

Eco-Friendly Flame-Retardant Solutions: Repurposing Polystyrene Waste into Fire-Resistant Polymers

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Abstract:

The most common types of insulation are Expanded and extruded polystyrene are commonly known as EPS and XPS, respectively; for more than 50 years, both types have been manufactured with the brominated flame retardant hexabromocyclododecane (HBCDD). As soon as HBCDD was Stockholm Convention controlled it because it is a substance of high concern in addition to European REACH laws. As a result, HBCDD insulation is not recommended. Insulation manufactured with HBCDD-equipped EPS or XPS is being phased out, and its waste cannot further undergo cutting-edge mechanical recycling. Most of the EPS and XPS built before the ban on HBCDDs are still in service. Research is being conducted to find more complex methods of reusing insulating material. Polystyrene from insulation is dissolved in a solvent and recycled in this research. Waste and eliminate both the co-dissolved HBCDD and the insoluble waste components. Due to this procedure, the study examines the mechanical characteristics of regenerated PS and the efficacy of HBCDD removal. Inorganic waste and other non-target polymers were safely separated, and the results indicated an overall increase in purity, removing more than 99.6 per cent of the HBCDD that was there to begin with. Recycled polystyrene's mechanical characteristics are in the typical quantity of virgin general-use PS, provided that residual solvents are removed if the recycled polymer has a residual solvent level of less than 0.1%, and then it may be used.

Keywords: PS, XPS, EPS, wasted, polystyrene, solvent.

1-Introduction

Expanded polystyrene (EPS) as well as extruded polystyrene (XPS) products have gained significant traction in the global construction and packaging industries.

Both materials possess stability and low specific weight, making them suitable for insulating applications and for use in the packaging of food and other consumer goods. Exterior thermal insulation composite systems (ETICS) are a convenient insulation material used in building construction and repair, and EPS is a key component of these systems. The European Union of Polystyrene Producers (EUMEPS) was founded in 2011, released data indicating that the packaging business in Asia produced over 1.3 million tonnes of EPS annually, while Europe produced approximately 1 million tonnes. The market for Expanded Polystyrene (EPS) in building applications is estimated to be 1.3 million tonnes annually in Europe and Asia. (Schlummer, 2017)

The management of EPS and XPS trash generated from packaging has been effectively implemented since these materials are often discarded immediately after use and are well addressed by existing waste packaging collection and return systems. To the flip side of , building waste generates very limited quantities of waste XPS and EPS. (Troya, 2022)

There are two primary factors contributing to this phenomenon. Firstly, most insulating panels remain intact and have not been removed. Secondly, polystyrene (PS) is mostly not separated from mixed demolition trash and is not exposed to recycling processes. (Aksit, 2019)

PS foams are commonly used components in the recycling of polystyrene (PS) on an industrial level. (Turner, 2020)

EPS recycling efforts primarily focus on managing and treating discarded EPS packaging materials. The abovementioned activities are executed using mechanical procedures, including compression, grinding, and re-compounding. EPS derived from building debris is often employed in lightweight concrete and render manufacturing processes. The complexity of recycling technology increases when post-consumer trash is treated due to the presence of various pollutants. The contaminants included in the sample encompass substances such as cement and glue, sticky tape, and food residues. (An, 2017) One significant challenge associated with recycling EPX and XPS materials is transporting them to the designated

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