Production of Super-Absorbent Material From Polystyrene Wastes for Qatari Soil Improvement

Albaadani, Bashar (School: Ashahanyia Preparatory and Secondary School for Boys)
Alathbah, Abdulmohsen (School: Ashahanyia Preparatory and Secondary School for Boys)

Polystyrene waste's non-biodegradable nature and lightweight structure lead to persistent ecosystem contamination, as it is easily dispersed by wind and water, worsening global environmental pollution. This study investigates the production of sulfonated Polystyrene, serving as a superabsorbent material (SAM), through a direct reaction with sulfuric acid at varying temperatures. The resulting SAM exhibits exceptional water uptake, reaching up to 640%, indicating its suitability for moisture retention applications. the degree of sulfonation achieved is substantial, reaching 67.52%, highlighting the effectiveness of the sulfonation process in introducing sulfonic acid groups to the polymer matrix. Furthermore, the SAM demonstrates a commendable gel fraction of approximately 85%, indicating its potential to form stable gels, crucial for retaining absorbed water. TGA analysis revealed sulfonated polystyrene exhibits reduced thermal stability (two-step degradation at 95.66°C and 252.9°C) versus untreated polystyrene (single step at 394.32°C), with both leaving ~20% residue. FT-IR confirmed sulfonation via S=O (1170–1000 cm?¹) and O-H (~3400 cm?¹) peaks. Sulfonation introduces hydrophilicity but weakens polymer integrity, demonstrating a trade-off between functionality and thermal durability. The incorporation of SAM into the soil improves the vegetative growth of plants such as Arugula, Coriandrum sativum and Tomato. These remarkable properties position the produced SAM as a promising material for improving arid soil. Its high-water uptake, significant degree of sulfonation, and robust gel fraction make it an attractive candidate for enhancing soil moisture content, promoting agricultural sustainability, and addressing the challenges posed by arid conditions in the region.

Awards Won: