SUPERVISOR'S COMMENTS

Author of the thesis: Shokry Sobhy Shokry Habashy

Name of the thesis: Design of a test ejector cooling system

Type of the thesis: Master´s thesis

Supervisor: Vaclav Dvorak

Institution of the supervisor: Technical University of Liberec, Dept. of Power Engineering Equipment

A. **Formal belongings of the thesis:** Very good minus
(Rate linguistic and typographical level of work, text structure, sorting chapters, illustrations, correctness and completeness of citations literary sources)

The submitted thesis comprises 56 pages, including the thesis assignment, author's declaration (in Czech), acknowledgement, table of contents, summary, introduction, motivation, used nomenclature and the list of references.

As regards formality, the thesis meets almost all common necessary criteria, however, formal and academic English should follow some typical features. For example, formal academic English should avoid using contractions. The order of the chapters in the thesis is not much logical, and their numbering could start from the introduction. There are two different numerals systems for the page numbering used. At the beginning of the thesis there is a Roman numeral system for several pages used, whereas for the rest of the thesis there is an Arabic numeral system employed. The list with the nomenclature used in the thesis is rather chaotic. Only some of the chapters are divided into numbered sections and subsections, while others are not. From what I gather, the paragraphs of the chapters should have the same and uniform spacing between them since it would improve the appearance of the pages. The main text may be, in some sections, hard to follow, however, the level of English appears to be very good. Furthermore, the main text is written in font size 14 points, which is rather large. In some cases, the captions of figures have not uniform font size. The thesis lacks the consistency of used labelling. In situations where there are two or more acceptable conventions, the student should choose only one and stick with it throughout the thesis. Rather confusing is the same referencing of provided literature sources and equations or formulas (e.g. page 20). There are also some mistypings and inaccuracies. For instance, there is repeatedly written word "incrases" in charts instead of the correct form "increases". The tables are difficult to follow and lack some sort of unification or template, i.e. there should be, in my opinion, the same number of decimal places for a particular variable. Again, the spacing between the tables is not uniform. Tables should be a concise and effective way to present some amounts of data. They should be designed carefully so that others can clearly understand them. On the other hand, it should be mentioned that the depictions of the tables are placed above the tables, which is quite beneficial. As for variables, even dimensionless variables should be cited

with their units either with (1) or (-). In addition, there is probably a huge misunderstanding of the terms "throat" and "throttle". The horizontal "x" axis in figure 24 does not correspond with table 6, the Mach number at the choked region must be in any case equal to unity. From the figure it may appear that the Mach number is around 0.2 for the labelled choked flow. There are many complex clauses that are not well-organized and make it difficult for the reader to understand the main idea of a particular sentence or clause. It would be much better if each paragraph comprised its topic sentence, I believe. I am not sure if a sufficient amount of time has been devoted to the formal belongings and proofreading of the thesis. Most of the errors in the thesis could have been corrected at the proofreading stage. Some figures lack lucidity and may be difficult to read for the reader. Additionally, there are many units which should be denoted with a subscript.

In some cases, the cited references are not correct. The formatting of the references is not consistent. Moreover, not all figures are labelled by a source. Finally, there are common rules of using punctuation in English. I am inclined to believe that these were not, in some cases, employed properly.

B. **Thesis theoretical part:** Very good
(Rate the extent and manner of research, a way of describing the problem solved or the suitability and complexity of used theoretical method.)

Although there is no unambiguous link between the theoretical part and the practical part, the theoretical background and literature review seems to be more comprehensive than the practical part of the thesis (I have counted more than 30 pages dealing with theory). Some of the chapters are, in my opinion, too extensive regarding the fact that no in-depth analyses of the whole system were done in the frame of the thesis. Additionally, there are a few incorrect statements. On page 23, the student is writing about a shock wave between the sections m-m and 2-2, and soon after that is writing that there is a uniform pressure between these two sections, which makes no sense at all. On the other hand, the literature review is quite relevant, and it appears that quite a lot of time was devoted to the study of the ejector refrigeration.

C. **Thesis practical part:** Very good minus
(Rate adequacy and sophistication of the methods used, the level and amount of data obtained.)

To solve parameters of the flow through the ejector, the analytical method by Chen et al. based on the governing equations for 1D flows was employed. This method requires correct values of loss coefficients to provide sufficient results. Mass balance equations are employed for all heat exchangers and the pump and the throttling valve. The influence of selected parameters on the ejector performance was demonstrated,

however, there is no analysis of the entire system, which was supposed to be one of the objectives of the thesis.

In the introduction (page V), the author is claiming that the thesis investigates the ejector on a fundamental level, and also that there is effort to improve its efficiency. Personally, I do not think that it has been performed in the frame of the thesis.

Some sentences and conclusions do not make sense, e.g. the sentence on page 29 *"When increases Pp in figure 23, Psy and Ppy increase which increases P2 and therefore Pc increases and ω increases because of boosting in the induced flow rate"*. It is blatantly obvious from the figure that ω is decreasing when Pp is increasing. It is also a pity that the student did not investigated the entire system in more detail, for example, by introducing any other models for determining the performance of an ejector, or by incorporating CFD methods since the analytical method is very sensitive on a proper selection of loss coefficients. From this point of view, there is a lack of experimental data, which is not student´s fault, so I would not blame him. In my opinion, there was not done so much work compared to other master´s theses created at the department.

D. **Results analysis:** Good
(Rate the level of processing of data, including the determination of measurement uncertainties, discussion of the results and formulated conclusions.)

A demonstration of the influence of chosen parameters on the ejector model itself has been performed. The results are depicted in tables and, in some cases, carry out into charts. Insufficient attention is, in my opinion, paid to the entire system and its modeling. The thesis lacks the study of the influence of key parameters on the performance or behavior of the entire system. Unfortunately, no experiments nor numerical analyses which could make the thesis more complex were conducted in the scope of the thesis. I would not blame the student for that since there is no such an experimental device at the department. Nevertheless, the student could have compared his results with currently available experimental data in the literature. Conclusions are formulated quite clearly, however, approximately a half of the text in the chapter is dealing with a theoretical background. I believe that it should not be placed in this chapter.

E. **Level and quality of the thesis:**
(*Rate overall complexity and scope of work and original contribution of the student.*)

To determine the ejector´s performance analytically, the student used knowledge gained from references. This proves student's ability to deal with the problem. Nevertheless, the student could also contribute by more detailed analysis of the entire system, including the pump and heat exchangers. I am inclined to believe that the student should have shown the influence of some crucial parameters on the behavior of

the entire system. In addition, there could have been conducted the cost evaluation of the system.

As far as I am concerned, the originality of the student´s work consists of the proposal of the ejector cooling system on a theoretical basis that is primarily based on the currently available model by Chen et al., making of some demonstrations that show the influence of selected parameters on the performance of the ejector, and analysing the obtained results.

Overall evaluation:

The thesis meets almost all the necessary criteria regarding both content and form. The student has proved his ability to conduct a reasonable review and to use the gained knowledge during his study to incorporate relevant relations into a spreadsheet software. To solve the problem, the student exploited available literature. However, only one model for describing the flow in an ejector has been investigated. The thesis contains quite many mistypings and inaccuracies. The most significant shortage of the thesis is, in my opinion, that there has been no study regarding the influence of key parameters on the entire cooling system performed. Furthermore, no other approach, nor a comparison with some available experimental data from the literature, have been involved. Finally, it should be mentioned that the quality of the thesis is far below average department standards.

Questions for the defense:

1) Can the student explain the modes of an ejector on the performance curve in more detail? (page 3)
2) In what regime is the ejector working when the student investigates the influence of particular parameters on the COP and the condenser temperature?
3) Does the drawn cycle in Figure 18 include the mixing and the pressure rise in the ejector? Could the student elaborate on this issue? (page 18)
4) The student is also writing about the fact that the 1D methods proved to give reasonable data, although no comparison with experiments nor numerical simulations has been performed. Based on what does the student think that the method is reasonably accurate?
5) The student is writing about the optimization of the cycle (page 45). What was the objective function of the optimization?
6) There is the statement that the thesis determines the design parameters for the test system. What are the independent variables for the design of an ejector?

SUPERVISOR'S COMMENTS

Qualification:

Although the aims of the thesis have not been accomplished completely, the thesis meets the requirements for the granting of a degree, therefore, I recommend it for the defense.

I suggest this work to classify as "Very good minus"

In Liberec, 4th June 2018

I certify that I am not in any personal relationship with the author of the work

Supervisor's signature