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REVIEW

of doctoral dissertation by Bhautik Dave MSc pt.

“Degradation of natural and anthropogenic pollutant on surface water in aspect of self-cleaning phenomenon”

prepared under the supervision of the supervisor dr hab. inż. Ewa Łobos-Moysa, prof.
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1. Legal basis for the review

The basis for the review was the resolution of the Discipline Council for Environmental Engineering, Mining and Power Engineering at the Silesian University of Technology dated 19 March 2026, forwarded by letter dated 1 April 2026, reference number RIE-BD/512.19.2026, signed by the Chair of the Discipline Council, Prof. Krzysztof Labus, PhD, Eng.

2. General description of the dissertation

The doctoral dissertation by MSc Bhautik Dave, entitled “Degradation of natural and anthropogenic pollutants in surface water in the context of the self-cleaning phenomenon”, is a 194-page study. The beginning of the work comprises an extensive introductory section, including the title page, an abstract in English and Polish, a list of publications forming part of the dissertation (i.e. scientific articles in which some of the results presented in the work were published prior to its completion), information on the PhD candidate's additional academic activities, a list of symbols and a list of key abbreviations. This is followed by a table of contents and the main body of the dissertation, comprising 8 main chapters: introduction, literature review, aim and scope of the research, methodology, analytical methods and data validation, results and discussion, general conclusions and prospects for further research, and a final summary. This arrangement indicates that the dissertation has a logical structure typical of experimental work in the field of environmental engineering. The dissertation concludes with a bibliography, a list of tables and a list of figures. The bibliography comprises 217 references. Taking the period 2022–2026 as the most recent, approximately 20% of the references, i.e. 43, are publications from the last five years. When taking a broader view that also includes 2021, the proportion of the most recent literature is approximately 30%. It can therefore be concluded that the literature base is extensive and up-to-date, although the proportion of publications from the last five years does not dominate over earlier literature. The PhD candidate bases his bibliography primarily on English-language works, mainly research articles from international journals, chapters in monographs, and studies on biodegradation, constructed wetlands and analytical methods.

The author indicates that the work comprises four single-topic publications that constitute part of the doctoral dissertation. These are materials published between 2024 and 2026, concerning, amongst other things, caffeine, nicotine, fungal biodegradation, the adaptation of microorganisms, and the use of constructed wetlands for the removal of PPCP waste. Furthermore, the PhD candidate's research activity is presented, including conference presentations, chapters in monographs, and other scientific publications. This demonstrates the link between the dissertation and the PhD candidate's publishing and research activity.

From an editorial perspective, the dissertation is comprehensive and contains a significant number of elements documenting the course of the research. The list of tables comprises 25 tables, while the list of figures comprises 59 figures, confirming that the work is equipped with numerous tables, diagrams, results of instrumental analyses, chromatograms, spectra and illustrations of experimental setups. This is beneficial in experimental work, as it facilitates the tracking of methodology, the course

of experiments and the interpretation of results. In my opinion, however, there is a lack of photographic documentation that would lend credibility to the diagrams generated by artificial intelligence.

In terms of editorial care, the dissertation has been prepared in a generally correct manner, though it is not free from editorial, linguistic and stylistic errors. Minor inconsistencies in terminology are noticeable in the dissertation. For example, the terms 'pilot-scale', 'constructed wetland-scale' and 'laboratory-scale constructed wetland' are used, which may cause certain ambiguity regarding the actual scale of the experiments. It would be advisable to standardise these terms and clearly specify whether the constructed wetland system was of a laboratory, semi-technical or pilot nature. Similarly, the title of the dissertation uses the singular form "pollutant", despite the work addressing several pollutants, which suggests that the plural form "pollutants" would be more correct.

In summary, the structure of the dissertation is generally in line with the accepted guidelines for the editing of doctoral theses. The work contains an introduction, a literature review, a clearly defined aim and scope of the research, a detailed methodology, a description of analytical methods, a results section, a discussion, conclusions, a bibliography, and lists of tables and figures. A minor editorial comment may be made regarding the presence of two concluding chapters of a summarising nature, "General Conclusions and Future Perspectives" and "Conclusions" — as these may partially duplicate the function of the final conclusions chapter. However, this does not alter the overall assessment that the structure of the dissertation is complete, well-organised and meets the standard for a research-based doctoral dissertation in the technical sciences.

