

**PRELIMINARY DESIGN OF PRECIPITATED SILICA PLANT FROM  
SULPHURIC ACID AND SODIUM SILICATE  
WITH CAPACITY OF 45,000 TON/ YEAR**



*By:*

**Linda Fatmawati**

**D500112005**

**Supervisor:**

**Dr. Ir. Ahmad M. Fuadi, MT**

**Kun Harismah Ph.D**

**CHEMICAL ENGINEERING DEPARTMENT  
FACULTY OF ENGINEERING  
UNIVERSITAS MUHAMMADIYAH SURAKARTA**

**2015**

**APPROVAL**  
**CHEMICAL ENGINEERING DEPARTMENT**  
**ENGINEERING FACULTY**  
**UNIVERSITAS MUHAMMADIYAH SURAKARTA**

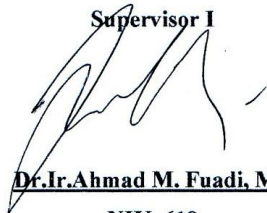
---

**Name** : Linda Fatmawati  
**NIM** : D500112005  
**Title** : Preliminary of Precipitated Silica Plant from  
Sulphuric Acid and Sodium Silicate with  
Capacity of 45,000 ton/year.  
**Advisor** : 1. Dr.Ir.Ahmad M. Fuadi, MT  
2. Kun Harismah, Ph.D

Surakarta, July 2015

Approved by,

Supervisor I




Dr.Ir.Ahmad M. Fuadi, MT  
NIK. 618

Supervisor II



Kun Harismah, Ph.D  
NIK. 402

Dean,



Ir Sri Sunarjono.MT., Ph.D  
NIK.682

Head of Chemical Engineering,



Rois Fatoni, ST, M.Sc, Ph.D  
NIK.892

## **STATEMENT LETTER**

I declare that this final report is original. There are no previous researches that have been submitted in order to get bachelor degree. As I know, there are no statements from other researchers, except the statements that are listed in the bibliography.

In the future, if there is a lie on my statements then I will be fully responsible.

Surakarta, July 2015

**Linda Fatmawati**  
**D 500 112 005**

## ACKNOWLEDGEMENT



The author says thank to Allah SWT who gives His blessing, so the author can has been able the final a project “**Preliminary of Precipitated Silica Plant from Sulphuric Acid and Sodium Silicate with Capacity of 45,000 ton/years**”.

In arranging the report, the author get supports from several parties. Because of that, the author wants to say thanks to:

1. Allah SWT who has given me His mercy and His blessing.
2. Both parents Mr. Suwardi, Mama Siti Farida, Opung Wito, Abang Fajar, My little brother (Hasan, Faqih, Fauzan) who always pray and giving a boost to the author in completing this report.
3. Mr. Dr. Ir. Ahmad M Fuadi, MT as supervisor I.
4. Mrs. Kun Harismah Ph.D as supervisor II.
5. Ismaae Yusoh as a partner of our final project.

The author realizes that in the preparation of plant task, there is still a shortage. Therefore, the author expects the suggestions and criticism from readers, so it can be used as a consideration. The author hopes that this plant design tasks can be useful to the reader.

Surakata, July 2015

Author

## ABSTRACT

In Indonesia, precipitated silica plant is an industry that can provide a good opportunity for the country. Indonesia has not been able to meet the needs of precipitated silica, so that Indonesia imports from other countries. From 2005 to 2012 Indonesia has exported 89,801.806 tons of precipitated silica, and the capacity for imports are 111,362.3 tons, so the precipitated silica plant is designed of 45,000 tons/year. Precipitated silica ( $\text{SiO}_2$ ) is the oxidation of non-metallic compounds. it has a solid powder form, white, odorless, insoluble in water, and has a crystalline structure. The process of manufacturing of precipitated silica using silicate acidification uses CSTR reactor (continuous stirrer tank reactor). It operates at a temperature of  $90^\circ\text{C}$  and at a pressure of 1 atm. This reactor proceeds in the liquid phase, irreversible, and non-adiabatic. The product of the reactor are separated in rotary vacuum filter, and then the output is a cake of  $\text{SiO}_2$ . It is dried with dryer.

Utility unit of the plant consists of the units of the water provider, the unit of steam supply, electricity and fuel supply unit, and laboratories to maintain the quality of materials and products to conform to the standards. This company is a limited Incorporation with a system of organizational structure and staff. As a plan, the company is built in Karawang, District Ciampel, and West Java Province. The establishment of the plant requires a total investment (capital investment) amounting to Rp 379,572,671,920 and production cost Rp 672,882,855,360. Economic analysis is obtained BEP 49.6 %, SDP 28.4 %, ROI before tax 30.78 %, ROI After tax (Inc, Ltd) 18.47% Profit after tax earned Rp 36,910,288,200

## **Motto**

“Practice makes right, repetitions make perfect.”

(Ustad Felix Siauw)

Hold themselves to ALLAH SWT ,

So ALLAH always remember us.

(Mr.Suwardi)

"Ongoing complaints are the signs that you are the smaller person than the problem you have. Stop complaining and start doing!"

(Mrs.Siti Farida)

“They can because they think they can”

(Linda Fatmawati)

“Not all the things that you worry could happen in your life. Stop worrying about something, because worries make you more afraid to do everything.”

(Linda Fatmawati)

“Nothing is impossible. Anything can happen as long as we believe.”

