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Sustainable Energy Generation from Plastic Waste: A Pyrolysis Approach for Industry

The research presents an easy-to-implement unit system which industrial facilities can use to convert their large plastic waste amounts from discarded packaging into sustainable energy. The system allows industrial facilities to reach complete or partial energy independence through plastic residue conversion into synthetic pyrolysis oil which would generate 91,500 L of fuel. The generated fuel from the system can power a combined heat and power (CHP) generation unit to produce 800 MWh of electricity throughout six months of operation. The system design includes advanced thermal control systems and minimal oxygen contact to protect hydrocarbon molecules until they reach their valuable compound state. The core thermochemical process of pyrolysis creates a foundation for additional chemical reactions including gasification and combustion.

The research evaluates all variables affecting pyrolysis outcomes and provides complete analytical models, mathematical frameworks and engineering calculations needed for system expansion and deployment. The research shows that plastic waste-derived fuels can power standard industrial machinery to produce both heat and electricity. The research proves that this system works for facilities handling 568 tonnes of plastic waste per year because it requires substantial investment but delivers significant results.

The research makes two main contributions through its technical findings which demonstrate how these systems support circular economy development and resource optimization. The method enables the extraction of hidden energy from plastic waste which creates sustainable environmental benefits and decreases fossil fuel usage while showing a workable method for industrial facilities to transition to cleaner operations.

Biography

Dimitrios-Aristotelis Koumpakis is a PhD candidate in Mechanical Engineering at Aristotle University of Thessaloniki, specializing in sustainability engineering and energy recovery from plastic waste. He also holds an MSc in Applied Automation Engineering Systems and a Dipl.-Ing. in Production and Management Engineering. His research focuses on pyrolysis, biofuels, and sustainable waste-to-energy technologies, with several publications in international journals and conferences. Alongside academia, he has worked as an electrical and electromechanical design engineer on large-scale industrial and energy projects across Europe. He is a recipient of scholarships for academic excellence and actively contributes to teaching and research.