GUIDEBOOK

Chemical Plant Design Project

Chemical Engineering Study Program – Undergraduate Program

Faculty of Industrial Technology

Universitas Islam Indonesia

2024

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CHEMICAL PLANT DESIGN PROJECT

1. Definition

   The Chemical Plant Design Project course is specifically aimed at applying the knowledge acquired throughout the students' academic studies. In designing chemical plants, students with strong reasoning and improvisation skills are expected to comprehensively integrate all chemical engineering principles into the preliminary design of a chemical plant. Process design serves as the foundation of Chemical Plant Design and is the primary responsibility of future chemical engineering graduates, before advancing to full-scale plant design, which requires collaboration with other disciplines.

2. Constrains
   a. Chemical Plant Design Project is a compulsory course and a requirement for obtaining a bachelor's degree (S1).
   b. It is an independent student project, where all chemical engineering principles are comprehensively applied to develop a plant design that involves the synthesis process through chemical reactions.
   c. It shall be undertaken by 1 (one) or a maximum of 2 (two) students per project title.
   d. The project title shall encompass the product, raw materials, process technology, and production capacity.

3. Student Eligibilities
   a. Shall be an active student in the Chemical Engineering Study Program, Faculty of Industrial Technology, Universitas Islam Indonesia, and not on academic leave.
   b. Shall have completed a minimum of 120 credits with a GPA of 2.00 or higher.
   c. Shall have registered for the Chemical Plant Design course/Textile Chemical Plant Design/Chemical Plant Design Assignment (registration requires prior payment of tuition fees).
   d. Course prerequisites:
      2010 Curriculum for Chemical Engineering Study Areas:
      - Chemical Plant Design I
      - Chemical Industry Equipment

      2010 Curriculum of Textile Engineering Study Areas:
      - Textile Chemical Plant Design I
      - Product Design I
      - Textile Manufacturing System IV

      Curriculum 2020: Can be taken in conjunction with Chemical Plant Design course after taking:
      - Process Equipment Design
      - Multistage Separation
      - Utilities
      - Process Control
   e. Fulfill the administrative procedures of the Chemical Plant Design Project

4. Prerequisites to take the Chemical Plant Design Project
   a. Key-in Chemical Plant Design Project course
   b. Register on https://simtekim-uii.id

5. Procedure for Registration of Chemical Plant Design Project
    a. At the start of each semester, the head of the Study Program appoints a Final Project coordinator, typically the Secretary of the Study Program.
    b. The coordinator proposes titles for the Chemical Plant Design projects, gathers input from faculty members, and allocates available lecturers as final project supervisors.
    c. The availability of project titles and supervisors is adjusted based on the number of students who have registered for their final projects in the current semester.
    d. Students who have completed the course registration can proceed with the registration process via https://simtekim-uii.id/.
    e. Once the registration process is complete, the coordinator updates the list of available project titles and supervisors on https://simtekim-uii.id/.
    f. The supervision process begins after the student receives the official assignment letter.
    g. In special cases where a student wishes to change the project title, they shall submit a request to the Study Program through the coordinator, with approval from the supervisor and a proposal for the new title. The proposed Chemical Plant Design Project title shall include details on the products, raw materials, process technology, and capacity, and shall not be a title that has been used in the past two years.

6. Supervision of Chemical Plant Design Project
    a. The Final Project Supervisor may consist of a Single Supervisor or Dual Supervisor.
    b. Lecturers who have at least the academic position of Assistant Professor (*Asisten Ahli*) can become the sole supervisor.
    c. The Dual Supervisor consists of the Main Supervisor and the Associate Supervisor (lecturers who have not met the academic position).
    d. The Supervisor's Appointment Letter shall be given to the supervisor(s) before the student begins to carry out the project.
    e. The project supervision period lasts for 6 (six) months, commencing in September for the Odd Semester and in March for the Even Semester. If this deadline is exceeded, students shall apply for an extension of the project timeline following the established terms and procedures. The extension of the Appointment Letter is permitted only once. If the student has not completed the project after this single extension and has not achieved the required 8th output, they will be required to change both their supervisor and project title.
    f. The designation of the Supervisor's Appointment Letter is final and cannot be changed except under the following circumstances: if the appointed supervisor indicates that they are unprepared to fulfill their role, if the supervisor becomes permanently disabled.
    g. If a change in group composition occurs during the guidance process, the title of the previous Design Project will be deemed void, requiring each student to adopt a new title for the Chemical Plant Design Project and a new supervisor during the subsequent Final Project registration period.
    h. Students opting to complete the Final Project individually (rather than in a group) will be responsible for the full guidance fee of 100%. Conversely, for students collaborating on the Final Project in groups, the guidance fee will be set at 50% per student.
    i. For students assigned two supervisors, the approval and endorsement of the Chemical Plant Design report shall be discussed with Supervisor II prior to consulting with Supervisor I.

7. Stages of Chemical Plant Design Project

a. The Chemical Plant Design Project is divided into stages and each stage has a mandatory output. Students shall conduct the Chemical Plant Design Project in accordance with the order of the following stages:
   - Stage 1: Design capacity determination
   - Stage 2: Process selection
   - Stage 3: Determination of material specifications
   - Stage 4: Creation of a qualitative flow chart
   - Stage 5: Mass balance calculation
   - Stage 6: Reactor design
   - Stage 7: Design of separators and supporting operating units
   - Stage 8: Process Flow Diagram (PFD)
   - Stage 9: Material storage equipment design
   - Stage 10: Design of material transportation equipment
   - Stage 11: Heat exchanger design
   - Stage 12: Heat balance calculation
   - Stage 13: Determination of the location, plant layout, and organizational structure of the company
   - Stage 14: Designing the utility unit
   - Stage 15: Economic evaluation calculation
   - Stage 16: Script preparation

   The complete list of stages and outputs can be seen in the Appendix.

b. Any issues related to the completion of the stages of the Chemical Plant Design Project shall be discussed with the supervisor, as documented in the Supversiory Consultation Sheet (see attached form). Guidance sessions should be conducted at least 8 (eight) times.

c. Upon completing each stage, students are required to report the outcomes (which have been consulted on and approved by the supervisor) to the coordinator (the approval sheet can be found in the Appendix).

d. Reporting shall occur during the first week of each month by uploading documents via https://simtekim-uii.id/.

e. A maximum of 5 (five) outcomes may be reported in a single submission each month. Students may report more than 5 (five) outcomes in one report only if recommended by the supervisor, accompanied by a clear and accountable justification.

f. The coordinator compiles an external recap every month and submits reports to the Study Program for monitoring purposes.

g. Approval for registration will be granted only if the student has completed the registration document prior to the registration period.

8. Systematics Content of the Final Project Script

The structure of the final project manuscript for the Chemical Plant Design comprises three main sections: the Introduction, the Content, and the Conclusion

a. The Introduction section consists of:

1. Final project title sheet Design Chemical Plant
   The title sheet contains the title of chemical plant, the emblem of the university, the name and number of the student, the name of the study program-faculty-university and the year of completion of the proejct.

- *The title*, made clear and focused, complete with a built-in capacity plan per year. The use of language for chemical names in the title is made uniform (Latin/Indonesian name).
- *UII emblem.* Before the UII emblem was given the sentence "Submitted as one of the requirements to obtain a Bachelor of Chemical Engineering degree"
- *The student's name*, written in full, shall not be abbreviated, under the name is the student's identification number.
- *The name of the institution* is the Chemical Engineering Study Program, Faculty of Industrial Technology, Universitas Islam Indonesia, Yogyakarta.
- *The year of completion of the academic year* is the year of the registration of examination and is placed under the name of the University.

The titles listed on the front cover page and the title page of the proposal and/or research report are all written in capital letters, as well as the title of each chapter. The title of the proposal and research report is written symmetrically with Times New Roman 14.

2. A certified Chemical Plant Design authenticity statement sheet with a stamp of Rp 10,000.00.
3. Supervisor endorsement sheet
4. Examiner endorsement sheet
5. Introduction
6. Offering Sheet (optional)
7. Table of contents
8. Table List
9. List of Figures
10. List of attachments
11. List of emblems/notations/abbreviations
12. Abstract

    The abstract contains a brief and complete description that provides a comprehensive overview of the content of the TA. The abstract is written in Indonesian Language and United Kingdom containing the outline of the Chemical Plant design, to the conclusion of the results of the economic analysis. The space in the abstract is 1 and is complemented by 5 keywords.

    Examples of title sheets, statements of authenticity, endorsement of supervisors and examiners can be seen in the appendix.

b. The content of the report consists of, among others:

CHAPTER I INTRODUCTION

1.1 Background
1.2 Determination of Plant Capacity
1.3 Literature Review
1.4 Overview of Thermodynamics and Kinetics

CHAPTER II PRODUCT DESIGN

2.1 Product Specification
2.2 Specification of Raw Materials and Supporting Materials
2.3 Quality Control

CHAPTER III PROCESS DESIGN

3. 1 Process and Material Flow Diagram
3. 2 Process Description
3. 3 Equipment Specifications
3. 4 Mass Balance
3. 5 Heat Balance

CHAPTER IV PLANT DESIGN

4.1 Chemical Plant Location
4.2 Plant Layout
4.3 Equipment Layout
4.4 Corporate Organization

CHAPTER V UTILITIES

5. 1 Water Supply and Treatment Unit
5. 2 Steam Generator Unit
5. 3 Power Generation Unit
5. 4 Compressed Air Supply Unit
5. 5 Fuel Supply Unit
5. 6 Waste Treatment Unit
5. 7 Refrigerant/Coolant Treatment Unit (if any)

CHAPTER VI ECONOMIC EVALUATION

CHAPTER VII CONCLUSIONS AND SUGGESTIONS

Explanation of the contents of the Chemical Plant Design report:

CHAPTER I INTRODUCTION

Background. This section contains elements of the problem of why to do Chemical Plant Design, which is reviewed from the aspects of *what, why* and *how*, namely what will be made in the Chemical Plant Design, why, and how a Chemical Plant is designed. Thus, all aspects related to Chemical Plant Design, for example, the prospects and end *use of* the products to be made, the market segments to be reached, the aspects of raw materials, processes, and social and economic aspects in general need to be briefly stated.

In the submission of the background, it shall be supported by relevant scientific sources, such as research results, seminars, papers, journals or other supporting reference data.

Determination of Chemical Plant Capacity. The determination of Chemical Plant capacity uses the principle of *supply and demand* by considering data on exports, imports, consumption, production, existing chemical plant capacity that has been established as well as the availability of raw materials. The data used in the calculation shall be sourced.

Literature Review. The first part of this sub-chapter contains a review of papers/papers related to research results relevant to the title of the project, including a comparison of existing process alternatives. The second part contains theoretical foundations as scientific foundations that support the design of the selected product or process. All references cited in literature reviews and theoretical foundations shall be sourced.

Kinetics and Thermodynamics Review. The kinetics review describes kinetic data such as reaction order, reaction rate constants, selectivity, reactant mole ratios, etc., obtained from reliable scientific sources (journals/patents). Meanwhile, the thermodynamic review explains the nature of the reactions involved (spontaneous/non-spontaneous), (reversible/irreversible), as well as the calculation and determination of the heat properties of the reaction (exothermic/endothermic).

CHAPTER II PRODUCT DESIGN

Product Specifications. This sub-chapter displays the physical, chemical, mechanical properties and at the same time information about the material safety of the products to be made and intermediate products.
Specification of Raw Materials and Supporting Materials. This sub-chapter displays physical, chemical, mechanical properties and at the same time information about the safety of materials from raw materials and supporting materials such as catalysts, solvents, inerts, and so on.
Quality Control. This chapter explains what quality control plans are carried out in the Chemical Plant Design to be in accordance with the product quality specifications to be made. This explanation includes raw material quality control, process quality control, and product quality control.

CHAPTER III PROCESS DESIGN

Process and Material Flow Diagram. This section contains a process flow block diagram that contains the main equipment and is displayed both quantitatively and qualitatively. Qualitative flow diagram should display the chemical formulas of the components, temperature, and pressure at each current/equipments. Meanwhile, the quantitative flow diagram displays the flow rate of each component that is consistent with the mass balance table.

Process Description. This section contains a description of the production process starting from raw material preparation, synthesis, to product purification/purification. The process description should describe the process flow in detail and sequentially and involve all the equipment that have been designed. The name, appliance code and information regarding the operating conditions of each current/appliance should be clearly and specifically described. If necessary, a brief explanation of the reasons for the equipment selection can be included to support the description.

Equipment Specifications. This section explains the detailed specifications of each equipment that is designed in accordance with the standard specifications that have been provided (Appendix). The detailed design of the reactor shall be attached to the manuscript. All equipment other than the reactor (where possible) is designed in detail and follows the minimum specification standards that have been provided taking into account the limitations of the operability of the equipment.

Mass Balance. This section is presented in a tabular format and contains the total mass balance as well as the mass balance of each equipment with a change in composition.

Heat Balance. This section contains the total heat balance and heat balance of each equipment with enthalpy/heat changes presented in a table format.

CHAPTER IV PLANT DESIGN

Plant *Location.* This chapter contains considerations for choosing the location of the Chemical Plant to be established. Several things that need attention in determining the location of the Chemical Plant, including ease of transportation, marketing, availability of raw materials/helpers,

labor, climatic conditions, environment and community, land needs and their development, water sources, electricity, governmental/regional regulations, and other considerations that support the choice of a Chemical Plant location.

Plant *Layout.* This section contains consideration of the plan for arranging the layout of units or parts or departments in a Chemical Plant according to the area needed and the available land area. The arrangement of the Chemical Plant layout includes plans for the arrangement of office space, production, warehouses, parks, parking, utility units, waste treatment and others. In addition to a detailed explanation of each section, the Chemical Plant layout arrangement shall be completed with drawings or schematics of the Chemical Plant layout and scale.

Equipment *Layout.* This section contains consideration of the arrangement plan or arrangement of the layout of machinery/process equipment in the production unit. Consideration in the arrangement of the layout of process equipment is adjusted to the dimensions of the machine (equipment), *space* between equipment, ease of *maintenance*, material arrangement and so on. The preparation of the layout of the machine plant shall be equipped with drawings or schemes of the machine/process layout and equipped with scales.

