REVIEWER'S OPINION OF FINAL THESIS

I. IDENTIFICATION DATA

Thesis name:	**Geometric nozzle study for an ejection cycle used for waste heat recovery in an internal combustion engine**
Author's name:	**Deepak Kumar Jangid Gopalakrishnan**
Type of thesis:	master
Faculty/Institute:	Faculty of Mechanical Engineering (FME)
Department:	Department of Automotive, Combustion Engine, and Railway Engineering
Thesis reviewer:	Rastislav Toman
Reviewer's department:	Department of Automotive, Combustion Engine, and Railway Engineering

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment — **challenging**

Evaluation of thesis difficulty of assignment.

The thesis assignment covers a simulation study of a nozzle used in an ejection cycle for a waste heat recovery system. CFD codes and volumetric thermodynamic model of the cycle should have been combined to study and further optimize the nozzle geometry in the steady-state and engine transient operation. Therefore, I find the assignment challenging.

Satisfaction of assignment — **fulfilled with major objections**

Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.

The assignment was fulfilled with major objections. The main objection is a complete omission of an analysis with a volumetric thermodynamic model and exclusive focus of all the analyses on a steady-state cases. The transient operation is only mentioned in the chapter 5 of the work. The student at least tested the nozzle operation in off-design conditions to account for the real-life transient behavior. However, it is not clear from the text whether the design and off-design conditions are realistic.

Method of conception — **partially applicable**

Assess that student has chosen correct approach or solution methods.

The final document does not contain any sensitivity studies for the settings of the 3D-CFD simulation: solver type, turbulence model, mesh properties, boundary conditions etc. It is possible that these were done, but the thesis document doesn't specify it. The document only mentions that the base model and geometries were supplied by the host institution, probably also with the settings for the simulation. Also, the already mentioned design and off-design conditions of the nozzle should be solved. Therefore, I find the overall methods used by the student only as partially applicable.

Technical level — **E - sufficient.**

Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.

It seems that the student focused his theoretical study almost exclusively to the expert literature, sources, and approaches gained from and used by the host institution. This is especially prominent in the first two theoretical chapters of the thesis. Then, the explanations of the subsequent steps, simulated/optimized results are often very basic, sometimes even a bit confusing. For example, the optimization of the nozzle geometrical parameters is limited to very few parameters, without any profound explanation why is it so. The same applies for the conclusions of the thesis. The conclusions lack more technical insight into the whole problem and a more global view.

Formal and language level, scope of thesis — **D - satisfactory.**

Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.

The thesis's formal and language level is satisfactory. The text is somehow logically arranged and divided into different sections or chapters. It contains some typos, it is a bit clumsy, and the level of conclusions – as it was already mentioned – is basic. The quality of the text decreases in the practical parts. The thesis is rather short, missing the already mentioned analyses from the assignment.

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Selection of sources, citation correctness **D - satisfactory.**
Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.
Student uses relevant and current sources, uses correct citations. However, the whole theoretical part cites only two sources, mainly one of them. A deeper theoretical research using also other resources would be beneficial.

Additional commentary and evaluation
Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.
Please insert your commentary (voluntary evaluation).

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Summarize thesis aspects that swayed your final evaluation. Please present apt questions which student should answer during defense.

The final evaluation of the thesis is primarily affected by two factors. The first one is that the results and methods in the final document are in general very basic and not very well technically grounded. The second one is the lack of thermodynamic and transient analyses required by the official thesis assignment. Therefore, I evaluate the final thesis only as "**E – sufficient**".

I would like to ask the student:

- Can you elaborate on the boundary conditions of the design and off-design conditions of the nozzle?
- Why and how have these been chosen?
- How could the thermodynamic volumetric model help to determine these conditions (also the engine transient operation)?

I evaluate handed thesis with classification grade **E - sufficient.**

Date: **29.1.2019** Signature: