ČVUT
ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

REVIEW OF FINAL THESIS

I. IDENTIFICATION DATA

Title:	**Bioethanol production technology from waste in Kazakhstan**
Author:	**Alikhan Uteyev**
Type of thesis:	master thesis (diploma thesis)
Faculty/Department:	Faculty of Mechanical Engineering (FME)
Department:	Department of Process Engineering
Reviewer:	Ing. Jiří Moravec, Ph.D.
Reviewer's affiliation:	CTU in Prague, Faculty of Mechanical Engineering, Dept. of Process Engineering

II. CRITERIA EVALUATION

Assignment **average demanding**

Evaluation of the difficulty level of the assignment.

The goal of the work was to prepare a review about lignocellulosic ethanol production technology, prepare its PFD, calculate mass and energy balances and provide economic evaluation of the technology. Techno-economic parameters of the technology should be compared to the conventional waste combustion technology and pros and cons of both technologies should be discussed. Possible usage of the biofuel production technology in Kazakhstan should be discussed.
The difficulty level of the thesis is average. The assignment is adequate for a master thesis.

Assignment fulfilment **fulfilled with lesser reservations**

Evaluate whether the submitted work fulfils the assignment. Specify eventually in comments which points were not fully met or vice versa whether the work is extended in some parts in comparison with assignment. If the assignment was not fulfilled completely, try to assess severity, impacts and eventually causes of particular shortcomings.

The work fulfils more or less all the points of the assignment. Just few information were written about comparison of biofuel production technology with conventional waste combustion technology and their advantages and disadvantages. Part of the review was completely copied from previous author's bachelor thesis. Everything was cited.

Solution procedure **correct**

Assess whether a correct procedure or method has been chosen by the student.

The author chose a correct procedure in the work. Particular steps of solution follow each other in a logical way. However, the procedure was partly given by the assignment.

Professional level **D - satisfactory**

Evaluate the level of expertise of the thesis, how the student uses knowledge achieved by study or obtained from scientific literature or practice.

For the successful fulfilment of the assignment, the author had to use knowledge of flowsheet preparation, balance calculations, basic heat transfer phenomena, physical chemistry and business plan economic. During the studies, however, a similar project have to be solved by each student. In my opinion, the depth of solution in the presented thesis could be bigger. Process flow diagram (PFD) and mass balances were done quite in a good way. There are just several mistakes. The most important one is a missing burning reaction in mass balances.
The part with energy balances is not so clear. It starts on a page, which follows several pages already containing heat transfer calculations. Determination of flow rates of utility media (oil, water) are not correct, as they are calculated probably only to cover the heat losses. Problem is that the processes are not described enough in detail. In the chapters relating to heat transfer, energy balances and economical calculations, information that something is done or used upon supervisor's advice appeared in the text many times. This leads me to a question whether the author was able to solve the balances by himself without supervisor's help.
Also the economic part is written quite superficially. A lot of information is missing in the text. The appendices (Excel files) contain some of them, but not all. The correctness and completeness of the calculations cannot be checked easily, but if I check the files, I found several mistakes and wrong calculations.

I was disappointed with small amount of information about comparison of biofuel production technology with conventional combustion technology. Advantages and disadvantages of the technologies were not described properly. I was also missing more detail conclusions about application of the technology in Kazakhstan. The relation between the technology production and Kazakhstan could be emphasized more in detail (more clearly).

Formal and language level, work extent **C - good**

Assess formal correctness, typographical and linguistic aspects of the thesis.

Although the work has 68 pages, the extent could be a little greater, so all the necessary information were properly described. The work is well organized and logically structured. Typographical level of the work is quite good, figures and tables are properly described and readable. The work is written in English. From grammatical point of view, the work contains quite a lot of mistakes and misspellings which decrease the quality of work. I indicated some of the problematic texts directly in the thesis.

Bibliography, citation correctness **C - good**

Comment the student's activity during the acquisition and use of learning materials to solve the thesis. Characterize the selection of bibliography. Assess whether the student used all relevant sources. Verify that all obtained information is properly distinguished from student´s own results and considerations, whether citing is done correctly corresponding to the ethical rules, whether bibliographic citations are complete and whether all citations are in accordance with the practice and standards.

The chosen references seem to be relevant, but some of them are quite old (2005, 2007). I think that 10 years is quite long time in the field of biofuel production technology and its usage in the world. The number of references is sufficient. I missed references just at two places in the thesis. A lot of references are in Russian language, so I could not check information originality. The author uses also a reference to his previous work. He directly copied text of chapters 1.2.1, 1.2.3 and 1.2.3.1 (six pages in total) from his bachelor thesis. This is not correct. Everything was cited, but not properly as a direct copy.

References are cited in form of numbers at the end of paragraphs, so it is not clear what particular information is cited. The format of references is not completely correct. Some information are missing in the list of references at many items (date of citation of internet sources, publisher, journal, year of publication).

Other comments

Comment the reached level of the main results in the thesis, e.g. the level of theoretical results or the level and functionality of presented technical solution, publication outputs, experimental skills, etc.

In summary, it can be said that the author demonstrated the ability to carry out a technical report corresponding to a feasibility study including carrying out a literature search. His knowledge about making flowsheets and mass balance calculations are quite good. The knowledge about energy balances and economical evaluation is, however, not at a good level. The information presented in the work are satisfactory for the thesis defence.

III. FINAL EVALUATION, QUESTIONS FOR THE DEFENCE, CLASSIFICATION DEGREE PROPOSAL

Summarize aspects of the final work, which influenced your final evaluation at most. Write out questions, which should be answered by the student at the thesis defence.

Detail comments to the work (not mentioned in the previous parts):

- P. 10, ch. 1.1.3.1, r. 2: Nitrogen or nitrogen oxide?
- P. 13, ch. 1.1.4.1: The unit TWh would be better than kWh.
- P. 13, ch. 1.1.4.3, last row: „13 million Gal. of heat“. What is „Gal.“?
- P. 16, par. 4, r. 3: „e-energy“ – does it have any meaning or is it a mistake?
- P. 16, Tab. 4: The table is not referred in a text.
- P. 18, par. 4, r. 1: „200 billion metric tons“ – for which country it holds? The information from year 2007 is quite old in this field.
- P. 20, r. 2: „2005“ – old information.

- P. 20, Tab. 6: Almost the same information were presented in the table 5. Why the information is presented again? Comments to the differences would be helpful.
- P. 20, last par.: Recalculations of annular production to l/h and kg/h are not clear. What is the number of working days/hours in year in your case? Density of the ethanol is 789 kg/m^3 (tab. 7), so 4166 l/h corresponds to 3287 kg/h, not 3271 kg/h. Why do you mention gallons when you make the balances in SI units? 1. U.S. gallon is 3.7854 l. There is no meaning for rounding to 3.78 l.
- P. 23, ch. 1.2.3.1.4: „SO_2 steam explosion" – what does it mean? I thought it is about water steam explosion?
- P. 26, eq. (1.2.3.3-1): Marking equations with long numbers is not appropriate. There is not so many equations in the work, thus one- or two-level marking would be sufficient, i.e. (1) or (1-1) in this case.
- P. 30, par. 1: Why not to start marking streams from 1? Logically the first stream should be 1.
- P. 30, last par.: What information were taken from the reference [6] here?
- P. 30, Fig. 2: There should be input and output utility stream to K-003 and also output stream 4, so the scheme is complete. Similarly, fig. 3 should be completed.
- P. 31, ch. 2.1.1.3, par. 2: "three or more vessels …" – such information is insufficient for economic calculation.
- P. 33, par. 1: Equipment necessary for rectification and purification is not described.
- P. 34, Fig. 5: Symbol and specification of heater in T-004 is missing. The same should be changed in Fig. 6 at apparatus T-003.
- P. 35, r. 3: Why the value of temperature is 53 °C?
- P. 36, par. 1, r. 4: The temperature of drying air (100 °C) at the inlet should be higher (depending on required ΔT for drying). The same information is on page 55, chapter 2.3.3.
- P. 40, Fig. 9: The calculated flowrate of enzymes does not correspond to the condition presented in text on the prev. page (10 g/l). Here it is 10 g/kg. The same holds for the yeast calculated in the next chapter.
- P. 41, Fig. 10: It is not clear, how the amount of CO_2 subtracted from components in K-007 was obtained.
- P. 44, par. 1, r. 2: Flowrate of air 200 000 kg/h is quite high!
- P. 44, par. 1, r. 4: Why it is calculated with ideal (100 % drying). It is not real.
- P. 45, ch. 2.2.1.7, r. 1: There will be burned 17 tons of solids/hour? It is quite a lot.
- P. 45, Fig. 14: Air flowrate is the same at the input and output. That cannot be true as it is used for burning! How the amount was calculated?
- P. 46: The units should be in kg/h in the text and also in the table.
- P. 47, eq. (2.2.2.1-1): The symbol "*" should not be used as a multiplication sign. It holds for all equations. Symbol $\dot{Q}$ is used for heat flux usually.
- P. 52, ch. 2.2.2.5: I think that only one equipment from T-002 and T-003 would be enough in the technology.
- P. 54: Why the chapter "Energy balances" starts here (after several pages with heat transfer calculations)?
- P. 55, ch. 2.3.2: The latent heat should be taken into account in the balance.
- P. 56, par. 1, r. 4: From which source the price of ethanol was taken? (Missing reference).
- P. 56, p. 3, r.5: Information that costs for energy can be estimated as 30 % of CAPEX is very rough. It will depend on the solution of the technology, on sources of energy that are available, etc. Was it just some supervisor's estimation or is it based on some values taken from literature?
- P. 56, eq. (2.4-1): What is the meaning of parameter *S*? The parameters *a*, *b*, *S*, *n* are not in the list of symbols.
- P. 57: The prices are in U.S. $? Missing reference.
- P. 58, eq. (2.4-4): How the overall heat transfer coefficient was determined?
- P. 58, par. 2: "The price of the columns was taken from online stores." – missing reference.
- P. 58, last par., r. 5: I am not sure, that any bank would like to invest 100 % of costs.
- Economical calculations (text + appendix):
  - The price for 1 t of ethanol is 505 $ in the text (p. 56), but 1000 $ is used in the calculations (app. F).
  - There is zero cash flow in the first year of the project (Fig. 21, appendix F). What does it mean?

- The presented lifetime of the unit is 15 years (p. 59), but the calculations are made just for 12 years (Fig. 21, app. F).
- Floating costs are not correctly calculated (appendix F).
- Interest on bank loan is 11 %. For which country is the estimation made? Is it real?
- Internal rate on return was calculated for 2 variants in the appendix, but there is no description, what is the difference between the variants. Why there were determined different values? Which one is correct? Why it is not described in the text of the thesis?
- Size of equipment and their amounts were not set. It is a question how precise can be the capital investment estimations in such a case.

- PFD:
  - The capacity of mixing and storage tanks is quite big (3000 m^3, 6000 m^3, 18000 m^3). It is not defined, whether it will be one or more equipment. There was mentioned, that there will be 3 or more fermentation tanks (p. 31, ch. 2.1.1.3). This is not sufficient. The economic calculation cannot be done properly then.
  - In K-003, the pressure is 1.5 MPa, temperature 195 °C and the volume of the vessel is 240 m^3. Will it be one equipment? Such apparatus would be very expensive! Pressure vessels are much more expensive than standard mixing vessels. Was it taken into account at estimation of the costs?
  - I am missing information about pressures in the streams and some units. It is not clear to me e.g. how CO_2 will be sucked from K-007. The pressure in vessels affects their production costs significantly!
  - I am missing stream 0 in the table of material balances.
  - I am missing names of equipment in the table of equipment.
  - Heating in T-001, T-003, W-001, K-008 is not defined (liquid, electricity).
  - Few equipment and streams is missing (air fan and filter, inlet of enzymes, inlet of yeast).
  - Is there any reason to have both tanks T-002 and T-003 in the technology? Why there is not used just one of them? Expansion vessel should be used in the loop.

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Questions for the defence:

1) Why did you choose to produce 24 000 000 l/year of the bioethanol? Is there any relation to Kazakhstan demands or resources?
2) What number of days/hours should corresponds to one year in your calculations?
3) On page 31 (last paragraph), you write that CO_2 could be used for syngas production. A facility for such production, however, should be nearby. Is it real in Kazakhstan? Is there such a facility already?
4) A specific heat loss 35 W/m^3 was used at energy balance of vessels. The loss is dependent on isolation of vessels. Nothing was written about this problem. What about the energy needed for mixing? It was not taken into account. What specific energy for mixing is used in such types of mixed vessels?
5) What is the reason for cooling the product in K-008 down to 20 °C when it is then heated to 80 °C in K-011?
6) On page 59 (ch. 2.4.2, par. 2, r. 3), you write that CO_2 emissions are 150 g per ton of wheat straw". How was it calculated? If I take the values from mass balances, I get 142 kg/ton at bioethanol production and 283 kg/ton from burning of solid residues (this value is probably not correct due to missing chemical reaction in calculations).

If I summarize all the above mentioned comments and evaluation notes, I suggest the thesis for the defence with the classification grade

C - good.

Date: 31. 8. 2018 Signature: Ing. Jiří Moravec, Ph.D.
v. r.