

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Kirill Abrosimov

PhD Program: Engineering Systems

Title of Thesis: Inverted Brayton cycle for waste heat recovery application

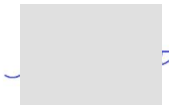
Supervisor: Prof. Aldo Bischì

Co-supervisor: Prof. Andrea Baccioli

Name of the Reviewer: Andreas Panayi, Professor of the Practice

I confirm the absence of any conflict of interest

(Alternatively, Reviewer can formulate a possible conflict)



Date: 08-10-2024

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications
- The summary of issues to be addressed before/during the thesis defense

Brief evaluation of the thesis quality and overall structure of the dissertation:

The dissertation provides a detailed study of the Inverted Brayton Cycle (IBC) for Waste Heat Recovery (WHR) applications, particularly for high-temperature sources such as heavy-duty LNG-fueled transport trucks and stationary engines. The overall structure is clear and logical, progressing from the technical and theoretical background to case studies and results. The chapters are well-organized, making it easy to follow the flow of research from motivation to conclusions. The dissertation addresses both technical and economic aspects of the proposed systems. The quality of the dissertation is very good.

The relevance of the topic of dissertation work to its actual content:

The topic, focusing on the IBC for WHR applications, is relevant to the presented content. The dissertation meets its objective of exploring the potential of IBC-based systems, presenting theory, case studies, and the results of techno-economic analysis. Its content contributes directly to the goal of identifying optimal configurations for WHR using IBC, making the dissertation relevant.

The relevance of the methods used in the dissertation:

The methodology used is appropriate for the research. The use of thermodynamic modeling in Aspen HYSYS for the technical performance evaluation, along with economic assessment tools, is appropriate. The multi-objective optimization and sensitivity analyses are relevant for identifying system performance under different operating conditions and economic parameters, demonstrating a well-rounded approach.

The scientific significance of the results obtained and their compliance with the international level and current state of the art:

The scientific significance of the dissertation is noteworthy, as it addresses a relatively underexplored area in WHR with the IBC. The work builds on existing literature by proposing novel configurations, such as the integration of LNG regasification into the IBC process and the IBC-ORC combination for stationary engines. The results of the optimization and economic analysis provide valuable insights for potential real-world applications. The research is in line with the international state of the art, and it aligns well with current environmental goals such as decarbonization and energy efficiency.

The relevance of the obtained results to applications:

The results presented in the dissertation are relevant to practical applications, especially in sectors like heavy-duty transport and power generation, where WHR can play a great role in improving energy efficiency. As demonstrated in the case studies, the IBC's ability to recover waste heat effectively shows potential for industrial adoption. The integration with LNG regasification could be very relevant for LNG-fueled transportation.

The quality of publications:

The author has published several papers, two of them in reputable journals such as Energy Conversion and Management and Energy. These publications demonstrate that the research has been peer-reviewed and recognized by the scientific community, reinforcing the quality of the work. The range of topics covered in the publications aligns well with the dissertation, contributing significantly to the understanding of IBC applications in WHR.

The summary of issues to be addressed before/during the thesis defense:

To consider:

- While the dissertation provides good theoretical and economic assessments, experimental data to support the model-based findings would be valuable, especially for the advanced configurations.
- While the techno-economic assessment is thorough, including a more detailed breakdown of cost factors, especially in the case of large-scale implementation, would strengthen the economic argument.
- Although the dissertation aligns with decarbonization efforts, a more in-depth analysis of the environmental benefits of the proposed systems, like CO₂ emissions reductions, could further emphasize the significance of the research.
- Discussion on how the proposed systems might scale in different industries or geographical regions would add more depth to the results.

Editing to address:

- The Table and Figure labels as well as their references are capitalized. Why? It should be lower case with only the first letter capital.
- The Bibliography is numbered. In other Skoltech dissertations it is not numbered. What is the Skoltech standard after all? When referenced in the text, the author, the year and the reference number are listed. Good practice is to list the author and the year, or the reference number only.
- Pg. 37 – Table 4 label appears twice
- Pg. 64 could be in landscape orientation for convenient reading on the screen.
- It would be good to have a blank line after the figure captions.

- Table 29 – not clear that it continues on the next page. A continuation label should be placed.
- Aspen HYSYS is marketed with capitalized letters. In the dissertation is referenced as Aspen Hysys.

The formulas have not been checked for correctness.

Provisional Recommendation

I recommend that the candidate should defend the thesis by means of a formal thesis defense

I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report

The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense