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Turning Plastic Waste into Standard Automobile Fuel: A Techno-Economic Assessment

Energy security and solid waste management are increasingly recognised as interconnected carbon management challenges. Municipal solid waste (MSW), particularly mixed plastic waste, poses a growing environmental problem that cannot be sustainably addressed through traditional methods such as landfill or incineration, which are costly and contribute to harmful emissions. To address this, the present study investigates the pilot-scale production of automobile-grade diesel from MSW plastics using an integrated three-step process: pyrolysis, distillation, and hydrotreatment. The process was experimentally optimised to maximise yield and fuel quality. The resulting product was comprehensively characterised, demonstrating compliance with commercial diesel standards. Key fuel properties—including energy content, viscosity, and cetane index—were verified, confirming its suitability for direct application in standard diesel engines. Performance trials on an automobile engine showed comparable efficiency to petroleum-derived diesel, with lower carbon intensity and reduced emissions, indicating strong potential as a sustainable transport fuel. In addition to technical validation, a techno-economic analysis was undertaken to evaluate production feasibility. Results suggest that the process can achieve competitive production costs, particularly when integrated into circular economy frameworks and supported by waste management incentives. The study highlights the dual benefits of reducing plastic pollution while producing a viable low-carbon fuel, offering a pathway towards both improved waste management and enhanced energy security. This work provides critical evidence for advancing waste-to-fuel technologies beyond the laboratory, demonstrating the scalability and real-world potential of converting mixed plastics into high-quality diesel. The findings are directly relevant to policymakers, researchers, and industry stakeholders seeking innovative, sustainable solutions to global energy and environmental challenges.

Biography

Dr. Md Jahirul Islam (Jahirul M I) is a clean energy researcher at Central Queensland University, Australia, recognised among the world's top 2% most-cited scientists (Elsevier & Stanford). He holds a PhD in Mechanical Engineering and has over 15 years' experience in waste-to-energy, renewable fuels, hydrogen, and sustainable technologies. He has published 90+ peer-reviewed papers, mostly in Q1 journals, with 6,300+ citations and an h-index of 31. Dr. Islam has secured \$1.9 million in competitive research funding, including the prestigious Advance Queensland Industry Fellowship, and his work bridges academia and industry to deliver innovative solutions for energy security and the circular economy.