2023-09-21	Method and device for converting waste plastic into thermally cracked oil, and FCC catalyst	Recycling Technology Association Co. Ltd., JP
6	IN202341058811A 2023-09-22	An improved method for recycling electronic plastics waste using bi-metal doped catalyst	National Institute Of Technology, IN

2. Device/System/Method for Pyrolysis of Waste Plastic:

Sr. No.	Publication Number Publication Date	Title	Assignee/Applicant(s)
1	CN108410490B 2023-09-01	Chlorine-containing waste plastic pyrolysis process and system	Guangdong Guoneng Zhonglin Industrial Co. Ltd., CN
2	CN107497562B 2023-09-01	Remanufacturing treatment device for door seal rubber sleeve or soft magnetic stripe waste	Anhui Wanlang Magnetic Plastic Co., Ltd., CN
3	IN202217057494A 2023-09-01	Liquefying and dehalogenating waste plastics	Eastman Chemical Company, US
4	WO2023178143A1 2023-09-21	Chemical recycling process comprising melting, pyrolysis and cracking waste plastic	
5	WO2023178137A1 2023-09-21	Chemical recycling process and system for melting and pyrolysis of solid waste plastic	
6	IN202341057669A 2023-09-08	A portable device for co-pyrolysis transforming used personal protective equipment (PPE) into liquid fuel	Garden City University, Dr. Vanitha Krishna Subbaiah, Dr. Ramchandra Prasad L. A, Shekh Humaira Siddiqa, Darcia Savina Angela D Mello, IN
7	CN116731390A 2023-09-12	A method for thermoelectric coupling degradation of polyethylene and products prepared by the method	Northeast Petroleum University, CN
8	KR2023131536A 2023-09-14	Method for removing chlorine from waste plastic pyrolysis oil.	SK Innovation Co. Ltd., KR; SK Geo Centric Co. Ltd., KR
9	KR2023131535A 2023-09-14	Refining method and device of waste plastic pyrolysis oil	
10	WO2023177147A1 2023-09-21	Method and manufacturing apparatus for manufacturing aviation fuel from waste plastic pyrolysis oil	
11	KR2023135767A 2023-09-26	Method and device for producing waste plastic pyrolysis oil with reduced chlorine	
12	CN219686263U 2023-09-15	An environmentally friendly waste plastic film recycling equipment	Tongling Yuefeng Plastic Co. Ltd., CN
13	CN116783268A 2023-09-19	Method and device for disposing of waste consisting of plastic material or biomass	Benzy Partnership Ltd., Italy
14	CN116789122A 2023-09-22	A preparation system and method for preparing graphene based on carbonization and electric shock of waste plastics	Harbin Engineering University, CN
15	US20230302689A1 2023-09-28	Waste plastic liquefaction device and a waste plastic liquefaction method	Shinko Tecnos Co Ltd, JP
16	CN107384458B 2023-09-29	High-temperature pyrolysis reactor and system and method for producing oil and carbon black by waste tire pyrolysis	Liuzhou Ganyuan Environmental Protection Technology Co Ltd, CN

