Prof. dr hab. inż. Wojciech Czekała Poznań, 18 April 2026

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THE REVIEW

of the doctoral thesis Ms. Anna Jasińska M.Sc. Eng. „*Valorization of poultry manure through anaerobic co-digestion with locally available organic waste - an integrated approach for bioenergy production and nutrient recovery in a circular economy framework*", implemented on Częstochowa University of Technology (Faculty of Infrastructure and Environment) and Ghent University (Department of Green Chemistry and Technology), as part of the program joint PhD.

Formal evaluation of the doctoral thesis

In the document RWIiS.BOD.511.1.2026.1.3 dated February 3, 2026, received from Prof. Paweł Mirek, the Vice-Dean for Science of the Faculty of Infrastructure and Environment, Częstochowa University of Technology, I was asked to review the doctoral thesis of Ms. Anna Jasińska, M.Sc. Eng.

Title of the doctoral thesis: „*Valorization of poultry manure through anaerobic co-digestion with locally available organic waste – an integrated approach for bioenergy production and nutrient recovery in a circular economy framework*".

Supervisors: dr hab. inż. Anna Grosser, prof. PCz (Częstochowa University of Technology)
prof. dr ir. Erik Meers (Ghent University).

I prepared the review based on materials sent by the Office of the Scientific Discipline of Environmental Engineering, Mining and Energy at the Częstochowa University of Technology.

Layout of a doctoral thesis

The doctoral thesis is the 243-page Elaboration. The scientific achievements related to the doctoral thesis include seven thematically related articles published or, as indicated in the Elaboration. The number of authors in individual articles ranges from three to nine. It should be noted that in five of these publications, the PhD student is the first author. The total impact factor in the individual years of publication was 26.1, and the total number of points in accordance with the Annex to the Communication of the Minister of Science at the time of publication was 720.

Presents publications and manuscripts associated with this doctoral thesis, together with their respective identifiers (According to the elaboration):

- Anna Jasińska, Anna Grosser, Erik Meers. (2023). Possibilities and limitations of anaerobic co-digestion of animal manure – A critical review. Energies. 16(9), 3885. – Review article, impact factor: 3.2, scientific journal rank by MNiSW: 140 points (D.1.).
- Małgorzata Kacprzak, Krystyna Malińska, Anna Grosser, Jolanta Sobik-Szołtysek, Katarzyna Wystalska, Danuta Dróżdż, Anna Jasińska, Erik Meers. (2023). Cycles of carbon, nitrogen and phosphorus in poultry manure management technologies environmental aspects. Critical Reviews in Environmental Science and Technology, 53(8), 914-938. – Review acticle, impact factor: 11.4, scientific journal rank by MNiSW: 200 points (D.2.).
- Anna Grobelak, Klaudia Całus-Makowska, Anna Jasińska, Marek Klimasz, Aleksandra Wypart-Pawul, Dominika Augustajtys, Estera Baor, Daria Sławczyk, Aneta Kowalska. (2024). Environmental Impacts and Contaminants Management in Sewage Sludge-to-Energy and Fertilizer Technologies: Current Trends and Future Directions. Energies. 17(19):4983. – Review article, impact factor: 3.2, scientific journal rank by MNiSW: 140 points (D.3.).
- Anna Jasińska, Anna Grosser, Erik Meers, Ana Robles Aguilar. (2024). Energy recovery from poultry manure in the process of semi-continuous anaerobic co-digestion with sewage sludge. Energy Reports, 12, 3969-3981. – Original research article, impact factor: 5.1, scientific journal rank by MNiSW: 100 points (D.4.).
- Anna Jasińska, Erik Meers, Anna Grosser. (2025). Sustainable digestate management as a supplement to the casing layer in mushroom cultivation. – Original research article, manuscript prepared for publication (D.5.).

