Ostbayerische Technische Hochschule
Amberg-Weiden

Review Ph.D. thesis Ing. Václav Novotný

Title of the thesis: Absorption power cycle with aqueous salt solution for low temperature heat utilization

The thesis presetend by Ing. Václav Novotný deals with the highly important and relevant topic of power cycles for waste heat recovery and utilization of low temperature heat. For this pupose, the author proposes a novel absorption power cycle (APC) with aqueous salt solution which has never been implemented before. The goal of the thesis was to prove the technical feasibility of such a cycle both theoretically and in practice. Based on theoretical cycle simulations and practical considerations Lithium Bromide aqueous solution – well known from absorption chiller cycles – was selected as working medium for the cycle. Since the practical implementation of power production from low temperature heat poses not only technical, but also economical challenges, especially with regard to the expander-generator unit, the author also proposes a novel approach using low-cost printed plastic turbines (additive manufacturing).

The aims of the thesis were fully achieved, building and succesfully operating the first LiBr APC ever and showing the technical feasibility of additively manufactured plastic turbines both in operation with air and in the actual APC under real operating conditions. An additional goal of the thesis was to measure the temperature glide predicted by theory in the desorber and absorber. This goal was also achieved, although the temperatur glide was found to be smaller than expected and future more detailed studies will have to be carried out to confirm the results.

The author carried out a comprehensive analysis of the state-of-the-art regarding absorption power cycles including a comparison with alternative cycles for utilization of low temperature heat (e.g., ORC). The presented analysis together with the performed cycle studies can well serve as an exhaustive review on the subject and has been published by the author in highly ranked scholarly journals and conference proceedings.

The dissertation has its strongest point in the very well elaborated engineering of the APC based on thorough theoretical considerations, showing a deep understanding of the theory of the subject. The work not only proves the technical feasibility of an LiBr APC, but also of additive manufacturing of low cost plastic turbines and points out numerous optimisation potentials in both fields, thus serving as pioneering work for future studies and opening new fields of research. Additionally, the experimental results confirm exisiting design and modelling approaches and point out weaknesses in the theoretical concepts, e.g., with regard to the expected temperature glide in desorber/absorber which should be studied more in detail in future. Thus, the dissertation is highly relevant and contributes notably both to the theory of the subject and the engineering practice.

This also applies to the methods used and the approach to the methods application which is very stringent and effective and can well serve as a blueprint for similar design and research tasks. It has to be greatly acknowledged that the author limited himself to the methods required and useful for achieving the goals of the dissertation and did not diverge into less relevant side-topics. For example, the turbine design studies were carried out using comparatively simple correlations and 1D methods and not applying 3D CFD, which is state-of-the-art for more complex turbine design. However, this would have contributed only marginally to the intended outputs of the research work and would have been clearly out of scope considering the comprehensive approach of the proof-of-concept of an entirely new absorption cycle design.

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All in all, the dissertation and the impressive list of publications related to the thesis clearly proves the student's knowledge in the special field of absorption power cycles and also shows that he is very proficient in applying the relevant research methods and to manage ambitious scientific projects.

The layout of the thesis is prepared to high standards and the dissertation is written in a clear and concise fashion. However, the use of English language/grammar and to some extent the visual presentation and readibility of diagrams are not totally up to the high level of the scientific content and could be further improved by professional copy editing. This applies especially if the thesis should be later published in form of a book. Notwithstanding, for the purpose of the thesis presentation this should not be a major concern and I do not consider a revision to be necessary.

I can recommend the dissertation to the final defense presentation without restraint.

Amberg, 18.04.2022
Prof. Dr. Raphael Lechner