3. Detailed assessment of the dissertation

In this work, the PhD candidate addresses an important and topical research problem concerning the degradation of pollutants found in the aquatic environment, with particular emphasis on the potential for intensifying the self-purification processes of surface waters. The subject matter of the dissertation aligns with current research trends in environmental engineering, environmental biotechnology and water and wastewater treatment technologies, as it concerns compounds that are difficult to remove completely in conventional treatment systems. The doctoral student bases his research on compounds such as caffeine, nicotine, methylparaben and triclocarban. The selection of pollutants should be considered appropriate, as it encompasses both naturally occurring compounds and those associated with human lifestyles, as well as anthropogenic compounds, which differ in their physicochemical properties, susceptibility to biodegradation and behaviour in the aquatic environment.

However, the title of the dissertation itself, written as "Degradation of natural and anthropogenic pollutant on surface water in the context of the self-cleaning phenomenon", raises some concerns. This title requires linguistic and terminological correction. Firstly, the work concerns several pollutants, and therefore the form "pollutants" would be more correct than "pollutant". Secondly, the phrase "on surface water" is incorrect in this context and should be replaced, for example, with "in surface water". Thirdly, the phrase "in aspect of self-cleaning phenomenon" is not entirely clear to me. Whilst this is an editorial issue, it concerns a particularly important element of the dissertation, as the title should unambiguously and correctly indicate the scope of the dissertation.

In Chapter 3, the PhD candidate formulates the aim of the dissertation and its research objectives. The primary aim of the dissertation is to develop and experimentally validate a strategy for microbial self-purification aimed at increasing the biodegradation of pollutants found in the aquatic environment. The author assumes that the natural ability of microorganisms to self-purify surface waters is insufficient under real-world conditions, particularly given the limited availability of nutrients, whereas the deliberate selection, adaptation and integration of specialised microorganisms may increase the efficiency of the degradation of the compounds under study. The research problem thus formulated should be regarded as interesting and valid from the perspective of environmental engineering. It should be noted, however, that the research hypothesis has not been formulated in the classical manner, e.g. in the form of a clearly named main hypothesis and specific hypotheses. It has been presented descriptively in sub-section 3.4 "Thesis Statement". This method of presentation is acceptable but less clear. In a doctoral dissertation, it would be preferable to formulate the main hypothesis and several subsidiary hypotheses unambiguously, e.g. concerning the impact of microorganisms' adaptation to synthetic wastewater, the differences between fungal and bacterial degradation, and the effectiveness of constructed wetland systems. This would facilitate a subsequent

assessment of whether the research results confirm, partially confirm, or do not confirm the assumptions made in the dissertation.

I have reservations regarding the way the aim of the study is formulated on page 28. The passage beginning with the words 'Targeted enhancement...' is unclear and difficult for me to understand. In its current form, I am unable to interpret unambiguously what exactly the author intended to convey in this sentence. I hope the author will address this point in their response to my review and explain the intended meaning of this passage.

The research methodology adopted was planned in stages and involves a transition from laboratory studies to an artificial wetland system. In the first stage, the degradation of caffeine and nicotine with the use of the fungus *Trametes versicolor* was assessed, while the next stage focused on investigation of the degradation of methylparaben and triclocarban using bacterial consortia. Subsequently, the adapted microbial systems were introduced into a constructed wetland system planted with *Phragmites australis*. The research setup constructed in this way should be regarded as logical, as it allows a transition from controlled conditions to a more complex biological-technological system. The use of synthetic wastewater as a controlled test matrix deserves special mention. This approach made it possible to reduce the variability typical of real wastewater and allowed for the assessment of the microorganisms' ability to grow and degrade pollutants using the nutrients contained in this matrix. This approach is justified at the stage of basic and semi-technical research, particularly when the aim is to assess the biodegradation potential of selected microorganisms.

At the same time, the methodology adopted has significant limitations, which should be more clearly highlighted in the study. Firstly, the concentrations of the pollutants under investigation, typically 100 mg/L, are significantly higher than the typical environmental concentrations of pollutants found in surface waters. The author explains that the aim was to assess the resistance and degradation potential of the microorganisms; however, studies designed in this way should be regarded primarily as stress tests rather than a direct representation of environmental conditions.