- Anna Jasińska, Anna Grosser, Erik Meers, Dagmara Piłyp. (2024). Stimulating Methane Production from Poultry Manure Digest with Sewage Sludge and Organic Waste by Thermal Pretreatment and Adding Iron or Sodium Hydroxide. Energies, 24 17(11), 2679. – Original research article, impact factor: 3.2, scientific journal rank by MNiSW: 140 points (D.6.).
- Anna Jasińska, Anna Grosser, Erik Meers, Dagmara Piłyp. (2025). Evaluation of saponification and chemical pretreatments for poultry manure co-digestion: methane production, EPS fraction analysis and kinetic study. – Original research article, manuscript prepared for publication (D.7.).

The doctoral thesis consists of five thematically coherent scientific articles published in peer-reviewed scientific journals with an Impact Factor. Additionally, two original research articles as a manuscripts prepared for publication were included in Elaborations. The total number of pages in the five published ppers is 117, and 75 in the two manuscripts prepared for publication. In my opinion, the materials were very well selected for the topic of doctoral thesis. This confirms the high quality of the papers. Most of the references are articles written in English and published within the last few years. References in individual papers exceed 150, demonstrating a very good use of the available literature.

For each of the seven published and prepared for publication papers, statements were provided indicating the PhD student's participation in the preparation of the publication. This participation was presented descriptively. The study did not provide a percentage of the total work for each publication. Based on the prepared statements, it can be concluded that Ms. Anna Jasińska's contribution to most of the indicated articles was extensive and leading. **The total points according to the list of journals is 720, and the total IF according to the year of publication is 26.1. Considering both presented parameters, I consider and would like to emphasize their high value as indicators of the scientific evaluation of the presented works.**

The doctoral thesis is a comprehensive study, including a collection of seven thematically similar articles. In addition to the publications, the 41-page study consists of the following elements:

- Abstract (English, Polish, Dutch)
- List of important abbreviations and symbols
- 1. Introduction
- 2. Aim and scope of the research
- 3. List of publications
- 4. Overview of publications
- 5. Conclusions
- 6. Other research achievements
- 7. References
- 8. Appendix

Analyzing the number of papers and the contribution of Ms. Anna Jasińska, MSc. Eng., to their preparation, as well as the points in accordance with the Annex to the Communication of the Minister of Science regarding the list of scientific journals and peer-reviewed materials from international conferences, I declare that the doctoral thesis meets the formal requirements contained in the Act of 20 July 2018 – The Law on Higher Education and Science (Journal of Laws of 2024, item 1571, as amended).

Substantive evaluation of the thesis

Faced with the need to protect the environment and the growing pressure to decarbonize agriculture, the search for effective methods for processing biomass with high energy potential has become a scientific priority. The poultry sector, one of the most dynamically developing sectors of animal production, generates significant amounts of by-products, whose improper management poses a real threat to water and soil quality. Traditional methods of utilizing these resources as fertilizers are increasingly proving insufficient, especially in the context of stringent environmental standards and the need to reduce greenhouse gas emissions. In this context, biogas technology is the optimal solution, enabling synergy between ecosystem protection and renewable energy production. This doctoral thesis addresses these challenges by addressing the issue of optimizing fermentation processes using poultry manure.

Doctoral thesis aims „*to develop an integrated approach to managing poultry manure through anaerobic co-digestion with sewage sludge and other locally available organic waste*". As indicated, the work covers issues of both engineering and environmental protection (waste management) and energy. The author „*undertook this research with the hope of highlighting the potential of solutions that are both environmentally friendly and realistically feasible in the context of locally available resources*".

The research scope was indicated in chapter 2.2 and, as stated, included:

- characterisation of substrates: analysis of the physicochemical properties of poultry manure, sewage sludge, and other co-substrates (fruit waste, grease waste),
- BMP tests (batch tests): determination of the biodegradability of mixtures and optimisation of the inoculum-to-substrate ratio,
- semi-continuous (CSTR) test: analysis of the stability of the anaerobic co-digestion process under conditions close to industrial scale, including high manure content,
- feed conditioning: evaluation of the impact of preliminary substrate preparation (various conditioning methods) on process performance,
- analysis of digestate quality: assessment of fertilizer value and environmental safety of digestate, including testing its potential as a substrate for mushroom cultivation,
- energy and environmental aspects: calculation of energy balance and GHG emissions for the tested variants.