**3. Pyrolysis of Waste Plastic:**

Sr. No.	Publication Number Publication Date	Title	Assignee/Applicant(s)
1	IN202341043189A 2023-09-01	System improvements for waste-to-energy conversion utilizing microwave pyrolysis	Bhavani P (Sagi Rama Krishnam Raju Engineering College, Bhimavaram, AP), Daggubati Sunil, Paul Daniel M (Narayana Engineering College, Guduru, AP), Bhumireddy Lakshmi, Seelam Koteswararao, IN (Kallam Haranadha Reddy Institute of Technology(KHIT),Guntur,AP)
2	IN202341041331A 2023-09-01	Method of using waste plastic oil as fuel on diesel engine	P. Gurusamy(Chennai institute of Technology, Sarthy Nagar), S. Hari Krishna Raj(Vel Tech High Tech Dr Rangarajan, Dr Sakunthala Engineering College, Chennai), N.Ramanan(Sri Jayaram Institute of Engineering and Technology, Gumddipundi), IN
3	KR2023127979A 2023-09-01	Improved conversion of plastic waste into fuel	Gupta Kamlesh Madanlal, Gupta Kavita Madanlal, IN
4	US11746036B2 2023-09-05	Molten salt assisted pyrolysis recycling of glass fiber reinforced polymer composites	University of Tennessee Research Foundation, US
5	IN202217065562A 2023-09-15	Method and device for preparing warm mixing agent by waste rubber and plastic cracking product	Borealis AG, Austria
6	KR2023132222A 2023-09-15	2- polyester resin using recycled bis2-hydroxyethyl terephthalate and article comprising same	SK Chemicals Co Ltd, KR
7	KR2023135765A 2023-09-26	Method and manufacturing apparatus for manufacturing aviation fuel from waste plastic pyrolysis oil	SK Innovation Co Ltd, KR SK Geo Centric Co Ltd, KR
8	CN116783242A 2023-09-19	Depolymerization process of solid mixed plastic	SABIC Global Technologies B.V., Netherland
9	WO2023178155A1 2023-09-21	Recovery of heat from low pressure waste streams	Eastman Chemical Company, US
10	WO2023178146A1 2023-09-21	Chemical recycling facility with reduced water consumption	
11	IN202217061587A 2023-09-15	Chemical recycling of solvolysis coproduct streams	
12	WO2023178157A1 2023-09-21	Chemical recycling facility with electric process equipment	
13	IN202321049485A 2023-09-22	Scalable strategies for refining crude tire pyrolysis oil using a waste eggshell-based adsorbent	Indian Institute of Technology Bombay, IN
14	KR2023135671A 2023-09-25	Method for refining pyrolysis oil for upgrading by steam-cracking	Total Energy One Tech, France
15	CN116817278A 2023-09-29	Medical waste pyrolysis incinerator	Weihai Environmental Protection Technology Service Co Ltd, CN

2. Waste Plastic Segregation/Sorting: Business/Technical News:

NextGen Consortium launches AI sorting study

Publication date: 11-09-2023

The NextGen Consortium, a multiyear industry collaboration addressing single-use foodservice packaging materials, has launched a study leveraging artificial intelligence (AI) to analyze the polypropylene (PP) material stream. NextGen will conduct this study with its managing partner, New York-based Closed Loop Partners' Center for the Circular Economy, and London-based Greyparrot, an AI waste analytics platform. The collaboration aims to track and categorize objects in the PP stream and determine the volume of valuable food-grade material passing through the system.

Reference: <https://www.recyclingtoday.com/news/nextgen-consortium-launches-ai-sorting-study/>

(Date of access: 16-10-2023)

Deep learning enables the sorting of new materials

Publication date: 12-09-2023

Fabrizio Radice, VP Head of Global Sales and Marketing at TOMRA talks about how deep learning is transforming the waste sorting and recycling processes, the economic and environmental benefits of smart waste management solutions and how it will shape the industry. Artificial intelligence has been used for decades in our traditional sorting technologies and software, allowing for an automated sorting process. As circuit automation enables plant operators to process considerably higher volumes than with manual sorting practices, efficiency levels are much higher. The plant can process multiple tons of waste a week and the software accurately detects atomic differences in materials (e.g. PET bottle vs. tray) to create high-purity mono fractions out of a mixed waste stream.

Reference: <https://waste-management-world.com/resource-use/deep-learning-enables-the-sorting-of-new-materials/> (Date of access: 16-10-2023)

Advancing Plastic Waste Classification and Recycling Efficiency: Integrating Image Sensors and Deep Learning Algorithms

Publication date: 12-09-2023

This paper introduces an approach that adapts image sensors and deep learning object detection algorithms; specifically, the You Only Look Once (YOLO) model, to enhance plastic waste classification based on the shape of the waste. Unlike conventional methods that rely solely on spectral analysis, our methodology aims to significantly improve the accuracy and efficiency of classifying plastics, especially when dealing with materials having similar chemical compositions but differing physical attributes. The system developed using image sensors and the YOLO model proves to be not only effective but also scalable and adaptable for various industrial and environmental applications.

