



CHAPTER I INTRODUCTION

1.1 The Background of the Plant

Precipitated silica is one of the chemicals that are often used as industrial raw materials, particularly industries that use rubber materials, insecticides, and supporting materials. The industries include food or beverage industry, ceramics industry and water filter. Precipitated silica (SiO_2) is the oxidation of silica, a non-metallic compounds. SiO_2 is a solid powder, white, odorless and insoluble in water except for fluoride acid. Precipitated silica has several crystal structures, like carbon in the form of graphite and diamond, it has the same composition with sand and glass, but the shape of the molecule is a cubic, while the glass has a tetrahedral structure (Ulman, 2005).

Precipitated silica is silica or silica powder that has a non- metallic oxide compound with the chemical formula SiO_2 . Our final project that we made are supported by previous studies carried out by (Wulandari, 2010) with the title design precipitated silica plant with a capacity of 15,000 tons / year, the reaction takes place in the liquid-liquid phase with the properties a reversible reaction, isothermal conditions, non-adiabatic. The reaction is exothermic so as to maintain a temperature of 60°C in order to keep the reactor is equipped with a cooling jacket. Then (Assafira, 2007) the design of precipitated silica plant acidification process alkali silicate solution with a capacity of 50,000 tons / year, manufacture of precipitated silica with a solution of alkali silicate acidification process is done in a Continuous Stirred Tank Reactor and at a temperature of 80°C and a pressure of 1 atm is equipped with a cooling jacket. Inside the reactor an exothermic reaction between sodium silicate with sulfuric acid. In designing a chemical plant by (Wahyuningsih, 2006) with the title the design of the plant precipitated silica from sodium silicate and sulphuric acid with a capacity of 16,000 tons / year, the process of manufacture of precipitated silica CSTR held in the reactor. In these reactors the reaction in the liquid phase, irreversible, isothermal, at a temperature of 90°C and a pressure of 1 atm.



In Indonesia, precipitated silica plant is one of the industries that provide good opportunities for the country. Indonesia has not been able to meet the needs of precipitated silica, so that Indonesia still imports from other countries. So far, Indonesia has exported as much 89801.806 tons from 2005 to 2012, and its import needs as much 111,362.3 tons. There is inability of producers to meet all the demand or the dependence on imports from other countries. If the precipitated silica plant is built, there are some benefits.

- a. Create jobs for the people of Indonesia
- b. Adding foreign exchange devise.
- c. Precipitated silica needs can be met without imports from other countries.
- d. Encouraging the development of Plant around that use precipitated silica as raw materials.
- e. It is expected to penetrate the export market.

1.2 Selection of The Capacity of the Plant Design

In deciding the capacity of the Plant Design, it must consider some factors, such as:

1.2.1 The Needs of Product Marketing in Indonesia

Indonesia is a country that has not been able to meet all the needs of precipitated silica, so that Indonesia imports it from overseas. It can be seen from the development of import export data of the year 2005-2012 in Table 1.1

Table 1.1 The export data and import data precipitated silica
(Biro Pusat Statistik, 2012)

Year	Export Data (ton)	Import Data (ton)
2005	7,145.798	6,631.321
2006	7,712.955	7,171.697
2007	8,116.294	9,907.146
2008	7,799.854	14,982.297
2009	8,253.079	14,58.001
2010	11,082.309	16,270.713
2011	23,908.344	23,203.442
2012	15,783.173	19,037.635



1.2.2 The Number of Raw Materials

The raw materials of precipitated silica are sulphuric acid and sodium silicate. Sulphuric acid raw material is obtained from PT. Timur Raya Tunggal in Karawang, West Java with a capacity of 49,500 tons / year (www.timurraja.com). Sodium silicate is obtained from PT. Mahkota Indonesia is located in Pulogadung, North Jakarta , with a capacity of 30,000 tons / year (PT. Mahkota Indonesia, 2008).

1.2.3 The Existing Capacity of Precipitated Silica Plant

In determining the capacity of the Plant, the researcher must know the data capacity of the existing Plant. The data capacity of the existing Plant can be seen in Table 1.2.

Table 1.2 The existing capacity of precipitated silica plant

No	Company Name	Location	Weight (ton)
1	PT. Tensindo Sejati	Semarang, Jateng	6,000
2	Nippon Silica Industrial	Nanyo, Jepang	40,000
3	PT. Crosfield Indonesia	Pasuruan , Jatim	10,000
4	Rhodia, Inc	Paulina, Brazil	36,000
5	Shouguang Baote Chemical & Industrial Co., Ltd	Shandong, China	140,000

Based on the data, we can determine the capacity of pre-draft precipitated silica Plant. The capacity is 40,000 tons / year. The 3 reasons 1) heat of the capacity, 2) It can meet domestic needs and the rest can be exported to increase foreign exchange, 3) It is expected to meet its domestic needs.

