



DEBUNKING BIODIGESTERS & ODOUR: *CAUSES, MYTHS, & MANAGEMENT.*



HOW BIODIGESTERS WORK

Biodigesters function through the process of anaerobic digestion where microorganisms break down organic material in the absence of oxygen. The biological process occurs in sealed, oxygen-free chambers and typically unfolds in four stages namely: hydrolysis, acidogenesis, acetogenesis, and methanogenesis (Yue et al., 2010). Through these stages, complex organic compounds are gradually converted into simpler molecules, resulting in the production of biogas and digestate. Biogas is a mixture primarily composed of methane (CH₄) and carbon dioxide (CO₂) which can be used for various activities which include cooking, heating, and electricity generation. Digestate, the nutrient-rich slurry left behind, can be used as a natural fertilizer or soil amendment,

closing the nutrient loop cycle (Chen and Neibling, n.d.). Together, these outputs make biodigesters a powerful tool for sustainable resource management.

A wide variety of organic materials—referred to as feedstock—can be used in biodigesters. Common feedstocks include livestock manure, food waste, and agricultural residues such as corn stalks or straw (Chen and Neibling, n.d.). These materials are often locally available and abundant, making biodigestion an attractive option for farms and municipalities aiming to reduce organic waste while producing energy.



BIODIGESTERS & THE ISSUE OF ODOUR

Biodigesters are systems that break down organic waste—such as manure, food scraps, and crop residues—through anaerobic digestion, producing biogas and nutrient-rich digestate as valuable byproducts (Chen and Neibling, n.d.). These systems are increasingly being adopted in sustainable agriculture and waste management due to their ability to reduce greenhouse gas emissions, recycle nutrients, and generate renewable energy in the form of methane-rich biogas (Orzi et al., 2010). By turning waste into resources, biodigesters contribute significantly to a circular economy and environmental conservation through nutrient cycling (Wiśniewska et al., 2021).

Despite the many benefits, a common concern regarding biodigesters is the bad smells associated with their operation. Bad odor is a frequent worry for those living in close to biodigester sites, and policymakers alike, especially when considering large-scale or community-based systems (Wiśniewska et al., 2021). This paper explores the causes of odor in biodigester operations, dispels common myths, and highlights effective strategies for managing or eliminating unpleasant smells associated with anaerobic digestion.



WHAT CAUSES ODOUR IN ORGANIC WASTE SYSTEMS?

Odour in organic waste systems is primarily caused by the natural decomposition of organic material, which releases gases such as ammonia and hydrogen sulfide—both known for their strong, unpleasant smells. The extent and nature of odour depend largely on the type of decomposition process: aerobic (with oxygen) or anaerobic (without oxygen) (Chen and Neibling, n.d.; Wiśniewska et al., 2021).

Aerobic digestion, typical of composting, produces fewer odorous gases if well-aerated but can smell if poorly managed. In contrast, anaerobic digestion, like that in biodigesters, occurs in enclosed systems and can generate odorous gases, but these are usually captured and utilized, minimizing release.

Odour concerns in biodigestion systems often occur at specific stages of the process. The main culprits include waste storage, preparation for fermentation, and digestate dewatering—all points where organic material is exposed and more likely to emit smells (Rincón et al., 2019; Wiśniewska et al., 2021). A major source of odour is the feedstock itself, such as raw manure or decomposing food waste, which produce strong smells even before entering the digester. Another common source of odour is the digestate, the nutrient-rich byproduct of anaerobic



digestion (Rincón et al., 2019). If not stored in covered tanks or lagoons, digestate can emit odours due to residual microbial activity (Chen and Neibling, n.d.). Stirring or agitation of digestate during handling can also temporarily release trapped gases. During anaerobic digestion, additional odours can occur from system overloads, imbalanced pH, or incorrect temperature control which can disrupt microbial activity, leading to incomplete digestion and higher emissions of odorous compounds (Chen and Neibling, n.d.; Rincón et al., 2019; Selormey et al., 2021).



HOW BIODIGESTERS ARE DESIGNED TO CONTROL ODOUR

Biodigesters are purposefully engineered to contain and control odour, making them a cleaner alternative to open-air composting or untreated manure storage. These systems operate as sealed, oxygen-free (anaerobic) environments, which prevents gases from escaping during the digestion process. This sealed design plays a key role in limiting the release of odorous compounds into the surrounding air (Manyi-Loh et al., 2013).

Inside the digester, the biological breakdown of organic material is carefully regulated, avoiding the uncontrolled decomposition that leads to foul smells. Parameters like temperature, pH, and retention time are monitored and adjusted to maintain stability and prevent the formation of excessive hydrogen sulfide or other sulphurous compounds (Selormey et al., 2021).

In essence, biodigesters serve as containment units during the anaerobic fermentation phase. This contrasts with open compost piles, manure lagoons, or improperly stored organic waste, all of which allow gases to escape freely. When properly managed, a biodigester is not only an efficient system for resource recovery but also a highly effective tool for odour reduction.

COMMUNITY PERCEPTION AND POLICY IMPLICATIONS

Public concern about odour is one of the leading sources of resistance to biodigester projects. Even when systems are well-managed, the fear of unpleasant smells can influence community acceptance and stall project approvals.