Reference: <https://www.mdpi.com/2076-3417/13/18/10224> (Date of access: 16-10-2023)



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Patents Published between 1-30th-September-2023:

Waste Plastic Segregation/Sorting:

Sr. No.	Publication Number Publication Date	Title	Assignee/Applicant(s)
1	KR2574655B1 2023-09-11	Segregated collection apparatus and virtuous system of recycled product based on the same	Ecocentre Co Ltd, KR
2	CN219686255U 2023-09-15	A sorting and separation device for waste plastics	Anyue Shangchuan Plastic Products Co Ltd, CN
3	CN116750498A 2023-09-15	Containerized plastic bottle sorting station	Guangdong Gongye Technology Co Ltd, CN
4	CN219686254U 2023-09-15	A magnetic filter for plastic waste	Lixin County Ruixiang Plastic Industry Co., Ltd., CN
5	CN219707967U 2023-09-19	A new compact kitchen waste bag separation mechanism	Shanghai Tongguan Municipal Facilities Technology Co., Ltd., CN
6	WO2023178156A1 2023-09-21	Removal of microplastics from plastic separation process using extractive fluid	Eastman Chemical Company, US
7	CN116793804A 2023-09-22	Extraction method of soil microplastic	Sichuan Agricultural University, CN
8	CN219723764U 2023-09-22	A waste recycled plastic color sorting and separation device	Nantong Tongzhou District Chuangbo Plastic Products Co. Ltd., CN
9	CN219748638U 2023-09-26	A recycled plastic crushing tool	Shanghai Ruiju Environmental Protection Technology Co Ltd, CN
10	CN219768839U 2023-09-29	A plastic waste sorting device	Jieshou Jinfeng Plastic Industry Co., Ltd., CN
11	CN116689449B 2023-09-29	Wetland plastic waste collection, separation and treatment mechanism and ecological restoration device	Shandong Academy of Forestry Sciences, CN
12	CN219768826U 2023-09-29	A waste plastic particle cleaning device for plastic particle recycling	Shandong Daoyun Renewable Resources Co Ltd, CN
13	US20230294107A1 2023-09-21	Inspection, sorting, and pyrolysis of plastic feeds	Encina Development Group, LLC, US

3. Conversion/ Recycling of Waste Plastic:

Business/Technical News:

UH research team awarded \$4m to convert plastic waste into useful materials.

Published date: 14-09-2023

The UH's Cullen College of Engineering will tackle the challenges with polyolefins through a three-pronged approach: value-added recycling, upcycling plastics and enabling their circular reuse. Recycling mixed plastics is a notoriously difficult and costly process. The researchers are developing a game-changing solution by creating modular "compatibilizers" - special polymers or molecules that can blend different types of plastic waste that otherwise do not want to mix. In this project, the researchers seek to upcycle polyolefin waste into durable thermoset materials. These polymers can be used in long-lasting applications, such as insulation, coatings, or automotive products, where they could be used for a decade or longer. Polyolefin are notoriously stable polymers. The team is bringing new functionality into the polymers through incorporating chemical groups that will accelerate their degradation.

Reference: <https://www.uh.edu/news-events/stories/2023/september-2023/09142023-robertson-welch.php> (Date of access: 12-10-2023)

An Unexpected New Way to Recycle – Scientists Transform Plastic Waste into Soap

Published date: 19-09-2023

Researchers from Virginia Tech have developed a method to upcycle plastics into valuable surfactants used in products like soap and detergents. This discovery, rooted in the molecular similarity between polyethylene plastics and fatty acids, could offer a profitable and environmentally-friendly alternative to traditional recycling. Researchers have developed a new method to recycle plastics, such as those from milk cartons, food containers, and plastic bags, into soap. The method: Heat the long carbon chains in the plastics then quickly cool them. Researchers from Virginia Tech have developed a novel technique to upcycle plastics into valuable chemicals called surfactants, which are used to create soap, detergent, and more.

