

MICROWAVE-ASSISTED PRETREATMENT FOR ENHANCED BIOGAS PRODUCTION FROM COW MANURE: A RESPONSE SURFACE METHODOLOGY STUDY



Author(s): Asad A. Zaidi^{1*}, Sohaib Z. Khan², Muhammad Asif³, Abdul Hameed Memon⁴

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Abstract:

Biogas production from cow manure offers a sustainable approach to waste management and renewable energy generation. However, the recalcitrant nature of lignocellulosic biomass limits anaerobic digestion efficiency. This study investigates the impact of microwave-assisted pretreatment on biogas yield from cow manure and employs Response Surface Methodology (RSM) to optimize key process parameters. A Box–Behnken design was used to analyze the influence of microwave power (300–800 W), pretreatment time (2–6 min), and solid-to-liquid ratio (20–60) on biogas production. The highest biogas yield recorded was 625 mL under optimal conditions of 550 W microwave power, 2 minutes pretreatment, and a 60:40 solid-to-liquid ratio. Gas chromatography analysis revealed methane content in the biogas ranging between 55% and 65%, indicating good energy potential. ANOVA confirmed the model's statistical significance ($p = 0.0425$), with pretreatment time being the most influential factor. Diagnostic plots validated model adequacy, and numerical optimization identified precise conditions for maximizing yield while minimizing thermal degradation risks. These findings highlight the potential of microwave pretreatment as a viable technique for enhancing biogas production from livestock waste. The study supports the development of decentralized, sustainable bioenergy systems and lays the groundwork for future scale-up and economic evaluation.

Keywords:

Biogas Production, Cow Manure, Microwave Pretreatment, Anaerobic Digestion, Response Surface Methodology, Sustainable Bioenergy

¹ Associate Professor, Department of Mechanical Engineering, Faculty of Engineering, Islamic University of Madinah, Madinah 42351, Saudi Arabia, Ph. +966502738671, Email: sali@iu.edu.sa

² Professor, Department of Mechanical Engineering, Faculty of Engineering, Islamic University of Madinah, Madinah 42351, Saudi Arabia, Ph. +966556185916, Email: szkhan@iu.edu.sa

³ Associate Professor, Department of Engineering Sciences, PNEC, National University of Sciences and Technology, Karachi, 75350, Pakistan, Ph. +923113359959, Email: muhammadasif@pniec.nust.edu.pk

⁴ Professor, Department of Mechanical Engineering, FEST, Hamdard University, Madinat al-Hikmah, Hakim Mohammed Said Road, Karachi, 74600, Pakistan, Ph. +923333126280, Email: hameed.memon@hamdard.edu.pk

For full paper, contact:

Prof Muhammad Imran Aslam

Editor-in-Chief, NED University Journal of Research

Ph: +92 (21) 99261261-8 Ext:2670; Fax: +92 (21) 99261255

Email: NED-Journal@neduet.edu.pk

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