CHAPTER I

INTRODUCTION

1.1. Background of factory establishment

Today, all industry sectors are directed at the use of technology that is less polluting and cost-effective operations. In Indonesia, the development of the chemical industry is growing quite rapidly. Along with the development of the chemical industry in Indonesia, resulting in the need for methanol (CH_3) which is a raw material and chemical supporting materials industry has increased. However, Indonesia still imports raw materials or chemical industry products from other countries.

Methanol (CH_3) is one of the hydrocarbon compounds of the alcohol group ($CnH_2n + 2O$) with an alkyl hydroxyl group (-OH). Derivative products of Methanol such as acetic acid, MTBE, rubber, chloroform, polyvinyl, formaldehyde. Methanol is a necessary chemical both domestically and abroad, in Indonesia alone consumption of methanol needs quite a lot.

Based on the methanol requirement data above, the need for methanol import will increase every year. This is very possible considering the need for methanol by other factories producing derived compounds is expected to continue to grow.

On the other hand, with increasing prices and limited oil-based fuels, methanol appears as an alternative fuel (fuel of alternative). Methanol can be used as diesel fuel, where methanol is converted to dimethyl ether. The quality of methanol alone is equivalent to a decrease in fossil fuel (fossil fuel). This has resulted in increased methanol market demand, especially in Asia.

Raw materials that can be methanol are natural gas and low calorie coal (low quality). For Indonesia, natural gas reserves have reserves of 170 TSCF, which are expected to meet the needs of up to 59 years (www.datacon.co.id). Seeing such cases, the government restricted the exploitation and use of natural gas, so as not to run out quickly.

Coal in Indonesia is very abundant, the availability of coal in Indonesia reaches 120.338 million tons and reserves of 28.017 million tons (Ministry EMR, 2013). The amount is spread in the territory of Indonesia, namely Sumatra and Kalimantan, is the 2 regions that have the largest source and coal reserves among other regions. In total, resources and reserves in Sumatera and Kalimantan respectively reached 72,879 million tons and 49,526 million tons (prokum.esdm.go.id). Of the total coal resources, 1% is very high calorie coal, 10% high calorie coal, 67% medium calorie coal, 22% low calorie coal type (Sukandarrumidi,2005). Coal in Indonesia is said to be classified as clean because it has low sulfur content (<1%) and ash content<5% (prokum.esdm.go.ig), so it is not too pollute the environment.

Coal utilization in general is less likely to be maximized, because coal is only used as a source of combustion energy, where in combustion energy source it uses high calorie type coal. And the government has not been optimal in the utilization of low calorie janis coal, so the amount is very abundant. On the other hand, low calorie type coal contains H (both in moisture and H_2) which result in low calorie value <3500 kkl / kg, making low calorie type coal suitable for processing into methanol. And seen from the low price of low calorie coal tends to be cheap, USD 0.015 in August 2016 (www.tambang.com), and the price of methanol is USD 0.40 in August 2016 (www.methanex.com).

Judging from the price of raw materials and also the price of products from methanol, the establishment of a methanol plant can provide considerable advantages, considering the large scale methanol plant in Indonesia is located in East Kalimantan, East Kalimantan Methanol Industri (PT KMI). PT KMI alone supplies its products about 4-5% of methanol needs in Asia. If in Indonesia a similar methanol plant is established, it can meet the demand for methanol supply of 8-11% in Asia region (www.Metanolmsa.com).

Establishment of a methanol plant in Indonesia can be done because it is supported by several reasons:

a. The needs of the world and Indonesia for methanol continue to rise significantly
b. The need for methanol increases with the increase in world energy demand
c. In the future, methanol is not only needed in many manufacturing industries, but also in industries related to energy resources, ie fuel needs
d. China is a country with the highest methanol consumption in the world, due to its rapid economic and industrial growth
e. Indonesia's methanol import volume is quite high, amounting to 60% of Indonesia's methanol export volume

1.2. Design capacity.

Determination of methanol production capacity, based on several considerations, namely:

a. Projection of methanol product needs in Indonesia.
b. The availability of raw materials.
c. Capacity of existing methanol plant.