Managing chicken manure currently is one of the greatest logistical and environmental challenges for modern poultry farming. Due to its very high nitrogen content and ammonia emissions, this raw material requires thoughtful management to avoid contamination of groundwater and soil. Although traditionally used as a natural fertilizer, its odor nuisance and microbiological risks prompt the search for more advanced management methods. A modern approach involves transforming this waste in biogas plants, allowing for the simultaneous production of renewable energy and the production of safe and stable digestate. This management model aligns with the principles of a circular economy, returning valuable nutrients to the environment in a controlled and economically efficient manner.

Pursuant to Art. 187. item 2 in the Act of 20 July 2018 – The Law on Higher Education and Science (Journal of Laws of 2024, item 1571, as amended), „*the subject of a doctoral thesis is an original solution to a scientific problem, an original solution in the application of the results of one's own scientific research in the economic or social sphere, or an original artistic achievement*".

Analyzing the information contained in the Elaboration, including published and prepared articles, it was determined that the research problem concerned the feasibility of utilizing chicken manure in anaerobic co-digestion with locally available organic waste. Particular attention was paid to achieving process stability, increasing methane production efficiency, and assessing the fertilizer value and safety of the resulting digestate.

Based on the research objectives and scope, the following hypotheses have been formulated:

- „H1: Anaerobic co-digestion of poultry manure with sewage sludge and other organic waste significantly increases biogas production efficiency compared to mono digestion of sewage sludge or poultry manure.
- H2: Preliminary conditioning (pre-treatment) of the feedstock mitigate ammonia inhibition and improve process stability and efficiency.
- H3: The digestate obtained from anaerobic co-digestion meets the quality requirements for use in agriculture and horticulture, and in particular can serve as an alternative substrate for mushroom cultivation".

In study, Ms. Anna Jasińska, M.Sc., Eng., presented Figure 1. - Graphical overview of the doctoral research structure and the individual publications (D.1–D.7) included in the thesis, which provided a clear overview of the structure and scope of the research. Figure 1 illustrates the connections between the publications. The figure summarizes the conceptual background, experimental stages, and practical implications of the conducted research. In my opinion, all the publications mentioned constitute a coherent and logical layout. Each publication presents the research materials and methods in detail, which I have no reservations about. In my opinion, the discussion of the results and the discussion of the results in the individual publications were also very well presented.

Doctoral thesis is devoted to the energy and fertilizer utilization of poultry manure through anaerobic digestion in a co-fermentation system with local organic waste. The research covered the entire path: from identifying technological barriers, through laboratory tests of methane efficiency, to analyzing the quality of the resulting digestate in the context of a circular economy. The results confirmed that co-fermentation of manure with sewage sludge stabilizes the process and increases biogas production compared to mono-fermentation. It was also demonstrated that the digestate has high fertilization potential and can be used as a substitute for other fertilizers and soil-improver products. Furthermore, it was proven that substrate treatment significantly increases their biodegradability, translating into higher energy recovery. The thesis provides comprehensive knowledge on the impact of raw material selection and pre-processing methods on the efficiency of biogas installations.

The research conducted by Anna Jasińska, M.Sc., Eng., falls within the scope of the Environmental Engineering, Mining and Energy discipline. The results obtained will undoubtedly help to partially fill some of the knowledge gaps mentioned and addressed doctoral thesis. Analyzing the substantive content of thesis, I would like to confidently emphasize its implementation nature and the direct potential for use of the results by the professional sector. Key conclusions and data, presented in detail and critically assessed in a series of thematically related scientific articles, provide a foundation for implementation in real-world industrial settings, offering tangible technological benefits. At the same time, it is important to note that this work is not limited to application aspects; due to its innovativeness and methodological reliability, it sets new directions within the discipline. The collected research material and documented results constitute a solid starting point that will successfully serve the design and implementation of subsequent research projects in the future.