Reference: <https://scitechdaily.com/an-unexpected-new-way-to-recycle-scientists-transform-plastic-waste-into-soap/> (Date of access: 12-10-2023)

Current technological options for recycling packaging waste: Challenges and opportunities in India

Publication date: 21-09-2023

Packaging in India comprises around 59% of total plastic consumption, with most of the waste originating from single-use and short shelf-life products. This article explores the existing and emerging technological options suitable for recycling post-consumer flexible plastic packaging waste in India. It also discusses the status of multi-material packaging waste, and the advancement being made for its recycling. The paper also explores India's increased momentum in the use of innovative recycling techniques, such as distributed recycling and manufacturing techniques and plastic waste in steel manufacturing.

Reference: <https://wires.onlinelibrary.wiley.com/doi/full/10.1002/wene.500> (Date of access: 17-10-2023)



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**Patents Published between 1-30th-September-2023:
Conversion/ Recycling of Waste Plastic**

Sr. No.	Publication Number Publication Date	Title	Assignee/Applicant(s)
1	CN116674117A 2023-09-01	A production method, system and medium for recycling recycled non-ferrous plastics	Jiangsu New Materials (Aksu) Co. Ltd., CN
2	IN202341051374A 2023-09-01	Production of recycled plastic aggregates and its utilization in concrete	Venkata Sreekanth Desu St Martins Engineering College, IN
3	IN202341050327A 2023-09-01	Development of plastic rope by using plastic waste bottles	St. Martin's Engineering College, IN
4	IN202341046372A 2023-09-01	A system and method for the production of recycled plastic tiles with steel reinforcement	Sai Vidya Institute Of Technology, Karnataka Dr. M.B Ananthayya, Prof.Nayana Manohari T K, Amogh A, Krishna Prasad M, Nithin V Manashetti, Neeraj R Kadam, IN
5	CN219618270U 2023-09-01	A waste plastic film recycling and processing device	Qianxinan Ruiliheng Plastic Industry Development Co. Ltd., CN
6	IN202341054753A 2023-09-01	Design and fabrication of plastic bottle recycling machine	Ramachandran N(<i>Sri Krishna College Of Engineering And Technology, Kuniamuthur</i>), Nallasamy P(<i>PSG College of Technology, Coimbatore</i>), Ramamoorthi R(<i>Sri Krishna College Of Engineering And Technology, Kuniamuthur</i>), Anchal Sharma, Saran kumar. T, Tsering Motup, Dr. A. Prabukarthi(<i>PSG College of Technology, Coimbatore</i>), J. Senthil Kumar(<i>Excel Engineering College, Komarapalayam, Namakkal</i>), T.R.Arunprasand(<i>Sri Shanmugha College of Engineering and Technology, Sankari, Salem</i>), R. Anand(<i>Nehru Institute of Technology, Coimbatore</i>), IN
7	CN116675219A 2023-09-01	Device for preparing graphene by recycling waste plastics based on carbonization electric shock method	Harbin Engineering University, CN
8	CN219618268U 2023-09-01	Plastic film processing waste recovery device	Zhengzhou Fushenggong Packaging Materials Co Ltd, CN
9	IN202341051976A 2023-09-01	A method of extraction of petrol from waste plastic	ATME College of Engineering Mysuru, IN
10	CN219618277U 2023-09-01	Plastic bottle overlap waste recycling device	Ma'anshan Runtai Intelligent Technology Co. Ltd., CN
11	CN219618276U 2023-09-01	Shock attenuation rubber punching press waste recycling mechanism	Dalian Lvshun Rongshan Rubber Co. Ltd., CN



12	IN202341035758A 2023-09-01	An eco-friendly interlocking paving block production	Jagruth Tech Pvt Ltd, IN
13	CN116690843A 2023-09-05	Method for preparing plastic bottle by using waste plastic	Ma'anshan Kangfu Plastic Products Co. Ltd., CN
14	CN116690845A 2023-09-05	A method for preparing recycled engineering plastic materials	Yang Hongyan, CN
15	CN116690844A 2023-09-05	Waste plastic recycling process	Hangzhou Hengfeng Plastic Products Co Ltd, CN
16	CN116690841A 2023-09-05	Waste polyethylene plastic pipe recycling device and method	Hubei Tianlin New Materials Co. Ltd., CN
17	US11745390B2 2023-09-05	System for recovery of mixed multi-plastic and natural fiber	Infinical Technologies LLC, US
18	CN116690842A 2023-09-05	Waste plastic bottle is retrieved with taking off mark cleaning system	Avin Shanghai Machinery Co Ltd, CN
19	CN219634263U 2023-09-05	Shoemaking industry rubber waste material processing apparatus	Shandong Lutai Shoes Industrial Co Ltd, CN
20	EP4237511A1 2023-09-06	System and method for converting waste plastic materials to useful products, and solid compression unit	Circular Plas Co., Ltd., Thailand
21	WO2023166433A1 2023-09-07	Method of recovery and regeneration of polyolefin plastics and relative recycling plants	Fadebe S.P.A., Italy
22	CN116714142A 2023-09-08	Waste plastic degreasing recovery device	Jieshou Hongda Plastic Industry Co Ltd, CN
23	IN202234040365A 2023-09-08	Method and reprocessing system for reprocessing plastic waste material, in particular pet waste material.	Coperion GmbH, Germany
24	CN219651982U 2023-09-08	A conveying device for plastic waste recycling	Wuhan Dongfu Optoelectronics Technology Co., Ltd., CN
25	CN219669075U 2023-09-12	Waste plastic bottle recycling and transferring device	Hebei Jiyue Reborn Supplies Recovery Co Ltd, CN
26	CN219667152U 2023-09-12	A crushing and cleaning mechanism for waste plastic recycling	Nantong Yirong Glass Products Co., Ltd., CN
27	CN219667122U 2023-09-12	A granulator for preparing modified recycled plastic particles from waste plastics	Lanxi Jiangfeng Industry and Trade Co. Ltd., CN
28	CN116731415A 2023-09-12	Waste plastic composite modifier and its preparation method	Dongguan Shuotai Industrial Co., Ltd., CN
29	KR2577310B1 2023-09-13	Waste plastic window crushing equipment and waste plastic window crushing process using the same	HD Company Co Ltd, KR
30	KR2023132323A 2023-09-15	Reinforced biodegradable plastics with advanced water barrier property using waste plastic and manufacturing method thereof	Indigoblue Co., Ltd., KR
31	KR2023132007A 2023-09-15	Regeneration method of daily waste plastic in film sheet form	CNKU Co Ltd, KR
32	KR2023132572A 2023-09-15	Polyolefin composition comprising polypropylene polymer and recycled plastic material	Borealis AG, Austria
33	CN219686261U 2023-09-15	Broken screening recovery structure of waste plastic	Wuhu Baolute Plastic Technology Co Ltd, CN
34	AT525879A4 2023-09-15	Reusable plastic containers and reprocessing methods	Greiner Packaging Int GMBH, Austria