Corporate Organization. This section contains the completeness of the company's organizational structure along with the authority and responsibilities of each part, the analysis and calculation of the number of employees needed for each part according to the *workload*, salary classification, working hour arrangements, as well as employee facilities and rights.

CHAPTER V UTILITIES

This section contains supporting units used in a production process and includes, among others: water supply and treatment units, steam generation units, power generation units, compressed air supply units, fuel supply units, waste treatment units, and *refrigerant/coolant treatment units* (if any). The description for each unit shall include a description of the process, the results of the calculation of material requirements and the specifications of the equipment used.

CHAPTER VI ECONOMIC EVALUATION

Economic Evaluation. This section contains a financial analysis for the establishment of a Chemical Plant and its completeness and an analysis of its economic feasibility. Financial analysis includes *capital investment* (*fixed* and *working capital*) and *total production cost* (*direct manufacturing cost*, *indirect manufacturing cost*, *fixed manufacturing cost*, and *general expenses*). Meanwhile, the economic feasibility analysis includes profit calculation, *percent return of investment* (ROI), *pay out time* (POT), *break-even point* (BEP), *shut down point* (SDP) and *discounted cash flow* (DCF).

CHAPTER VII CONCLUSIONS AND SUGGESTIONS

The conclusion describes a summary that concisely describes the results of the entire Chemical Plant Design process, starting from product specifications, processes, and economic evaluation. The suggestions contain recommendations given to the results of the Chemical Plant Design in accordance with the objectives of the Chemical Plant Design. In making conclusions and suggestions, it is necessary to pay attention to which aspects really need to be emphasized (highlighted), so that in this case it is possible that the Chemical Plant Design is not worth following up, which does not mean that the Chemical Plant Design has failed.

c. The final part of the Chemical Plant Design consists of:

BIBLIOGRAPHY

The bibliography contains the libraries or references referenced in the Chemical Plant Design. How to write references (citations) or bibliographies is explained in the Writing Rules section.

ATTACHMENT

The appendix contains matters that are not explained in the whole in the content of the Chemical Plant Design report. However, in writing the content of the report, the description of each section or chapter (sub-chapter) that contains an appendix shall include the sequence number, the title of the attachment and the page number. The annex contains, among others:

- Detailed design of the main synthesis equipment (reactor) equipped with data, tables, supporting graphs, and others that are considered necessary.
- *Process Flow Diagram* (PFD)
- Chemical Plant Design guidance consultation card

9. Project Defense

a. Rules for defense

1) The requirements that shall be met for the submission of the defense registration include:
   (i) It has been declared to have passed the judiciary closing theory
   (ii) Pass the Comprehensive course with a minimum grade of C
   (iii) All stages of work have been reported before the registration period.
   (iv) Fill out the registration administrative documents for the defense registration and attach supporting documents for registration requirements
   (v) Register for the defense registration through https://simtekim-uii.id/
2) The Head of the Study Program appoints a team of examiners consisting of the Chief Examiner, namely the First Supervisor, and 2 Examiner Members
3) The Head of the Study Program announces the official schedule of the defense registration to the Examiner Lecturer and the student concerned
4) The Head of the Study Program has the right to replace the Examiner Lecturer if he is unable or sick
5) The Head of the Study Program has the right to change the schedule (early or late) if there are things that hinder the implementation of the exam, and shall submit the change to the Examining Lecturer and the Student concerned no later than 1 day (24 hours) before the registration is carried out
6) The implementation of the Offline Exam is carried out as follows:
   a) The Examiner and the Student concerned are present a maximum of 5 minutes before the time
   b) Students prepare the equipment's needed for the Offline exam including:
      i. Offline:
         ✓Final project presentation
         ✓ A1 size PFD printout
         ✓ A3 size PFD printout

c) The examiner team consists of the Chief Examiner, Examiner 1, and Examiner 2
d) The Chief Examiner opened the defense registration by reading tasmiah (Bismillahirrahmanirrahim)
e) The Chief Examiner invites students to present the main points of the Final Project for a maximum of 15 minutes
f) The Chairman of the Examiner invites the Examiner Members to ask exam questions each for 30 minutes
g) The Chief Examiner invited students to leave the exam room, and waited for the call back to the room.
h) The Chairman and Members of the Examiners discuss the results of the defense.
i) The Chief Examiner summoned the students and announced the results of the defense.
j) The Chief Examiner closed the defense with the recitation of tahmid (Alhamdulillahirabbil'alamin)
k) The Chairman and Members of the Examiners fill in the relevant documents, namely the Attendance List, Event Minutes, Suggestions for Improvement, and Exam Scores
l) The revision score component filled in by the examiner can be completed after the student makes a revision according to the advises of the examiner team
m) The Chief Examiner submits the relevant documents to the Head of the Study Program

7) The Examiner's decision is final and binding, and is classified as follows:
    a. **PASS**: Granted if the registration score is 60 or higher, with no major or minor revisions required.
    b. **PASS WITH REVISIONS**: Awarded if the registration score is 60 or higher, but major or minor revisions to the registration document are necessary.
    c. **FAIL**: Issued if the final registration score is below 60, or if two examiners each assign a score of 60 or lower.

   The maximum allowable difference between examiners' scores is limited to 20 points.
8) The assessment of the defense examination uses rubrics. The grading test score given by each examiner shall involve all components listed in the rubric. Assessment can be based on the question-and-answer process during the registration or completeness of the manuscript.
9) Students who are declared PASS are required to submit the inventory number of the Chemical Plant Design report to the Study Program.
10) Students who are declared to PASS WITH REVISION, are required to follow the Revision Supervision.
11) Students who are declared FAIL are required to follow the consultation of the Final Project with the supervisor before applying for re-registration.

b. Final Project Reporting

A report must be submitted in softcopy format (1 PDF file) to the Study Program's email: teknik.kimia@uii.ac.id, for archiving purposes by both the Study Program and the Library. If necessary, a softcopy may also be provided to the Supervisor.

10. Revision

a. Revision Guidance

1) Students must follow the revision process with the Examiner Lecturers based on the suggested improvements.
2) Students are allowed a maximum of 2 (two) months to complete revisions after the defense registration, subject to the following conditions:
    a. If, within the first month, the student has not received approval for the revisions, the Final Project grade will be lowered by one level.
    b. If the revisions are not completed within 2 (two) months of the defense registration, the student will be required to repeat the defense registration.
3) Students must prepare responses to the suggested improvements using the following format:

No.	Comment Improvements	Old Manuscript Versions	Revised Manuscript Version	Page	Signature
1.	Writing Format				
	a. …				
	b. …				
2.	Background				
	a. …				
	b. …				
3.	Process Flow Diagram				
	a. …				
	b. …				
4.	Calculation Method				
	a. …				
	b. …				
Dst					

Special notes:

- The detailed form will be submitted by the registration committee
- In the revised text, the revised sentence is given GREEN

4) Students must submit their responses to the suggested improvements to the Examiner Lecturer and present their supporting arguments.
5) The Examiner will review the responses and evaluate the validity of the arguments presented.
6) The revision process is considered complete once all suggested improvements have been approved, and the relevant documents, including the Revision Guidance Card and Revision Guidance Scores, have been signed.
7) The Examiner Lecturer will then forward the completed documents to the Head of the Study Program.
8) Students who have been declared to have **COMPLETED REVISION GUIDANCE** are required to submit the inventory number of their Design Chemical Plant report, along with the signature of the Head of the Study Program, to the Study Program before submitting the report to the library (this can be sent via email: teknik.kimia@uii.ac.id).

