



**UNIVERSITY OF GENOA**

Polytechnic School

**Thesis Title**

Thesis for the Master of Science Degree in Energy Engineering

**Supervisors**

<XXX>

<XXX>

**Co Supervisor**

<XXX>

**Candidate**

<XXX>

**Date**

<XXX>

## **ACKNOWLEDGMENTS**

Acknowledgements means using your own words for thanking people who helped you during thesis preparation. They could be colleagues, mates, relatives and even teachers.

Any contribution for improving the present Template is greatly appreciated.

Please refer to Energy Engineering (En2) coordinator for feedback and suggestions.

This version was updated on February 6, 2017

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## ABSTRACT

All the pages have been formatted in the accepted font and margin alignment. This is a simple MSc thesis template that can be used for directly typing in your content. However, if you paste your text into the document, do so with caution as pasting could produce varying results. In this example the font is Times New Roman, dimension 12, line spacing is one and a half, paragraph is justified. Left margin and right margins are 3.5 and 2.5 cm respectively. Top and bottom margins are 2.5 cm. Footer contains page number and eventually thesis title short name.

- When directly typing into the title page, the appropriate information should be filled in the required fonts.
- Please be careful that Plagiarism is unauthorized in entire document.
- When writing an abstract, bare in mind an abstract is a short descriptive summary of your thesis. In an paper (Conference or Journal), the number of words accepted might vary e.g. 200-250 words.
- An MSc thesis abstract is longer, but it needs not to exceed two pages.

Abstracts are typically written last although they are the **most important part of the thesis**. They should have a little bit of everything: the background, the scope of your project, the purpose, findings and conclusions. An abstract is neither paragraphed nor cited. It should not be written as a literature review or a discussion of results. In a simplistic manner, your abstract, in a few words, should answer the questions: why should we care about your research; how did you get your results; what did you learn, find, create, invent; and finally what do your results imply?

## LIST OF TABLES

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Figure 1.7: Example of high resolution graphic inserted with “paste special, as enhanced metafile” .....	X

## NOMENCLATURE

<b>Symbol</b>	<b>Meaning</b>	<b>Units</b>
B	borehole separating distance	[m]
Fo <sub>H</sub>	Fourier number based on BHE depth, $ Fo_{rb} = \alpha_{gr} \tau / H^2 $	[-]
H	depth of Borehole heat exchangers	[m]
k <sub>gr</sub>	ground thermal conductivity	[W/mK]
L	overall length of borehole heat exchangers	[m]
$\dot{Q}$	heat transfer rate	[W]
$\dot{Q}'$	heat transfer rate per unit length	[W/m]
R	radius, radial coordinate	[m]
r <sub>b</sub>	borehole radius	[m]
R <sub>bhe</sub>	borehole thermal resistance	[mK/W]
T	Temperature	[K] or [°C]
<b>Greek letters</b>		
$\alpha_{gr}$	ground thermal diffusivity, $ \alpha_{gr} = k_{gr} / (\rho c) $	[m <sup>2</sup> /s]
$\gamma_f$	$ \gamma_f = 0.5 (Fo_H)^{-0.5} $	[-]
$\rho$	ground density	[kg/m <sup>3</sup> ]
$\theta_8$	excess temperature, equation (8)	[°C]
$\tau$	time	[s]
<b>Subscripts</b>		
ave	average	
b	borehole	
f	secondary fluid	

## CHAPTER I: LITERATURE REVIEW

The background and literature review section needs to provide sufficient fundamental background information about the subject to support your objectives, hypothesis (or research questions) and methods, and review the pertinent literature related to the specific problem / hypothesis you are addressing. It must also provide some idea of your research goals and approach to research. Specific objectives can be introduced in this chapter. The Background and Literature Review chapter often concludes with a summary of the organization of the thesis, including identification of the general content of specific chapters and appendices.

A very important issue in any chapter is the correct referencing to previous literature work. In your thesis any paragraph should be a your own contribution. **Plagiarism is unauthorized.** You cannot copy and paste text from external sources without referencing the source and without elaborating the original text with your own words.

### *Section header*

Given the length of each chapter, it is required to use headers and sub headers (possibly sub-sub headers). These can be numbered or one can just rely on different formats. The section headers in this document are labeled “heading 2” (“heading 1” was used for chapter titles). The heading styles formats should be consistent throughout the document.

### **Sub heading (heading 3)**

The subheadings here have a different format (“heading 3”) than the section headers.

### Sub-sub heading (heading 4)

You can even get to another level of headers, defined here as “heading 4.” Please include all headers in The table of contents.

## Equations

Equations can be created in MS WORD equation editor or they can be created with other software. Equations should be numbered. They can be numbered sequentially throughout the entire thesis or chapter by chapter. Equations should be indented or centered with the equation number to the right.

$$root = \frac{-b^2 \pm \sqrt{4ac}}{2a} \quad (1)$$

This equation was written with the equation editor. This editor is fine for relatively simple equations, other options are available for more complex equations.

Equations are cited in the text as in the following example:

The inspection of Eq. (1) reveals that 2 roots are available from calculation.

If chapter by chapter numbering is selected, the above equation would be (1.1), if the related chapter is number 1 and the equation is the first presented.

Symbols in the equations are described in the text when they are introduced, say below the equation where they are inserted. Symbols are also described in the Nomenclature Section.

Numbers use the point as separating symbol for decimals and have units.

As an example: the input power is 0.75 MW.

Notice here above the space character between 0.75 and MW is the “glueing” one CTRL+SHIFT+BAR

Usually 3 significant figures are enough for engineering purposes while representing physical quantities. Furthermore decimals must be related to the real possibility of measuring a given quantity (this is why for example the temperature cannot be represented with more than 2 decimals).

## Tables

Tables should have meaningful information with descriptive headers. Table legends go above the Table. Please avoid using vertical rules.

Table 1.1: XXX

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<b>XXX</b>	<b>XXX</b>
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## Figures

A good way is to copy your graphic (for example from PowerPoint or excel) and when pasting it into word, use the “paste special” “as an “enhanced metafile”. This also substantially reduces the resulting file size in comparison with pasting graphs in as excel graphics. Figure legends go inside or below the Figure.

Axis titles and axis numbering are written with proper character dimensions in order to allow an easy comprehension of the related information (i.e. not to small).

Symbols are different in shape in order to distinguish them also in case of black and white printing. Symbols have proper dimensions: not to small, not to big.

Symbols are used for representing quantities calculated (or measured) in given conditions and they represent discrete series of results.

Continuous (and dotted) lines are employed for representing continuous functions (e.g. the results from an equation), the curve fitting of discrete points, some boundaries in the diagram.

Secondary X and Y axes can be employed when series of results pertain to very different value ranges.

Each Figure (and Table) is numbered and a caption is given just below it.

See the examples below.

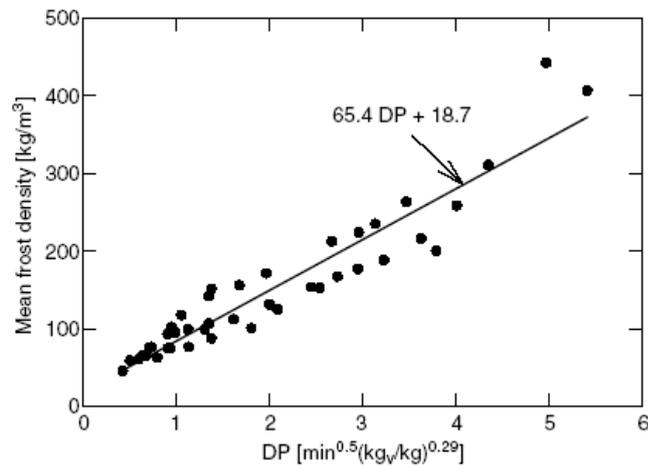


Figure 1.1. Measured frost density vs the Density Parameter DP.

The continuous line (best fit) represents the proposed correlation.

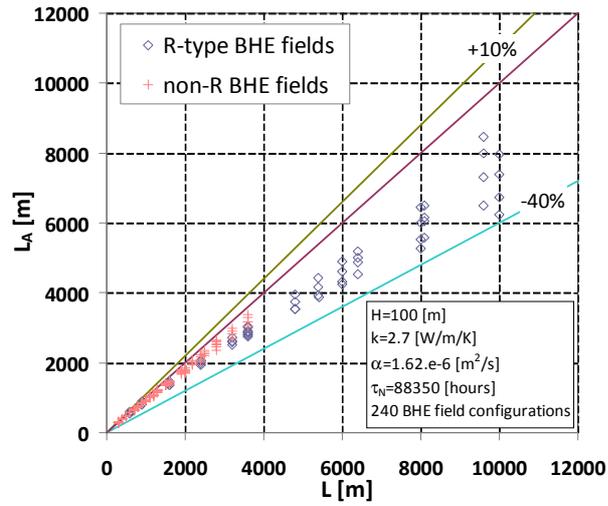


Figure 1.2. Reference L values and corresponding  $L_A$  quantities

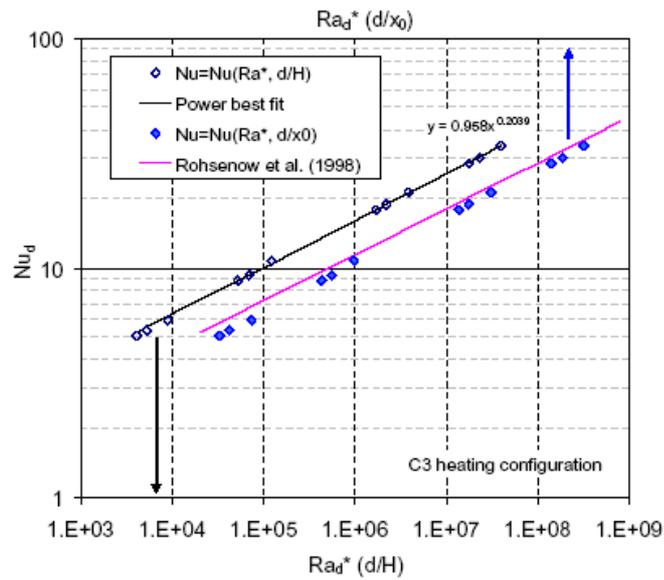


Figure 1.3. Nusselt numbers as a function of both overall ( $d/H$ ) or local ( $d/x_0$ ) Rayleigh numbers

Figures can also be pictures and photographs describing the laboratory equipment or the environment described in the thesis.

Schematics describing a test section or a piece of equipment or instrumentation are also Figures.



Figure 1.4. View of the Half Dome site

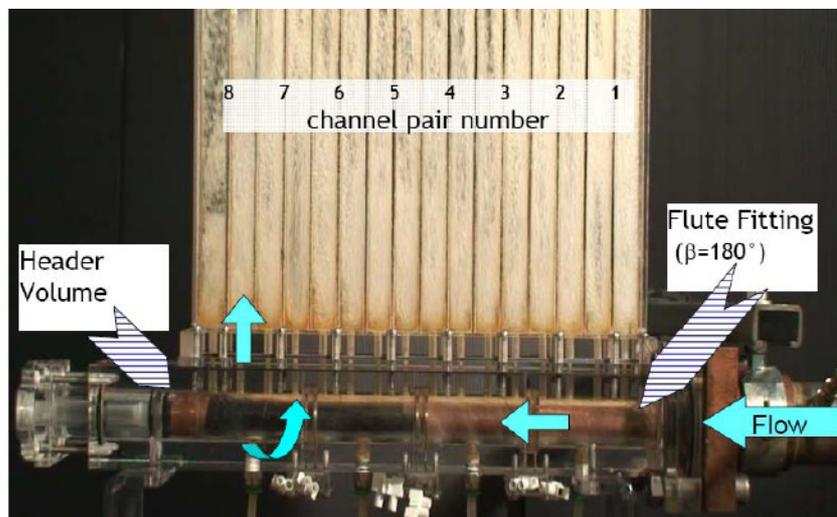


Figure 1.5. Test section side view. The arrows show the flow direction in either the header part or vertical parallel channels