Community education plays a key role in overcoming this challenge. By providing clear information, offering site visits, and maintaining transparency around operations, project developers can build trust and dispel misconceptions.

On the policy side, many countries have introduced standards and guidelines for odour emissions, often tied to air quality or environmental permitting. Monitoring tools, such as gas sensors and odour diaries, help ensure compliance and provide reassurance to nearby residents (Meegoda et al., 2025; Wiśniewska et al., 2021).

Ultimately, addressing community concerns and embedding odour management into policy frameworks is essential for securing the long-term success and social license for biodigester initiatives.



CONCLUSION

Concerns about odour from biodigesters are valid but can also be overstated. In reality, odour is a manageable challenge. Proper design, careful feedstock handling, and regular maintenance can significantly reduce odour nuisances.

While mitigation strategies are effective, the type of organic waste used can inherently produce foul smells, impacting surrounding communities. It's the handling, storage, and preparation of the feedstock and digestate that can generate odours, not the anaerobic digestion process itself. These sources can be managed to greatly reduce odour issues.

Ultimately, effective odour control not only protects the environment but also fosters good relationships with neighbours and the broader public. A well-managed biodigester is valued not just for its efficiency but for its ability to integrate harmoniously with both nature and society.

ODOUR MANAGEMENT STRATEGIES

A range of strategies can be implemented to effectively manage odour in biodigestion systems. One of the most important is the use of covered storage for digestate, preventing exposure to air and the escape of smelly gases. Simple coverings, such as floating plastic membranes or sealed tanks, can significantly reduce emissions (Chen and Neibling, n.d.).

Biofilters, scrubbers, and activated carbon systems are commonly installed on ventilation or gas exhaust systems. These devices trap or chemically neutralize volatile compounds like hydrogen sulfide, improving air quality around the digester facility. Process optimization, including balancing the carbon-to-nitrogen (C:N) ratio and maintaining stable operating conditions, further minimizes odour formation (Barbusiński et al., 2020; Rincón et al., 2019; Selormey et al., 2021).

Best practices include regular maintenance, the correct mixing of feedstock, avoiding overload, and promptly addressing any leaks or abnormalities.



REFERENCES

Barbusiński, K., Urbaniec, K., Kasperczyk, D., Thomas, M., 2020. Chapter 2 - Biofilters versus bioscrubbers and biotrickling filters: state-of-the-art biological air treatment, in: Soreanu, G., Dumont, É. (Eds.), From Biofiltration to Promising Options in Gaseous Fluxes Biotreatment. Elsevier, pp. 29–51. <https://doi.org/10.1016/B978-0-12-819064-7.00002-9>

Chen, L., Neibling, H., n.d. Anaerobic Digestion Basics.

Manyi-Loh, C.E., Mamphweli, S.N., Meyer, E.L., Okoh, A.I., Makaka, G., Simon, M., 2013. Microbial Anaerobic Digestion (Bio-Digesters) as an Approach to the Decontamination of Animal Wastes in Pollution Control and the Generation of Renewable Energy. International Journal of Environmental Research and Public Health 10, 4390–4417. <https://doi.org/10.3390/ijerph10094390>

Meegoda, J.N., Chande, C., Bakshi, I., 2025. Biodigesters for Sustainable Food Waste Management. International Journal of Environmental Research and Public Health 22, 382. <https://doi.org/10.3390/ijerph22030382>

Orzi, V., Cadena, E., D’Imporzano, G., Artola, A., Davoli, E., Crivelli, M., Adani, F., 2010. Potential odour emission measurement in organic fraction of municipal solid waste during anaerobic digestion: Relationship with process and biological stability parameters. Bioresource Technology 101, 7330–7337. <https://doi.org/10.1016/j.biortech.2010.04.098>

Rincón, C.A., De Guardia, A., Couvert, A., Soutrel, I., Guezal, S., Le Serrec, C., 2019. Odor generation patterns during different operational composting stages of anaerobically digested sewage sludge. Waste Management 95, 661–673. <https://doi.org/10.1016/j.wasman.2019.07.006>

Selormey, G.K., Barnes, B., Kemausuor, F., Darkwah, L., 2021. A review of anaerobic digestion of slaughterhouse waste: effect of selected operational and environmental parameters on anaerobic biodegradability. Rev Environ Sci Biotechnol 20, 1073–1086. <https://doi.org/10.1007/s11157-021-09596-8>

Wiśniewska, M., Kulig, A., Lelicińska-Serafin, K., 2021. Odour Nuisance at Municipal Waste Biogas Plants and the Effect of Feedstock Modification on the Circular Economy—A Review. Energies 14, 6470. <https://doi.org/10.3390/en14206470>

Yue, Z., Teater, C., Liu, Y., MacLellan, J., Liao, W., 2010. A sustainable pathway of cellulosic ethanol production integrating anaerobic digestion with biorefining. Biotechnology and Bioengineering 105, 1031–1039. <https://doi.org/10.1002/bit.22627>

This work was supported by BMO in an agreement that encourages research, research dissemination, and public outreach. The donors will not be involved in the study design, collection, analysis, interpretation of data, the writing of the documents, or the decision to submit it for publication.