35	KR2578120B1 2023-09-15	Eco-friendly uniform using recycled polyester fabric and manufacturing method thereof	Rexia Int Co Ltd, KR
36	CN114378978B 2023-09-19	Full-biodegradable plastic recycling equipment and production process	Hainan Chuangjiada Biotechnology Co Ltd, CN
37	CN219705788U 2023-09-19	Broken section device of waste plastic bottle jar	Tao Lang Environmental Protection Technology Ltd Co Ltd, CN
38	CN113910493B 2023-09-19	Integrated plastic processing station leftover material screening and recycling system	Henan Jiaying Renewable Resources Co ltd, CN
39	CN219708577U 2023-09-19	Automatic edge strip recycling device for polyethylene foam production	Zhejiang Hanxin Industry & Trade Co. Ltd., CN
40	CN219726896U 2023-09-22	Waste plastic processing, recycling and regenerating device	Sichuan Langdi New Material Co ltd, CN
41	CN116786566A 2023-09-22	Medical waste treatment equipment with disinfection function	Zaozhuang Vocational College, CN
42	CN116787818A 2023-09-22	Method for manufacturing plate from waste high polymer material	Nantong Longsheng New Materials Technology Development Co Ltd, CN
43	CN116804154A 2023-09-26	A method for continuous recycling of waste plastic and waste rubber	Qingdao Huicheng Environmental Protection Technology Group Co Ltd, CN
44	CN115926464B 2023-09-26	Preparation method of silicon rubber reinforced particles and reinforced rubber powder	Qingyuan Gaoneng Jiejia Modified Material Technology Co. Ltd., CN
45	US20230303797A1 2023-09-28	Recycling system and process using subcritical and/or supercritical water	Seauciel LLC,US
46	DE102022107063A1 2023-09-28	Plant for agglomerating and shredding plastic recycle	Wissing Johannes, Germany
47	WO2023180222A1 2023-09-28	A mechanical polyolefin recycling process	Borealis AG, Austria
48	CN116814086A 2023-09-29	Plastic garbage recycling method	Xian Jiaotong University, CN
49	CN116812866A 2023-09-29	Method for preparing synthesis gas by taking waste plastics as raw materials	Beijing University of Chemical Technology, CN
50	CN219768829U 2023-09-29	Waste plastic recovery device for plastic product processing	Henan Zhongyang Environmental Protection Technology Co Ltd, CN
51	CN219768834U 2023-09-29	Smashing device for recycling waste plastics	Linyi Jiemin Plastic Industry Co Ltd, CN

4. Global Plastic Recycling Market Research Report

1) Pyrolysis of waste plastic:

- The global Waste Plastic Pyrolysis Plant market size is projected to grow from USD million in 2022 to USD million in 2029; it is expected to grow at a CAGR of Percent from 2023 to 2029.
- Major market players are
 - Beston Machinery Co., Ltd.
 - Kingtiger Environmental Technology Co., Ltd.
 - Henan Mingjie Environmental Equipment Co., Ltd
 - Shredwell Recycling
 - Hunan Benji Environmental Energy Technology Co., Ltd
 - Ruixin Environmental Specialty Equipment Manufacturing Co., Ltd
 - Henan Doing Environmental Protection Technology Co., Ltd
 - Henan Realtop Machinery Co, Ltd.
 - Agile Process Chemicals LLP
 - Pyrolyze
 - Klean Industries

2) Plastic waste management:

- The global plastic waste management market size was valued at US\$ 36.96 billion in 2021 and it is expected to hit over US\$ 59.24 billion by 2030 with a registered CAGR of 5.4% from 2022 to 2030.
- Some of the prominent players in the global plastic waste management market include:
 - Veolia Environment
 - Waste Connections Inc.
 - Covanta Holding Corporation
 - Stericycle
 - SUEZ
 - Waste Management Inc.
 - Clean Harbors
 - Waste Connections Inc.
 - Remondis SE
 - Biffa
- Asia-Pacific is the largest segment for plastic waste management market and will lead in next ten years.

- The plastic waste management market is expected to be driven by rapid industrialization, expanding urbanization, and growing concern about the environmental impact of incorrect plastic waste management.

3) Recycling of waste plastic:

- Plastic Recycling Market was valued US\$ 50.58 Bn. in 2022 and is expected to reach US\$ 78.61 Bn. by 2029, at a CAGR of 6.5% during a forecast period.
- The global Plastic Recycling Solutions market was valued at US\$ 43040 million in 2022 and is anticipated to reach US\$ 65190 million by 2029, witnessing a CAGR of 5.9% during the forecast period 2023-2029.
- Asia Pacific is the largest market, with a share about 64%, followed by Europe and North America with the share about 18% and 16%.
- In terms of product, PET is the largest segment, with a share about 38% and in terms of application, the largest application is packaging & consumer goods, with a share about 37%.
- Key market players:
 - Indorama Ventures.
 - Far Eastern New Century.
 - MBA Polymers.
 - DAK Americas.
 - Plastipak Holdings.
 - Longfu Recycling Energy Sciencetech.
 - Greentech.
 - KW Plastics.
- The growing problem of plastic waste worldwide and the need for more ecologically acceptable waste management methods drive the market for plastics chemical recycling to rapid growth.
- The depolymerization demand for plastics chemical recycling will boost the market.
- Asia Pacific will continue to lead its way, whereas North America's plastics chemical recycling market will experience the strongest growth till 2030.

References

- <https://reports.valuates.com/market-reports/OYRE-Auto-29M5256/global-plastic-recycling-solutions>
- <https://www.fortunebusinessinsights.com/recycled-plastic-market-102568>
- <https://www.marketsandmarkets.com/Market-Reports/recycled-plastic-market-115486722.html>
(Date of access: 13/10/2023)

**5. Expired/Lapsed/Withdrawn/Abandoned Patents:**

Sr. No.	Publication Number Publication Date	Title	Assignee/ Applicant(s)	Legal Status
Pyrolysis/Depolymerization of Waste Plastic				
1	JP2005076007A 2005-03-24	Method of thermally decomposing medical waste including chlorine-containing plastic and thermal decomposition apparatus	MIC KK, JP	No legal event data found
2	JP2005082710A 2005-03-31	Method for continuous depolymerization of polyester, polycarbonate or polylactic acid with supercritical fluid and continuous depolymerization apparatus.	Keio Gijuku, JP	No legal event data found
3	JP2005089612A 2005-04-07	Thermal decomposition method for plastics and apparatus therefor	Toshiba Plant Systems & Services Corp, JP	No legal event data found
Segregation/Sorting of Waste Plastic				
4	CN1218987C 2005-09-14	Method for separating aluminium foil and plastic film from waste aluminium film	Xu Zhaoping, CN	Lapse of patent right due to non-payment of the annual fee 2008-11-19
Conversion/Recycling of Waste Plastic				
5	JP2005076816A 2005-03-24	Damping plate, and its manufacturing method	Hayashi Riichiro, JP	No legal event data found
6	JP2005081794A 2005-03-31	Recycled fiber reinforced plastic molding	Bridgestone Corp; Dainippon Ink & Chem Inc, JP	No legal event data found
7	KR1024964B1 2011-03-25	Recycling method of FRP waste material	Misawa Homes Co., Ltd., JP	Lapse due to unpaid annual fee 2016-03-19
8	CN1223650C 2005-10-19	Industrial method of reusing waste plastics to produce gasoline and diesel oil	Shuaigenxin Energy Source Technology Co., Ltd., CN	Lapse of patent right due to non-payment of the annual fee 2009-12-02
9	JP2005126669A 2005-05-19	Method for recycling plastic, treated and recovered plastic, thermosetting resin-forming material and recycled plastic	Sumitomo Bakelite Co Ltd, JP	Decision of refusal 2009-02-12
10	CN2649594Y 2004-10-20	Apparatus for disposable production of fuel, natural gas and carbon black using waste plastic and rubber	Guan Lixiang, CN	Cessation of patent right 2013-12-18
11	CN1208430C 2005-06-29	Oil refining process from waste plastic and equipment	Wu Kebin, CN	Termination of patent right or utility model 2015-11-18

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