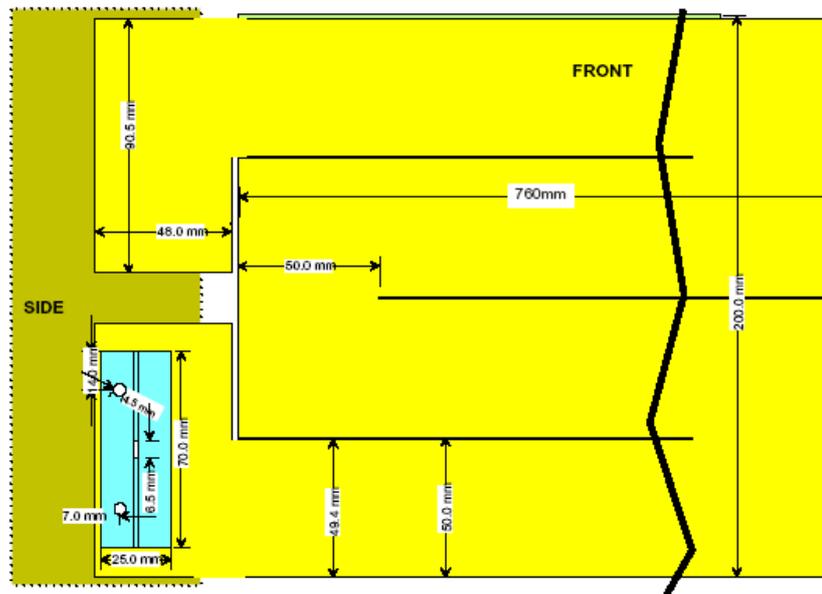


Figure 1.6. Heater geometry and connector position. Yellow parts represent the NiCu foil

## **CHAPTER II: METHODOLOGY**

In addition to the detailed methods you need to describe in this section, you need to provide specific objectives and an overview of your approach if they have not already been presented in the introductory chapters. These paragraphs are in “thesis-body text.” Other styles including captions, headers etc. can be used as presented in the previous chapter.

A part on uncertainty analysis of measurements or calculations is suggested for methodology validation.

## **CHAPTER III: RESULTS AND DISCUSSION**

Results, findings, discussion of results, correlations to be developed, comparison with literature models and correlations. This chapter is the original core of your thesis. It contains your own original contribution to the topic you tackled. Diagrams and Tables are used for representing your findings according to different representations.

A part on sensitivity analysis of measurements or calculations is suggested to show how your results are affected by the method assumptions.

This template is best used for directly typing in your content.

## **CHAPTER IV: CONCLUSIONS**

In general, there should be no new information presented here. It should be a synthesis of information that you've already discussed and eventually suggestions and remarks for further development of the present work in other theses or scientific investigations.

This chapter is a couple of pages typically and does not contain formulas or additional diagrams (tables)

## REFERENCES

Includes all references: articles, media facts, books, reports, regulations, internet articles, papers that you referenced from the text. In the text, citations can be Fang and Bhandari, (2012) or An et al., (2011), if more than two authors.

This section is the presentation of your references in alphabetical order. References can be written in single space with extra space between references as in the format below. The most important thing is to make sure all references are complete and that the format of your references is consistent throughout.

Aasurname N. (2020). Journal paper title. *Journal Name*, Volumenumber, pagestart-pageend.

An H.J., Wilhelm W.E., Searcy S.W. (2011). How to cite a Journal paper: A literature review. *Biomass and Bioenergy*, 35, 3763-3774.

Fang Z.X., Bhandari B. (2012). Comparing the efficiency of protein and maltodextrin on spray drying of bayberry juice. *Food Resource International*, 48, 478-483.

Surname, S.Z., Secondauthor, W.S. (2007). How to cite a complete conference proceedings paper. In: *Proceedings*, 2<sup>nd</sup> International meeting of Masters Students, Paper # XW15, Potsdam NY, November, 2007.

## **Appendix A**

Type or paste your appendices here. Appendices are a place to organize and include all of the “extra” material that is important to your research work but that is too detailed for the main text. Examples can include: specific analytical methods, computer code, spreadsheets of data, details of statistical analyses, etc. But, these materials do not speak for themselves. There should be a reference to these materials from the main chapters (complete details included in Appendix A) and there should be some text at the beginning of each appendix to briefly explain what the information is and means that is included in that appendix.