9) If the Study Program discovers that a student has committed fraud in the preparation of their Final Project or has violated ethical standards, the Head of the Study Program reserves the right to impose sanctions in accordance with the nature of the violation.

11. Final Project Revision Consultation (Not Passed Defense Examination)

a. Final Project Revision Consultation is attended by students with Supervisors in accordance with the Examiner's suggested improvements
b. The maximum revision duration is 1 month from the exam and can be extended to a duration of 1 month if needed
c. Students prepare answers to suggested improvements following the format given during the calculation:
d. Students submit answers to suggested improvements to the Supervisor and present their arguments
e. The supervisor checks the answers to the improvements, and tests the arguments
f. Final Project revision consultations for students who do not pass the registration must be conducted with a minimum of three meetings, as follows:
   - Confirmation of the revision comments, if necessary.
   - Students submit and present their revised responses.
   - Students present further revisions, if additional adjustments are still required.
g. The Supervisor stated that the revision consultation had been completed, and completed the relevant documents in the form of a Revised Consultation Sheet
h. Students shall then re-register for the defense and submit relevant documents to the Head of Study Program through the https://simtekim-uii.id/.
i. Students follow the Defense registration according to the provisions of point 9.a.

10) Other Terms

Rating system

No.	Component	Percentage (%)
(i)	First Supervisor grade	30 or 50
(ii)	Second Supervisor grade, if applicable	20 or 0
(iii)	Chief Examiner grade	10
(iv)	Examiner 1 grade	15
(v)	Examiner 2 grade	15
(vi)	Revision grade, if any: (a) Examiner 1 (b) Examiner 2	 5 5
Total Final Score		100

Note:

- The assessment system for the supervisor and grading process uses a rubric that can be seen in the Appendix.
- The maximum supervisor score by the supervisor is 85.

WRITING RULES

1. General Description

Some general provisions that shall be considered in writing a Chemical Plant Design Project manuscript:

a. The manuscript is typed with an A4 size HVS paper size.
b. Writing a report script shall use a computer with Roman fonts or its variants (Times New Roman, Book Antiqua, Bookman Old Style, and so on) with a size of 12 for the entire manuscript, except for the report title and chapter number using a bold font size of 16.
c. The writing is arranged in a distance of 2 (two) spaces, except for the abstract and the table of contents with a distance of 1 (one) space, made evenly left and right (*justify*), and each beginning of the writing of a new paragraph begins at the 7th (seventh) beat.
d. The left and top margins are 4 cm, the right and bottom margins are 3 cm from the edge of the paper.
e. Headers and footers are not allowed on all report pages, except page numbers.

2. Language

a. Using formal academic English writing.
b. The use of words or terms that come from a foreign language shall be italicized.
c. The presentation of the material is outlined in perfect sentences using passive sentences and not using personal pronouns.
   Example:
   "Before we do the test...".
   shall be written
   "Before the test was carried out ...".
d. The number, symbol or name that begins a sentence shall be spelled. The beginning of a sentence should not begin with an abbreviation, number, number or symbol.
e. The number shall be typed with a number, for example **100 g of product**, except at the beginning of the sentence, then the number shall be spelled: **Ten grams of product**.
f. The writing of numbers shall follow the rules of the language used, in English manuscripts decimals are marked with periods, while thousands are marked with commas.
   Example*:*
   The reactant mass used was 20.1234 g instead of 20,.1234 g
   Export data is 2,500,000 tons/year, not 2.500.000 tons/year

3. Writing Titles, Chapters, Sub-chapters, and Sub-sub-chapters

1. Especially for writing the title of the report on the cover page, and at each change of chapter number, use a font size of 16 bold which is written symmetrically/in the center (*center*).
2. The writing of chapter numbers shall use Roman numerals (CHAPTER I, CHAPTER II, CHAPTER III, etc.). The writing for each subchapter is written with Arabic numerals 1.1, 1.2, 1.3, etc., while the writing of subchapters uses Arabic numerals 1.1.1, 1.1.2, 1.1.3, ... etc., and if there is a break, then lowercase letters (a, b, c, ... etc.). After the last number in the subchapter or subchapter does not end with a period.
3. The writing of sub-chapters and sub-sub-chapters is adjusted, starting from the left border or margin with a bold font.

4. Page Numbering, Equations, Figures, Tables, and Appendices

a. Page numbering

- The page numbers of the introductory section (preface, table of contents, list of pictures, list of tables, pages of endorsement, etc.) use small Roman numerals (i, ii, iii, ... etc.) and placed in the bottom center of the page, approximately 1.5 cm from the bottom limit of the paper.
- The page number of the report body section uses Arabic numerals. Especially for pages that contain chapters numbered at the bottom of the middle of the page, approximately 1.5 cm from the bottom limit of the paper, while other pages are numbered at the top right of the page, approximately 2 cm from the upper limit of the paper.
- The numbering of the pages of the report content is made sequentially from the first chapter to the last chapter (1,2, ..., 100).

b. Figure numbering

- The image number is placed after the word "**Figure**" and the order of the numbering is adjusted to the chapter number followed by the image number, where the image is contained in the content of the report.
- Except for the first letter, the caption of the picture uses lowercase letters and does not end with a period.
- The title or caption of the picture is placed under the figure and the layout of the writing is arranged in such a way.
- Each figure that is uploaded (as a description material) shall have a sentence explanation in the body of the report, and the first letter of the word picture is written in capital letters (see example).
- If the figure is cited from a specific source, the source shall be listed
  Example:

  ……. Data on annual adipic acid imports can be seen in Figure 4.3. Figure 4.3 shows that ..... etc.

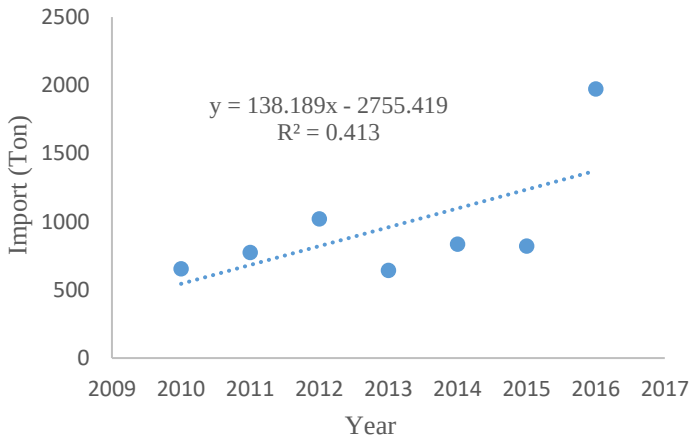

Figure 4.3 Graph of Adipic Acid Import Data in Indonesia

c. Table numbering

- The table number is placed after the word "**Table**" and the order of the numbering is adjusted to the chapter number followed by the table number, where the table is contained in the content of the report.

- Except for the first letter, the table description uses lowercase letters and does not end with a period.
- The title or description of the table is placed on top of the table and the layout of the writing is arranged in such a way.
- Each table that is loaded (as a description material) shall have an explanation of the sentence in the body of the report, and in writing the first letter of the table word use capital letters (see example).
- If in a table the size exceeds or moves to the next page number, then on top of the different tables the page shall be annotated, for example*:* Continued Table 4.2
- If the table is cited from a specific source, the source shall be listed.
- Data that is already displayed in a table does not need to be displayed in a graph and vice versa.

  Example *:*

  …… The amount of water that shall be prepared in the utility unit is shown in Table 5.4. The table shows that...

Table 5.4 Total water requirements

It	Need	Amount (kg/h)
1	*Domestic water*	4.017
2	*Service water*	705
3	*Cooling water*	22.023
4	Process water	961
5	*Boiler feed water*	796
Total		28.503

Note:

If the table content is too large or long, the font size can be reduced or adjusted to match the table appearance.

d. Attachment Numbering

If the report is completed with an attachment, then before the attachment shall be given a pause paper that reads "ATTACHMENT". Each attachment is marked with a capital letter, e.g. APPENDIX A, APPENDIX B, and so on. Under the word APPENDIX is written the title of the appendix. The word APPENDIX and the title are written in the center.

Appendices are numbered pages by first writing the attachment number (A – 1, A – 2, ..., B – 1, B –2, ... etc.).

5. Reference Writing

a. Sentences/paragraphs/statements/data taken from other sources (not the result of your own thoughts) shall be accompanied by information from the source of the literature (reference).

b. In general, part of the reference source that should be written is the name and year of publication of the reference.

c. It is allowed to use *citation styles* with commonly used *author-date* types such as APA, MLA, Harvard, and so on. What takes precedence is consistency. In the same text, it is not allowed to use more than one *citation style*.

6. Bibliography Writing
    a. The bibliography only contains the literature that is used as a reference and mentioned in the manuscript.
    b. Bibliography writing is compiled based on *the citation style* used in writing references. It is allowed to use reference managers (Mendeley, EndNote, Zotero, and so on) in writing references and bibliographies.

APPENDIXES

A.1. Design Stages

Stage 1	Key Design	Output	%	% cumulative
1	Determination of Chemical Plant Design capacity	Background and capacity determination (Chapter I)	5	5
2	Process selection, thermodynamics and kinetics reviews	Literature review and theoretical foundations (Chapter I)	5	10
3	Determination of the specification of the materials involved and process risk analysis based on the MSDS of the materials	Product Design (Chapter II)	5	15
4	The creation of a qualitative process flow diagram	Qualitative flowchart (Chapter III)	5	20
5	Mass balance calculation	Quantitative flow chart and mass balance table (Chapter III)	5	25
6	Main Equipment Design part 1 (reactor)	Reactor specifications (Chapter III) and detailed design (Appendix)	10	35
7	Design of Main Equipment part 2 (separators and other operating units)	Specification of separators and other supporting devices (Chapter III)	10	45
8	Process Flow Diagram (PFD)	PEFD and process description (Chapter III)	5	50
9	Material storage equipment design	Specification of material storage equipment (Chapter III)	5	55
10	Design of material transportation equipment	Specification of material transportation equipment (Chapter III)	5	60
11	Design of heat exchanger	Specifications of heat exchangers (Chapter III)	5	65
12	Heat balance calculation	Heat balance table (Chapter III)	5	70
13	Determination of the location, layout, and organizational structure of the company	Location, Chemical Plant layout, and organizational structure (Chapter IV)	5	75
14	Utility unit design	Utilities (Chapter V)	10	85
15	Economic Evaluation Calculation	Economic evaluation (Chapter VI)	10	95
16	Manuscript preparation	Full text	5	100

A.2. Chemical Plant Design Project Supervision Sheet

Student Name	:
Student ID No.	:
Academic Semester/Year	:
Name of Supervisor	:

No.	Date	Consultation Topic	Initials

Yogyakarta, Month xx, 20xx

Supervisor,

(Name of Supervisor)

(NIK. xx521xxxx)

A.3. Revision Supervision Sheet

Student Name	:
Student ID No.	:
Academic Semester/Year	:
Name of Examiner	:

No.	Date	Consultation Topics	Initials

Yogyakarta, Month xx, 20xx

Supervisor,

(Name of Supervisor)

(NIK. xx521xxxx)

A.4. Guidelines for Assessment (rubric)

No.	Guidance Materials	Grade			
		<60	60 - 69	70 - 79	80 - 100
1.	Determination of Design Capacity	Unable to complete the calculation of the design capacity	Some calculations are wrong so that the conclusion is wrong	Able to complete calculations but wrong in concluding	Able to complete calculations and produce correct conclusions
2.	Process Selection	Unable to choose the right process	Able to choose a process but incomplete so that the conclusion is wrong	Able to choose a complete process but wrong in concluding	Able to choose the process comprehensively, and correctly in concluding
3.	Determination of Material Specifications	Unable to determine material specifications	Able to specify specifications but incomplete	Able to determine the specicipation completely, but unable to explain each parameter	Able to determine the specicipation completely and explain each parameter
4.	Making a Qualitative Flow Chart	Unable to create flowcharts	Able to create flowcharts but partially wrong	Able to create flow diagrams correctly but unable to explain them well	Able to create flow charts correctly and explain them concisely, concisely and completely
5.	Mass Balance Calculation	Unable to calculate the mass balance	Some calculations are wrong so that the conclusion is wrong	Able to complete calculations but wrong in concluding	Able to complete calculations and produce correct conclusions
6.	Heat Balance Calculation	Unable to calculate heat balance	Some calculations are wrong so that the conclusion is wrong	Able to complete calculations but wrong in concluding	Able to complete calculations and produce correct conclusions
7.	Reactor Design	Unable to design a reactor	Some of the design is wrong so that the conclusion is wrong	Able to design reactors, calculate correctly but incorrectly in explaining the working principle and how to design	Able to design reactors, calculate correctly and explain the working principle and how they are designed
8.	Separator Design	Inability to design separators	Some of the design is wrong so that the conclusion is wrong	Able to design reactors, calculate correctly but incorrectly in explaining the working principle and how to design	Able to design reactors, calculate correctly and explain the working principle and how they are designed
9.	Material Storage Device Design	Inability to design material storage devices	Some of the design is wrong so that the conclusion is wrong	Able to design reactors, calculate correctly but incorrectly in explaining the working principle and how to design	Able to design reactors, calculate correctly and explain the working principle and how they are designed