1.2.4. Determining The Location of The Plant

Site selection is important in determining the value of the production and economic of the Plant. As a Design, the Plant will be established in the district of Karawang, The sub district of Ciampel West Java, with consideration of primary and secondary factors.

1. Primary factors

a. The existing of the raw materials

The raw materials used are sulphuric acid and sodium silicate. Sodium silicate obtained from PT Mahkota Indonesia in Pulogadung



North Jakarta, which is 54.3 km from Ciampel, Karawang. Sulphuric acid can be from PT. Timur Raya Tunggal in Klari, Karawang, which is 17.1 km from Ciampel.

b. Transportation

In the supply of raw materials and marketing product, it is necessary to have facilities and adequate transportation infrastructure. Karawang in West Java is the right choice. That is because the adequate transportation facilities such as land, sea and railway. The land there is a Jakarta-Cikampek toll road within 1.5 km on the northern coast and the train station, so that the distribution of raw materials and products are more easily. The sea-lanes, Tanjung Priok port within 66.1 km from the Plant site. Out of content product and raw material transport is Soekarno-Hatta 70 km from the Plant site.

c. The workers

Election of workers should have done using certain considerations such as the number, quality, minimum wages, productivity, and workers skills. Labor selected from the areas around Karawang. That is Karawang regency government, that the labor absorption ratio of 1977.84 people per company. In addition, based on data from the Central Bureau of Statistics Karawang, the numbers of job seekers in 2010 for diploma are 4,396 people and for undergraduates are 3,007 people (Pemerintah Kabupaten Kerawang, 2011). Besides Karawang, the election workers also can be supplied from all over Indonesia who has higher education as graduates of vocational schools, and colleges.

d. The utilities supply

Utilities that need to be considered are water, electricity, and other supporting facilities. To meet the demand for electricity, the Plant uses electricity networks of 750 Kw and a generator. Water requirements can be obtained from the management of the industrial area, river, and sea water treatment.



e. Marketing

Marketing of products is in Ciampel Karawang District of West Java. It is caused that this region is the largest consumer of tire manufacturers such as PT. Sumi Rubber Indonesia in Karawang and Cikampek-PT. Bridgestone Tire Indonesia in Karawang, the cosmetics industry at PT. Cedefindo in Bekasi, the pharmaceutical industry and rubber industries such as PT. Cilatexindo Graha Alam in Bekasi and PT. Ciluar Baru in Bogor.

f. The condition of location

Karawang is a pretty good location because it is located on a flat plateau with an altitude variation of 0-5 m above sea level, it has a good drainage, strong soil structure, and has good hydrological aspects because there is Citarum and Cilamaya rivers which can be used for needs water Factory (Baasel, 1974). Ciampel sub-district has a height of 11-25 m above sea level.

2. Secondary factors

2.1. The land expansion

Karawang is an industrial area. It needs to expand the land for Plant expansion in the future.

2.2. The government policies

The establishment of the precipitated silica Plant may supports the government policy in order to develop industry-related workers equity and increase product of development, especially in Java. The establishment of the Plant should pay attention to the environmental safety and it does not interfere with the surrounding area. Based on the considerations above, the precipitated silica Plant will be established in Karawang, West Java.

1.3 Literature Review

1.3.1 The kind of process

1. Wet process

a. Acidification silicate



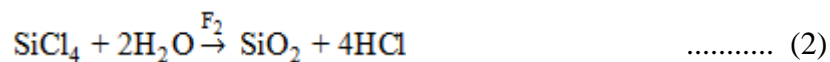
The process of precipitated silica by neutralization of sodium silicate solution with an acid solution (H₂SO₄) is through the process of filtration, drying, milling, and granulation. It produces precipitated silica that has the same size and takes place at temperatures of 90-100°C, which the following reactions.



This process is for the mixing process to avoid the formation of gel (Ulman, 2005).

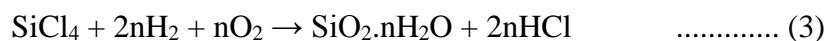
b. SiCl₄ reaction with fluoride

SiCl₄ has high purity that is equal to 99%. Hydrolysis process uses a temperature of 60°C. In the process, need special treatment due to form a gel. The reaction is



2. Dry process

This process is SiCl₄ evaporation and decomposition with hydrogen at a temperature 1800-2000°C. Thus, it forms silica acid powder products. The reaction is



For my project that use is acidification silicate with following consideration easy to control because the operating condition is 1 atm , with stirring arrangement gel can be avoided , and product is diversify.