(Linda Fatmawati)

## DEDICATION

This work is dedicated for:

- ✚ Mama is someone who always giving the spirit, which never underestimated my ability that has always believe that i could be successful and dont care what people say .
- ✚ Father is a firm but he is the person most instrumental in my life.
- ✚ My brother Fajar is second father to me. He'll never be replaced.
- ✚ For my three little brother especially Hasan, Faqih, Fauzan. I will give the best for our family.
- ✚ My partner **Ismaae Yusoh** who has always giving spirit.
- ✚ For my best Danis, Tri Rochayatun, Choirul Huda S, Tri Yanto, Sugih, Kunthi Thank you so much always support me. LOVE YOU ALL!!!
- ✚ For Mr. Budi thank you so much always hear my complaint always give me advise.

## TABLE OF CONTENTS

TITLE.....	i
APPROVAL .....	ii
STATEMENT LETTER.....	iii
ACKNOWLEDGEMENT .....	iv
ABSTRACT .....	v
MOTTO .....	vi
DEDICATION.....	vii
TABLE OF CONTENTS .....	viii
LIST OF TABLE .....	x
LIST OF FIGURE.....	xi
CHAPTER I INTRODUCTION .....	1
1.1 The Background of the Plant .....	1
1.2 Selection of The Capacity of the Plant Design .....	2
1.3 Literature Review.....	5
1.4 The usefulness of products.....	6
1.5 Properties of Physical and Chemical Raw Materials and Products .....	6
1.6 The General Process Review .....	8
CHAPTER II PROCESS DESCRIPTION .....	9
2.1 The Specification of Raw Materials and Products.....	9
2.2 The Process Concept.....	9
2.3 The Thermodynamic Review.....	10
2.4 The Flowchart .....	11
2.5 The Process Stages.....	11
2.6 The Flowchart of Material Balance and Heat Balance .....	13
2.7 The Plant Layout and Equipment .....	17
CHAPTER III THE SPECIFICATION OF THE EQUIPMENT.....	22
3.1 Tank of Sodium Silicate (T-01) and Tank of H <sub>2</sub> SO <sub>4</sub> (T-02).....	22
3.2 Mixer (M-01) .....	22
3.3 Heat Exchanger (HE-01).....	23
3.4 Reactor 1 and Reactor 2 .....	23
3.5 Pump .....	25
3.6 Bucket Elevator.....	29
3.7 Belt Conveyor .....	30
CHAPTER IV PROCESS SUPPORT UNIT AND LABORATORY.....	31
4.1 Process Support Unit.....	31
CHAPTER V MANAGEMENT .....	55
5.1 Company .....	55
5.2 Organizational Structure .....	56
5.3 Employee Welfare .....	63
5.4 Health and Safety .....	63
5.5 Production Management .....	64
5.6 Production Plan.....	64
5.7 Production Control.....	65
CHAPTER VI ECONOMICAL ANALYSIS .....	68



6.1 Basic Calculation .....	68
6.2 Cost Calculation.....	71
6.3 General Expenses.....	73
6.4 Feasibility Analysis.....	73
6.5 The Result of Calculation .....	75
CHAPTER VII CONCLUSION .....	81
BIBLIOGRAPHY .....	82
APENDIX .....	86

## LIST OF TABLE

Table 1.1	The export data and import data precipitated silica.....	2
Table 1.2	The existing capacity of precipitated silica plant.....	3
Table 2.1	The data of reaction formation of precipitated silica.....	10
Table 2.2	The component of material flow.....	13
Table 2.3	The material balance mixer (M-01).....	13
Table 2.4	The material balance of reactor 1 (R-01).....	14
Table 2.5	The material balance of reactor 2 (R-02).....	14
Table 2.6	The material balance, rotary drum filter (RDF-01).....	14
Table 2.7	The material balance, rotary dryer (RD-01).....	15
Table 2.8	The total of material balance.....	15
Table 2.9	The heat balance of mixer (M-01).....	15
Table 2.10	The heat balance of reactor (R-01).....	16
Table 2.11	The heat balance of reactor (R-02).....	16
Table 2.12	The heat balance of rotary drum filter (RDF-01).....	16
Table 2.13	The heat balance of rotary dryer (RD-01).....	17
Table 2.14	The heat balance around heat exchanger (HE-01).....	17
Table 2.15	Building precipitated silica.....	19
Table 3.1	The needs of electricity for process.....	49
Table 5.1	Schedule for each group.....	61
Table 5.2	Positions and requirements.....	62
Table 5.3	Data of the number of process employee.....	62
Table 6.1	Cost index chemical plant year 1990-2010.....	69
Table 6.2	Physical plant cost.....	75
Table 6.3	Fixed capital cost.....	76
Table 6.4	Working capital investment.....	76
Table 6.5	Manufacturing cost.....	76
Table 6.6	General expense.....	77
Table 6.7	Fixed cost.....	78
Table 6.8	Variable cost.....	78
Table 6.9	Regulated cost.....	79

## LIST OF FIGURE

Figure 2.1	Qualitative of flowchart.....	11
Figure 2.2	Material balance of flowchart.....	13
Figure 2.3	The layout of precipitated silica plant.....	19
Figure 2.4	The layout of equipment layout of precipitated silica plant.....	21
Figure 4.1	Diagram process of water treatment.....	36
Figure 5.1	Organizational structure.....	67
Figure 6.1	Relationship between years and cost index.....	70
Figure 6.2	Graphic of parameters of economic analysis.....	80