No.	Guidance Materials	Grade			
		<60	60 - 69	70 - 79	80 - 100
10.	Design of Heat Exchanger	Unable to design heat exchangers	Some of the design is wrong so that the conclusion is wrong	Able to design reactors, calculate correctly but incorrectly in explaining the working principle and how to design	Able to design reactors, calculate correctly and explain the working principle and how they are designed
11.	PFD Creation	Unable to make PFD	Able to create PFD but partially wrong	Able to make PFD correctly but unable to explain it well	Able to properly create a PFD and explain it concisely, concisely and completely
12.	Determination of the location, Chemical Plant layout, and organizational structure of the company	Unable to determine the location, Chemical Plant layout, and organizational structure	Able to determine but some are wrong	Able to determine correctly but unable to explain it well	Able to correctly determine and explain it concisely, concisely and completely
13.	Utility Unit Design	Inability to design utility units	Some of the design is wrong so that the conclusion is wrong	Able to design reactors, calculate correctly but incorrectly in explaining the working principle and how to design	Able to design reactors, calculate correctly and explain the working principle and how they are designed
14.	Economic Evaluation Calculation	Inability to calculate economic evaluation	Some calculations are wrong so that the conclusion is wrong	Able to calculate correctly but incorrectly in explaining the method	Able to calculate and explain the method correctly
15.	Script Preparation	Unable to compile the manuscript final report correctly, and neatly	Able to compile the manuscript final report but some are wrong and untidy	Able to compose the manuscript final report correctly, without mistakes, and neatly but unable to explain the flow of the script	Able to compile the manuscript final report correctly, without mistakes, and neatly and be able to explain the flow of the manuscript final report

A.5. Grading Assessment Rubric

No.	Component	Value				Proportion
		<60	60 - 69	70-79	80 - 100	
Communication and writing						
1.	Presentation	The material presented was not clear and not fluent	The material presented was not clear and fluent	The material presented was clear but not fluent	The material presented is clear and smooth	10%
2.	Writing a registration manuscript	Not following the guidelines for the preparation of the final project and not in accordance with the rules for writing scientific papers	Not following the guidelines for the preparation of the final project but in accordance with the rules of writing scientific papers	Following the guidelines for the preparation of the final project but not in accordance with the rules of writing scientific papers	Follow the guidelines for the preparation of the final project and in accordance with the rules of writing scientific papers	10%
Ability to answer questions of chemical engineering technical material						
3.	Capacity determination	Unable to explain the method of determining the capacity of the plant	Able to explain one of the methods of determining Chemical Plant capacity with inaccurate calculations	Able to explain one of the methods of determining Chemical Plant capacity based on integrated supply and demand	Able to explain one of the integrated supply and demand capacity determination methods, as well as predict the upcoming market over the next 5 or 10 years	5%
4.	Chemical Plant layout	Unable to explain the method of arranging the layout	Able to explain national/international security standards on layout	Able to explain national/international security standards on layout with examples	Able to explain national/international safety standards on layout and prioritize work efficiency	5%
5.	Process selection logic	Unable to explain the selection process	Lack of ability to embody the selection of processes carried out	Able to explain one of the selected processes	Able to explain the advantages and disadvantages of biological/physical/chemical processes	10%
6.	Specifications of raw materials, supports, and additives	Unable to explain material specifications	Able to explain the specifications of the material but not yet able to write down the chemical structure of the material	Able to explain material specifications and material chemical structure	Able to explain the specifications of the material, the chemical structure of the material, and the harmful properties of the material used	10%
7.	Mass balance and heat balance	Inability to explain the mass and heat balance	Able to explain the mass and heat balance without calculation	Able to explain the mass and heat balance accompanied by the physical/chemical transfer process that occurs	Able to explain the overall mass and heat balance as well as on special equipment, accompanied by the physical/chemical transfer process that occurs	10%
8.	PEFD	Unable to explain PEFD process diagrams	Able to explain PEFD process diagrams but there are process logic errors	Able to explain PEFD process diagrams with correct process logic	Able to explain PEFD process diagrams with correct process logic, accompanied by explanations of controls and operating conditions	15%

No.	Component	Value				Proportion
		<60	60 - 69	70-79	80 - 100	
9.	Equipments design logic	Unable to explain the main equipments/support design method	Able to explain the basic logic of designing the main equipments /support	Able to explain the main / support equipments design method but there is a calculation error	Able to explain the main equipments design method / support in accordance with the standards / rules of equipments design	15%
10.	Economic evaluation	Unable to explain the economic calculations of the Chemical Plant	Able to explain RoI and PoT calculations with inaccurate calculations	Able to explain RoI and PoT calculations with precise calculations	Able to explain RoI and PoT calculations with accurate calculations and explain BEP and SDP graphs	10%
Total						**100%**

A.6. Output Verification Page Format for Each Output

Chemical Plant Design of xxx from xxx with capacity of xxx Tons/Year

Output No. xx

prepared by:

Name	**:**	**Name**	**:**
NIM	**:**	**NIM**	**:**

It has been inspected and approved by:

Supervisor 1	**Signature and date**
……..	……..
Supervisor 2	
……...	…….

A.7. Chemical Plant Design Project Manuscript Title Page Format

No: <Identification>

<TITLE OF CHEMICAL PLANT DESIGN>

CHEMICAL PLANT DESIGN

Filed as One of the Requirements

To Obtain a Bachelor's Degree in Chemical Engineering

By:

Name : **Name :**

Student No. : **Student No. :**

CHEMICAL ENGINEERING STUDY PROGRAM

FACULTY OF INDUSTRIAL TECHNOLOGY

UNIVERSITAS ISLAM INDONESIA

YOGYAKARTA

<YEARS>

A.8. Format of the Final Project Manuscript Endorsement Page

SUPERVISOR ENDORSEMENT SHEET

< TITLE OF CHEMICAL PLANT DESIGN>

CHEMICAL PLANT DESIGN

By:

Name :

Student No. :

Name :

Student No. :

Yogyakarta, _____

Supervisor I,

Supervisor II*,

_____

_____

**** If the Chemical Plant Design Supervisors are two persons.***

A.9. Format of Statement Sheet of Authenticity of Final Project Manuscript

STATEMENT OF AUTHENTICITY OF RESULTS

< CHEMICAL PLANT DESIGN >*)

I am the undersigned:

Name :	**Name :**
Student No. :	**Student No. :**

Yogyakarta, _____

I hereby declare that this chemical plant design project report has been written in accordance with the applicable scientific guidelines. Should any violations be discovered in the future, I am prepared to take full responsibility and accept the consequences in accordance with the prevailing regulations. This statement is made truthfully and is intended to be used as necessary.

Signature	Signature
Stamp duty	Stamp duty
<Student Name>	<Student Name>

A.10. Format of Chemical Plant Design Tester Certification Sheet

EXAMINER ENDORSEMENT SHEET

< TITLE OF CHEMICAL PLANT DESIGN>

CHEMICAL PLANT DESIGN

By:

Name : _____

Student No. : _____

It Has Been Defended in Front of the Examiner's Session as One of the Requirements to Obtain a Bachelor's Degree in Chemical Engineering
Chemical Engineering Study Program, Faculty of Industrial Technology
Universitas Islam Indonesia

Yogyakarta, _____

Examining Team,

<Full Name> _____
Head

<Name Complete> _____
Member I

<Name Complete> _____
Member II

Acknowledged by:
Head of Chemical Engineering Study Program
Faculty of Industrial Technology
Universitas Islam Indonesia

_____

A.11. Equipment Specification Writing Guide

L.6.a. Reactor Specifications

Guide: There are many different types of reactors in the chemical industry. The specifications displayed shall contain general specifications (the same for all reactor types) and special specifications that match the type of reactor selected. In principle, whatever is designed/evaluated/calculated shall be displayed on the equipment specification sheet. The type/type of reactor chosen shall be specific and represent the processes/reactions that occur in it. Therefore, avoid writing down the ideal reactor type/type such as: *mixed-flow reactor, continuous flow reactor, well-mixed reactor, plug-flow reactor,* etc.