In the reviewed doctoral thesis, analyzing the Elaboration, including the presented papers, I would like to refer to certain observations, which I present below in the form of comments or questions:

1. Issue about the presentation of papers D.5 and D.7. "*manuscript prepared for publication*." As stated in Elaboration: „*The scientific output related to this doctoral thesis comprises 7 thematically related papers published or prepared for publication between 2019 and 2025*". Pursuant to Art. 187. item 1 in the Act of 20 July 2018 – The Law on Higher Education and Science (Journal of Laws of 2024, item 1571, as amended), „*A doctoral dissertation may be a written work, including a scientific monograph, a collection of published and thematically related scientific articles, a design, construction, technological, implementation, or artistic work, as well as an independent and separate part of a collective work. I kindly ask you to address and clarify this issue*.". I would kindly ask you to discuss and clarify this issue. What is the reason for this arrangement of work in the context of published and unpublished papers? At the same time, I would like to emphasize that I have no comments on the planned and performed research, the content of which was indicated in papers D.5 and D.7. Both papers are well prepared and valuable.

2. I kindly ask to estimate the percentage of the Ms. Anna Jasińska, M.Sc., Eng., contribution to the preparation of each manuscript, taking into account all stages of its publication.

3. As indicated in Figure 1 (Page 25 of Elaboration), issues related to “Intensification of biogas production” were showed in papers D.6. and D.7. What areas does publication D.7. complement with respect to papers D.6.?

4. As indicated in Figure 1 (Page 25 of Elaboration), issues related to “Digestate quality and management” were showed in papers D.4. and D.5. What areas does publication D.5. complement with respect to papers D.4.?

5. As mentioned earlier, the Elaboration did not explicitly identify the scientific problem. Question: How could the scientific problem be defined, including by referring to the hypotheses (which, in my opinion, were well presented) identified in the Elaboration,?

6. In what areas of the national economy could the solutions you suggested potentially be implemented? How would this impact the implementation of activities related to the circular economy and sustainable development?

7. Which type of biomass (that was not used in research) could, have great potential in the context of joint management with poultry farming?

8. There were some minor errors found in the Elaboration, but they did not affect its overall value, e.g. on page 24 it was written „*The scientific output related to this doctoral thesis comprises 7 thematically related papers published or prepared for publication between 2019 and 2025*.”. The papers were published in 2023-2025, but I assume that none of the papers were completely prepared in 2019.

Final conclusion

The reviewed doctoral thesis explored the potential for managemen of chicken manure in anaerobic co-digestion with locally available organic waste. As indicated, particular attention was paid to improving process stability, increasing methane production efficiency, and assessing the fertilizer value and safety of the digestate. Integrating co-digestion with waste and pre-treatment enables efficient renewable energy production. Thanks to the sustainable use of digestate, this process represents a rational strategy for transforming waste into valuable products.

Based on the received Elaboration, in my opinion, Ms. Anna Jasińska M.Sc. Eng., clearly possesses knowledge in the field of discipline and the ability to conduct research. It is concluded that the results obtained as part of her doctoral thesis are of an implementable nature and can be applied in practice after meeting certain conditions.

The doctoral thesis is a collection of seven thematically related scientific papers. Five of them received positive reviews in the journals Critical Reviews in Environmental Science and Technology, Energy Reports, and Energies, and were published between 2023 and 2025. All of the listed articles were published in journals within the disciplines of Environmental Engineering, Mining, and Energy. Two additional papers was "*prepared for publication*."

The subject of this doctoral thesis is an original solution to a scientific problem. The scope and results of the research conducted indicate that Ms. Anna Jasińska, M.Sc. Eng., possesses the ability to independently conduct research. Considering the current research topic addressed by the doctoral candidate, the appropriateness of the methods employed, and the development and presentation of the results and conclusions, **I evaluate this doctoral thesis positively**, regardless of the comments and questions raised in the review.

The doctoral thesis meets the formal requirements set out in the Act of 20 July 2018 - The Law on Higher Education and Science (Journal of Laws of 2024, item 1571, as amended), therefore **I request that it be admitted to subsequent activities in the proceedings for the award of the academic degree of doctor** in the discipline of Environmental Engineering, Mining and Energy. Considering the high level of research conducted, confirmed by the publication of the obtained results in scientific papers in prestigious journals, constitutinga doctoral thesis, **I suggest considering awarding the doctoral thesis**.

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