

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: Assoc. Prof. Beni Cukurel

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	02/09/2024 Date: DD-MM-YYYY
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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

The thesis "Inverted Brayton Cycle for Waste Heat Recovery Application" investigates the techno-economic feasibility of the Inverted Brayton Cycle (IBC) for high-temperature waste heat recovery (WHR) applications. The overall structure of the dissertation is logical, with clear sections dedicated to background research, methodology, results, and conclusions. There appears to be some novelty in the research conducted, and I am confident others will expand the work in the future with higher order simulations to capture component and system efficiencies under varying loads, as well as conducting experimental demonstration of the technology. Nevertheless, the inclusion of both theoretical analysis and practical case studies enhances the quality of the thesis and the work is presented in a structured and coherent manner which satisfies the threshold to be accepted as a doctoral dissertation.

The dissertation topic, focused on the Inverted Brayton Cycle (IBC) for Waste Heat Recovery (WHR) applications, is highly relevant to current trends in energy efficiency, sustainability, and the reduction of industrial CO₂ emissions. The thesis systematically explores various configurations of the IBC, particularly in the context of heavy-duty trucks and stationary power generation systems. The inclusion of both standalone IBC systems and combined IBC-ORC (Organic Rankine Cycle) systems reflects a comprehensive approach to addressing the research question.

The methods used in the dissertation are appropriate and well-suited for the research objectives. The author employs a combination of theoretical analysis, computational modeling, and techno-economic assessments, which are standard and effective approaches in the field of energy systems engineering. The use of Aspen Hysys for thermodynamic modeling and Matlab for optimization tasks is well-justified and provides reliable results. The empirical approximations and sensitivity analyses further enhance the robustness of the findings.

The results obtained in this thesis contribute to the body of knowledge on WHR technologies and provide insights into the practical applications of the IBC. The study's findings, particularly on the techno-economic analysis of the Inverted Brayton Cycle (IBC) when integrated with both the liquefied natural gas (LNG) regasification process and the Organic Rankine Cycle (ORC) for waste heat recovery, are innovative and relevant to the field.

The obtained results have strong relevance to practical applications, particularly in the fields of heavy-duty transport and stationary power generation. The techno-economic analyses provide valuable insights into the feasibility of implementing IBC-based WHR systems in real-world scenarios and make it viable under certain market conditions. The findings are translated to fuel savings, payback period, sensitivity to LNG prices, and levelized cost of energy.

The results are presented with a level of detail that meets international standards, and the publications derived from this work have been disseminated in reputable scientific journals.

When I was reading the thesis, the following questions came to mind, however they do not need to be addressed before the defense.

- How does the choice of working fluid in ORC impact the overall efficiency of the combined IBC-ORC system?
- How does the IBC's performance degrade over time?
- What would be the implications of using alternative cooling media in the IBC system?
- How would the IBC system perform under variable operational conditions, such as fluctuating waste heat input? How would you address the thermal inertia of the system components, particularly during transient operations?
- Can the author elaborate on the scalability of the proposed IBC model for different industrial applications and their relevant scales? What are the application bounds of the model?

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