General Specifications		
Code	:	
Function	:	
Type/Type	:	
Operating Mode	:	Batch/Semi-batch/Continuous*
No. of equipment	:	
Price, Rp	:	
Operating Conditions		
Temperature, ℃	:	
Pressure, atm	:	
Process Conditions	:	Adiabatis/non-adiabatis, isothermal/non-isothermal*
Construction and Materials		
Construction materials	:	
Shell Diameter (ID), m	:	
Thick shell, in	:	
Total height, m	:	
Head type	:	
Insulation		
Material	:	
Heat conductivity, W/m.K	:	
Insulation thickness, m	:	

Special specifications, adjusting the type of reactor and can be seen in the table

Types of reactors	Specifications and units	
Tanks with a mixer, can be: ✓ Stirred Tank Flow Reactor (RATB) ✓ Batch *reactor* with stirrer ✓ Slurry reactor	a.	Types and sizes of mixers
	b.	Stirring speed, rpm
	c.	Power/stirring power, hp
	d.	Number and size *of baffles*
	e.	If the reactor is non-adiabatic: ▪ Coolant type ▪ Coolant requirement, kg/hour ▪ Heat transfer mode (jacket/coil)

	e.	Heat transfer mode, if using a jacket: ▪ UD, W/m2K ▪ Heat transfer area area ▪ Jacket thickness, m If using a coil: ▪ UD, W/m2K ▪ Heat transfer area area ▪ Coil dimensions (NPS, *Schedule Number*, total length, number of turns, coil stack height)
Fixed Bed Catalytic Reactor	a.	Types of catalysts
	b.	Catalyst shape
	c.	Catalyst size, mm
	d.	Stack height, m
	e.	Porosity of the pile
	f.	WHSV/hour
	g.	*Pressure drop*, atm
	h.	If the reactor is non-adiabatic: ▪ Heat transfer mode ▪ Types and needs of coolant
Fixed Bed Multitube Reactor	a.	Types of catalysts
	b.	Catalyst shape
	c.	Catalyst size, mm
	d.	Stack height, m
	e.	Porosity of the pile
	f.	WHSV, /hour
	g.	*Pressure drop* along the catalyst pile, atm
	h.	Tube dimensions (construction material, diameter, length, quantity, type and pitch size)
	i.	Coolant type
	j.	Coolant needs
Fluidized Bed Catalytic Reactor	a.	Types of catalysts
	b.	Catalyst shape
	c.	Catalyst size, mm
	d.	Minimum fluidization speed, m/s
	e.	Porosity of the catalyst stack at minimum fluidization speed
	f.	Catalyst circulation rate, kg/h
	g.	*Superficial velocity*, m/s
	h.	*Bubble diameter*, m
	i.	Fluidization zone height, m
	j.	Transport is favored height, m
	k.	*Stripping agent* (types and requirements)
	l.	Regenerator dimensions (optional)
	i.	Heat transfer mode (optional)
Bubble Reactor	a.	Types and sizes *of dispersers/spargers*
	b.	*Superficial gas velocity*, m/s
	c.	*Bubble diameter*, m
	d.	High liquid level, m

	e.	Mass transfer coefficient, unit adjust
	f.	If the reactor is non-adiabatic: ▪ Heat transfer mode ▪ Types and needs of *coolant*
Trickle Bed Reactor	a.	Types of catalysts
	b.	Catalyst shape
	c.	Catalyst size, mm
	d.	Stack height, m
	e.	Porosity of the pile
	f.	WHSV, /hour
	g.	*Pressure drop*, atm
	h.	*Solid loading*, kg
	i.	Liquid holdup, s
	j.	Mass transfer coefficient, unit of adjustment
	h.	If the reactor is non-adiabatic: ▪ Heat transfer mode Types and needs of coolant

Coolant: coolant/heater
WHSV: Weight hourly space velocity (feed rate in kg/h divided by catalyst weight)

L.6.b. Specification of Separator

1. Distillation Tower

Name and code :

Function :

Kind : Multistage Distillation / Binary Distillation / Mufticomponent Distillation / Azeotropic Distillation / Extractive Distillation / Steam Distillation / Complex Mixture Distillation / Batch Distillation

Type : TRAY/PACKED-TYPE DISTILLATION COLUMNS

Material :

Operating conditions :

a. Feed
b. Distillate
c. Bottom

Specifications :

Shell

a. Diameter
b. Height
c. Thickness

d. Material

Head

a. Type
b. Thickness
c. Material

For tray type

a. Tray type (sieve, valve, bubble-cap, etc)
b. Feed plate
c. Actual number of plates
d. Hole arrangement
e. Hole diameter
f. Number of trays
g. Tray spacing
h. Number of holes

No. of equipment:

Price :

2. Absorber and Stripper

Name and code :

Function :

Type : Tray Columns / Packed Columns / Spray Contactors / MULTISTAGE CONTACTORS / DIFFERENTIAL CONTACTORS / ABSORPTION BY CHEMICAL REACTION

Material :

Operating conditions :

Specifications :

Shell

a. Inner diameter
b. Height

c. Thickness

Head

a. Type
b. Thickness

For tower type with filling/packing material

a. Packing type
b. Packing construction materials
c. Packing arrangement
d. Packing diameter
e. HETP

Absorbent/stripping agent

Number of equilibrium stages

No. of equipment :

Price :

3. Extraction

Name and code :
Function :
Types of equipment : *Stage-Wise/Continuous Contact*
Material :
Operating conditions :
Specifications :

Shell

a. Inner diameter
b. Height
c. Thickness

Head

a. Type
b. Thickness

Solvent

Pressure drop

No. of equipment :

Price :

4. Knock out drum

Name and code :

Function :

Type :

Material :

Operating conditions :

Specifications :

Shell

a. Inner diameter
b. Thickness
c. Height

Head

a. Type
b. Height

5. Membrane

Name and code :

Function :

Type :

Material :

Operating conditions :

Specifications :

a. Module
b. Flow pattern
c. Number of channels in 1 module

d. Number of modules in 1 housing
e. Permeat flux
f. Tube length
g. Hydraulic diameter of the channel
h. Module diameter
i. Housing diameter

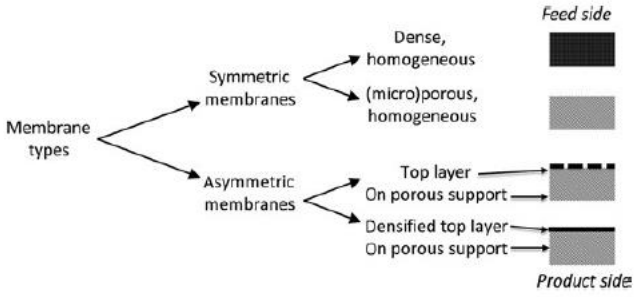

Figure 11.2: Type of membranes.