There is also inconsistency in the dissertation regarding the scale of the wetland studies. The author uses the terms 'pilot-scale', 'constructed wetland-scale' and 'laboratory-scale biomimetic constructed wetland system'. It is therefore not entirely clear whether the constructed wetland system should be treated as laboratory-scale, semi-technical or pilot-scale. In a doctoral dissertation, such a distinction should be unambiguous, as the scale of the studies determines the scope of possible generalisations and the assessment of the implementation potential of the proposed solution.

Although the analytical scope of the work includes FT-IR, NMR, qNMR, HPTLC and SEM techniques, it does not in every case allow for a full assessment of the 'fate' of the pollutants under investigation. The author himself points out that in some of the tests, the focus was mainly on the degradation of the parent compound, without fully identifying the transformation products or assessing their toxicity. This is a significant limitation, as in the case of pollutants, a reduction in the concentration of the parent compound alone does not always signify detoxification of the system.

The wording of some of the conclusions also raises concerns. In the results section, the author notes that the fungal-bacterial system did not always outperform monocultures and that its advantage lay in functional complementarity rather than additive synergy. Meanwhile, the conclusions chapter states that the combined system consistently demonstrated greater efficacy and that the synergy of microorganisms is a prerequisite for the effective self-purification of multi-contaminated wastewater. This is too strong a claim and is partly inconsistent with the earlier interpretation of the results.

Despite the shortcomings, linguistic ambiguities and elements requiring clarification, the work should be regarded as interesting and valuable in terms of the subject matter addressed, the research concept adopted and the potential significance of the results for the development of methods for the biological enhancement of water self-purification processes.

4. Editorial comments

1. On the title page of the paper, the linguistically incorrect phrasing of the title draws attention: "Degradation of natural and anthropogenic pollutant on surface water in aspect of self-cleaning phenomenon". As the paper concerns several pollutants, it would be appropriate to use the plural form, "pollutants". Furthermore, the phrases "on surface water" and "in aspect of" are unnatural in academic English and should be reworded.

2. In the dissertation, the PhD candidate does not always consistently use the same notation for technical terms and abbreviations. For example, the list of abbreviations includes “FTIR”, while the text of the dissertation also uses “FT-IR”. In an academic dissertation, a single notation for a given abbreviation should be adopted and used consistently throughout the text.
3. The list of symbols includes “0 C Degree Celsius”. This is incorrect. The unit of temperature should be written as “°C”. In the list of abbreviations, the PhD student expands the abbreviation NA as “Nutritional Agar”. However, later in the dissertation the term “Nutrient Agar” appears, which is the correct and commonly used term. This notation should be standardised.
4. There are formatting errors in the table of contents; for example, in the final list of figures, the term “List of figures” appears, whereas “List of Figures” would be more correct and consistent with the rest of the dissertation. A consistent style should be maintained throughout the dissertation for the titles of chapters, lists and auxiliary elements.
5. The English abstract contains the phrase “successful system accumulation”. It appears that the author meant the acclimatisation or stabilisation of the system, rather than its accumulation. In its current form, this wording is imprecise and may lead to misinterpretation.
6. The Polish abstract contains calques from English, e.g., “relewantność środowiskowa [environmental relevance]”, “silnie recalcitrantnych zanieczyszczeń [highly recalcitrant pollutants]” and “akumulacja układu [system accumulation]”. In Polish, the following terms would be more appropriate: “znaczenie środowiskowe”, “zanieczyszczenia trudno biodegradowalne” and “aklimatyzacja” or “stabilizacja układu”.
7. On page 28, in the chapter on the aim of the study, the passage beginning with the words “Targeted enhancement...” is unclear and difficult for me to understand. The sentence is constructed incorrectly, and the names of the pollutants under investigation have been inserted in such a way that they disrupt the meaning of the statement.
8. On page 33, in the diagram concerning the extraction and analysis of caffeine, the word “Caffein” appears instead of “Caffeine”. This is a minor but noticeable typo that should be corrected, particularly as it concerns one of the main compounds under investigation.
9. There is inconsistency in the paper regarding the scale of the wetland studies. The author uses the terms “pilot-scale”, “constructed wetland-scale” and “laboratory-scale biomimetic constructed wetland system”. This terminology should be standardised, and it should be clearly stated whether the system used was laboratory-scale, semi-technical or pilot-scale.¹

5. Issues to be clarified during the defence:

1. In his dissertation, the PhD candidate addresses the problem of the degradation of pollutants found in surface waters, relating it to the phenomenon of self-purification. The very title of the dissertation suggests that the fundamental research problem is the possibility of utilising or intensifying natural self-purification processes to remove selected natural and anthropogenic pollutants. However, in the dissertation, the concept of self-purification is used quite broadly, and in some parts it is not entirely clear to me whether the author understands it as a natural process occurring in the aquatic environment, or as a process technologically assisted by the introduction of specialised microorganisms into a designed system of constructed wetlands.