1.4 The usefulness of products

The uses of Precipitated Silica (Ulman, 2005):

- a. The rubber industry use precipitated silica as a reinforcing material
- b. The cosmetics industry use precipitated silica as a compactor and anticaking.
- c. The toothpaste industry use precipitated silica as an additional active ingredient and abrasion agent.
- d. The paper industry use precipitated silica as filler.
- e. As an agent of silicone rubber.



1.5 Properties of Physical and Chemical Raw Materials and Products

1.5.1 Raw Materials

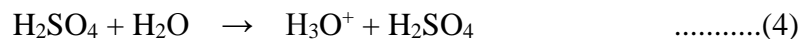
1. Sulphuric Acid (Kirk Othmer, 1982)

The physical properties of sulphuric acid

- Chemical Formula : H_2SO_4
- Shape : *Viscous liquid*
- Specific Gravity : 1.857
- Boiling Point : 274°C
- Freezing Point : 10.49°C
- The Molecular Weight: 98.08 g/mol
- Odor : little bit characterized
- Enthalpy Of Formation: -212.03 kkal/gmol
- pH : less than 1.0
- Heat Capacity : 33.12 kal/mol K (20°C)
- Solubility In Water : Soluble
- Viscosity : 2.67 cp (20°C)

The chemical properties of Sulphuric Acid (Ulman, 2005)

- Sulphuric acid is a strong acid that has valence of two and hygroscopic and volatile.
- If sulphuric acid is diluted into water, the pure sulphuric acid dissociates.



- At high temperatures, Sulphuric acid will decompose to be a sulfur trioxide and water vapor.



2. Sodium Silicate

The physical properties of sodium silicate

- Chemical Formula : $\text{Na}_2\text{O} \cdot 3\text{SiO}_2$
- Shape : *liquid*
- Color : uncolored
- The Molecular Weight : 254.27 g/mol



- Density (20°C) : 3.083 1b/L
- Enthalpy Of Formation : -808.36 kkal/gmol
- Heat Capacity (25°C) : 42.38 kal/mol K
- Boiling Point : 102°C

The chemical properties of Sodium Silicate

- Sodium silicate is soluble in water, but it cannot be hydrolyzed, such as salt precipitated silica that is neutral with a ratio of 3.2 to 3.5.
- Sodium silicate are stable at room temperature and atmospheric pressure are stable.
- Sodium silicate reacts with other salts, such as magnesium sulfate that forms magnesium precipitated silica. The reaction is:



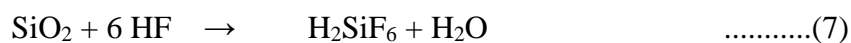
1.5.2. Products

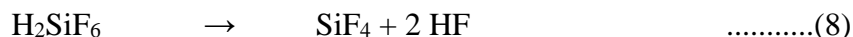
The physical properties (Kirk, 1982)

- Chemical Formula : SiO_2
- Color : uncolored
- Shape : Powder
- Molecular Weight : 60.1 g/mol
- Melting Point : 1.713°C
- Boiling Point : 2.230°C
- The Heat Capacity : 10.73 kal/mol K
- Bulk density : 0.03-0.45 g/cm³
- True density : 1.0-2.1 g/cm³
- Refractive index : 1.45
- Surface Area : 45-700 m²/gram
- Average size particle : 1-10 μm

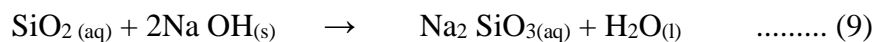
The Properties

- Precipitated silica is insoluble in water, but it is soluble hydrofluoric acid (HF). The reaction is





- Precipitated silica is acidic, so it can react with a base. The reaction is:



- Surface of precipitated silica consists of silanol groups (Si-OH) and siloxane (Si-O-Si). Silanol group is hydrophilic, stable in water when adsorbing water from the surrounding air, and it will form hydrogen when heated.

1.6 The General Process Review

Precipitated silica formation process consists of several 5 steps.

a. Precipitation

Precipitation is the reaction between sodium silicate with sulphuric acid to produce precipitated silica. This process is carried out at a temperature of 90°C and a constant pH from 7.0 to 9.9 (Esch, 1996).

b. Filtration

Separation of salts contained in the product precipitation, and byproducts in the form of sodium sulphate. In this process, there is still about 15-25% of the content of filter cake (Ulman, 2005).

c. Drying

Dry the liquid filter cake from the filtration process to reduce the moisture content up to 3% (www.bhs-sonthofen.de).

d. Milling

The Milling of the precipitated silica up to ± 325 mesh

e. Packing