6. Centrifuge

Name and code :
Function :
Type :
Material :
Operating conditions :
Specifications :

a. Capacity
b. Bucket diameter
c. Bucket radius
d. Rotor rotation rate
e. Motor power

7. Separator

Name and code :
Function :
Type :

Material :

Operating conditions :

Specifications :

Shell

a. Long
b. Thick
c. Outer diameter

Head

a. Long
b. Thick

No. of equipment :

8. Filter press

Name and code :

Function :

Type :

Material :

Operating conditions :

Specifications :

a. Capacity
b. Filtration area area
c. Number of plates and frames

9. Decanter

Name and code :

Function :

Type :

Material :

Operating conditions :

Specifications :

Shell

a. Diameter

b. Height

c. Thickness

Head

a. Type

b. Height

c. Thickness

L.6.c. Specification of Material Storage Equipment

Tank	**T-01**	**T-02**	**T-03**	**T-04**
Functions				
Storage time	… (day/week)	… (day/week)	… (day/week)	… (day/week)
Phase	(liquid/gas/solid)	(liquid/gas/solid)	(liquid/gas/solid)	(liquid/gas/solid)
Number of tanks				
Tank type	Cylinder (horizontal/vertical)	Ball	Conical Hopper	Rectangular tub with lid
Operating conditions	Temperature (°C) : Pressure (atm) :	Temperature (°C) : Pressure (atm) :	Temperature (°C) : Pressure (atm) :	Temperature (°C) : Pressure (atm) :
Specifications	Construction Material: Tank volume (m^3): Diameter (m): Height (m): Number of courses: Shell thickness (in):	Construction Material: Tank volume (m^3): Diameter (m): Shell thickness (in):	Construction Material: Volume (m^3): Shell diameter (m): Konis tip diameter (m): Shell thickness (in):	Construction Material: Volume (m^3): Length (m): Width (m): Height (m):
Head & Bottom	(Head Type) Head thickness (in) : (Bottom Type) Bottom thickness (in):			
Price (Rupiah)				

L.6.d. Specification of Material Transportation Equipment

Specification of Transportation Equipment for Solid, Liquid and Gas Materials

It	Material Existence	Equipments Type	The parameter whose value shall be indicated, SI units.
1	Dense	*Belt Conveyor*	a) Purpose/Function of equipments designation b) Name of Transported Material c) Operating Conditions – Pressure & Temperature d) Material Form: Coarse, Powder e) Conveyor Type – Belt, Chain, Screw, Pneumatic f) Capacity – maximum load per unit length of conveyor (kg/m) g) Speed – speed (meters per minute) h) Motor Power – Motor Power (Watts) i) Dimensions – Length (horizontal and vertical), width, height j) Driver Pulley diameter – pulley diameter (m) k) Material Construction l) Price (Rupiah)
2		*Chain Conveyor* includes: • *Scraper Conveyor* • *Apron Conveyor* • *Bucket Conveyor* • *Bucket Elevator*	
3		*Screw Conveyor*	
4		*Pneumatic Conveyor*	
5	Liquid	*Positive Displacement* includes: a. Reciprocating pump b. Rotary Pump c. Pneumatic Pump	a) Purpose/Function of equipments designation b) Name of Pumped Material c) Viscosity – mPa.s (cP) d) Capacity - m^3/h e) Pump Head – m f) Fluid Temperature - ℃ g) Installation – Horizontal/ vertical h) Submersibility – dry/immersed i) Pump Type – PD, DP, others j) Additional information: Gas content, solid content, particle size, density, pH, operating pressure, Sealles, Self-priming, API/ISO/EN, Explosion protection k) Motor Power – Motor Power (Watts) l) Material Construction m) Price (Rupiah)
6		*Dynamic Pumps* include: • Centrifugal pump • Vertical Turbine pump	
7		Others	
8	Gas	Compressor includes: a) Positive Displacement b) Dynamic c) Jet	a) Purpose/Function of equipments designation b) Compressed Material Name c) Suction and Discharge Pressure – Bar d) Suction Temperature - ℃ e) Capacity - m^3/h f) Site Elevation (or Local Barometric Pressure) – m g) "Normal" operating conditions h) Other operating conditions i) Duty Cycle
9		Blower	
10		Fan	

			j) Electrical Characteristics and area classification k) Availability of cooling water l) Compression ratio m) Single/multistage n) Volumetric Efficiency o) Compressor Type p) Minimum & Actual RPM q) Motor Power – Motor Power (Watts) r) Material Construction s) Price (Rupiah)

L.6.e. Specification of Heat Exchanger

1. Heat Exchanger/condenser
   - HE Type : Double Pipe

Operating Condition				
Position	**Shell**		**Tube**	
Fluid				
Fluid type	Cold/hot		Cold/hot	
	In	Out	In	Out
Liquid flowrate	…	…	…	…
Vapor flowrate	…	…	…	…
Temperature	…	…	…	…
Pressure	…	…	…	…

Mechanical Design			
Annular		**Tube**	
Length	…	Length	…
Hairpin	…	Hairpin	…
ID	…	ID	…
		OD	
		A	…
		BWG	…
ΔP_{cal} / ΔP_{allow}	…	ΔP_{cal} / ΔP_{allow}	…
Rdcal / Rd_{min}	…	Rdcal / Rd_{min}	…

- HE Type : Shell & Tube

Operating Condition				
Position	**Shell**		**Tube**	
Fluid				
Fluid type	Cold/hot		Cold/hot	
	In	Out	In	Out
Liquid flowrate	…	…	…	…
Vapor flowrate	…	…	…	…
Temperature	…	…	…	…
Pressure	…	…	…	…

Mechanical Design			
Shell		**Tube**	
Length	…	Length	…
Passes	…	Passes	…
ID	…	OD	…
Baffle spaces	…	Number	…
		A	…
		BWG	…
		Pitch	…
ΔP_{cal} / ΔP_{allow}	…	ΔP_{cal} / ΔP_{allow}	…
Rdcal / Rd_{min}	…	Rdcal / Rd_{min}	…

2. Boiler
   Operating Condition
   - Boiler type :
   - Capacity : (kg/s)
   - Steam capacity : (kg/s)
   - Fuel type :

- Working pressure: (ATM)
- Temperature : (K)
- Boiling exhaust : (kg/s)

Mechanical design

- Shel is mentioned : optional (steam drum/mud drum)
  Length : (m)
  Diameter: (m)
- Tube count :
- Tube diameter : (m)
- Heating surface : (m2)

3. Evaporator

Evaporator type: Single evaporator / multi effect evaporator

Operating Condition						
Position		**Shell**		**Tube**		**Unit**
Total fluid circulated		….		…		(kg/s)
Fluid		Inlet	Outlet	Inlet	Outlet	
	Vapor	…	…	…	…	(kg/s)
	Liquid	…	…	…	…	(kg/s)
	Steam	…	…	…	…	(kg/s)
	Solid	…	…	…	…	(kg/s)
Temperature		…	…	…	…	(F)
Pressure		…	…	…	…	(ATM)

Mechanical Design				
Number of effect				**Unit**
Shell		**Tube**		
Length	…	Length	…	(ft)
Passes	…	Passes	…	
ID	…	OD	…	(in)
Baffle spaces	…	Number	…	(in)
		Surface area (1st effect)		(ft2)

		Surface area (2nd effect)		(ft2)
		Surface area (3rd effect)		(ft2)
ΔP_{cal} / ΔP_{allow}	…	ΔP_{cal} / ΔP_{allow}	…	Atm
Rdcal / Rd_{min}	…	Rdcal / Rd_{min}	…	hr.ft2.F/Btu