How, then, does the PhD candidate define self-purification in the context of this dissertation, and how does it differ from the classic biological treatment process carried out in a technological system?

2. In the chapter on the aim of the dissertation, the author states that the subject of the research was the degradation of caffeine, nicotine, methylparaben and triclocarban. These compounds differ in origin, physicochemical properties, solubility, susceptibility to biodegradation and environmental significance. This selection appears interesting, yet the dissertation does not always clearly indicate the main criterion for their selection: prevalence in the environment, toxicity, difficulty of biodegradation, representativeness for different groups of pollutants, or the availability of analytical methods.

What, then, was the fundamental criterion for selecting precisely these four pollutants for the study, and which of their properties did the PhD candidate consider most important when designing the experiment?

3. Synthetic wastewater was used as the primary test matrix in the study. This approach undoubtedly has advantages, as it reduces variability in the composition of the medium and facilitates the comparison of results. At the same time, synthetic wastewater does not fully reflect the complexity of real surface waters or wastewater, which contain variable concentrations of organic matter, suspended solids, salts, autochthonous microorganisms and other pollutants that may influence biodegradation.

On what basis was the composition of the synthetic wastewater used developed, and to what extent does this matrix reflect actual environmental conditions?

4. In Chapter 3.4, the Author presents the so-called 'Thesis Statement', in which he describes the basic assumptions of the work. However, no classical research thesis or hypothesis has been formulated in the form of an unambiguous statement that could subsequently be verified on the basis of the results obtained. In my opinion, the thesis is an essential element of a doctoral dissertation, as it indicates the author's line of reasoning and shows which research problem was to be addressed.

What main thesis or research hypothesis did you formulate before commencing your research, and which results of the work do you consider most important for its confirmation?

5. The author indicates that the use of fungal, bacterial and fungal-bacterial systems can intensify the degradation process of the pollutants under investigation. At the same time, the results section states that the mixed system did not always outperform monocultures, and its action was characterised by functional complementarity rather than simple additive synergy (pp. 158–159). Meanwhile, in the conclusions, the importance of microbial synergy has been quite strongly emphasised.

Do the results obtained confirm actual synergy between fungi and bacteria, or do they rather indicate their complementary action depending on the type of contaminant and the stage of the system's operation?

6. The study primarily assessed the degradation of parent compounds, using techniques such as FT-IR, NMR, qNMR and HPTLC. However, in the case of micropollutants, a mere reduction in the concentration of the starting compound does not necessarily imply complete mineralisation or complete detoxification of the system, as transformation products with unknown biological activity may be formed.

Could you explain to what extent the observed disappearance of the tested compounds indicated their actual biodegradation, and to what extent merely their transformation into other products, and whether an assessment of the toxicity of the intermediate products was planned?

6. Final conclusion

With reference to the currently applicable regulations, i.e. Article 187 of the Act of 20 July 2018 Law on Higher Education and Science, it should be noted that a doctoral dissertation should demonstrate the candidate's general theoretical knowledge in a given scientific discipline or disciplines and confirm their ability to conduct independent scientific research. At the same time, the subject of the doctoral dissertation should be an original solution to a scientific problem or an original solution regarding the application of the results of the candidate's own scientific research in the economic or social sphere.

On the basis of the doctoral dissertation submitted for review, I conclude that the work sufficiently meets the conditions specified above. The content of the dissertation confirms the PhD candidate's theoretical knowledge. The defined objective and scope of the research, its planning and description, as well as the interpretation of the results obtained, demonstrate the PhD candidate's sufficient academic maturity. At the same time, in my opinion, by completing the dissertation submitted for review, the PhD candidate has acquired the skills to conduct independent research.

I therefore request the Discipline Council for Environmental Engineering, Mining and Power Engineering at the Silesian University of Technology to admit Bhautik Dave, MSc, to the next stage of the qualification process required for the award of a Doctor of Engineering and Technology degree in the discipline of Environmental Engineering, Mining and Power Engineering.

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