1.2.1. Projection of methanol demand in the country.

Table 1.2.1 Data Import Methanol in Indonesia

(BPS, 2016)

Years	Import Methanol (kg)	Years	Import Methanol (kg)
2000	59,420,790	2008	63,102,359
2001	57,576,136	2009	76,973,648
2002	48,287,536	2010	192,223,851
2003	57,935,536	2011	275,947,247
2004	81,210,748	2012	261,865,693
2005	46,591,876	2013	341,455,237
2006	29,992,713	2014	557,361,725
2007	63,293,031	2015	628,257,845

From the import data, it turns out that the amount of imported methanol volume increases every year. The amount of methanol is expected to continue to grow, due to the need for methanol by other factories that produce derivative compounds. In Indonesia there are two big enough Methanol plants, namely:

a. Medco Methanol Bunyu

Production capacity of Medco Methanol Bunyu own factory is 330.000 ton / year. While the domestic supply of 297,000 tons/year.

b. East Kalimantan Methanol Industry

Production capacity of Kaltim Methanol Industrial factory itself is 660,000 tons / year. While the domestic supply of 260,000 tons/year.

So total domestic production of 990,000 tons/year.

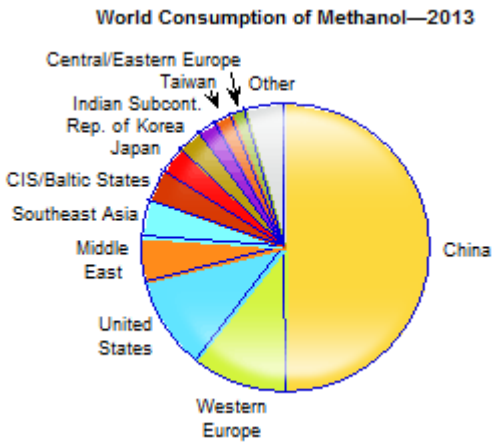

Figure 1.2.1 Word Consumption of Methanol

1.2.2. Availability of Raw Materials

The availability of coal resources in Indonesia reached 120,338 million tons and reserves of 28,017 million tons. The amount is spread in the territory of Indonesia, namely Sumatra and Kalimantan, is the 2 regions that have the largest source and coal reserves among other regions. Overall, resources and reserves in Sumatera and Borneo respectively reached 72,879 million tons and 49,526 million tons.

Taking into account the availability of abundant raw materials and market demand opportunities, on the manufacture of methanol that relies on raw materials of low quality coal, will increase the portion of Indonesia in methanol business in Asia in particular and become a major revenue earner for the government and investors.

1.2.3. Capacity of an Existing Methanol Plant

Based on these considerations, the design capacity of the methanol plant is 150,000 methanol per year which will be established in 2025 for the following reasons:

1. Can provide economic benefits, because it can increase the production capacity of methanol has been established (PT Kaltim Methanol Industry with a capacity of 660,000 tons/year and PT Medco Metanol Bunyu with a capacity of 330,000 tons/year)
2. Anticipating the factory that has operated to increase its production capacity

1.3. Factory Location Selection

Site selection is very important in the design of the plant, as this may affect the position of the factory in the competition and the survival of the plant. Choosing the right location can provide maximum benefits. The factors-factors that need to be considered in determining the location of the factory built, including primary factors and secondary factors.

I.3.1 Primary Factor

The main objective of this methanol plant includes the production and distribution of the product, the two activities are arranged based on the type, quality, time, and place required by consumers and affordable price level, and of course still provide benefits for the factory itself. Primary factors include:

1. Location of raw material source
   The main raw material of methanol is synthesis gas from Coal taken from PT. Kaltim Prima Coal. This methanol plant will be established in West Kalimantan.
2. Product marketing
   The marketing location may affect the price of the product. Establishment of a factory location adjacent to the main market, aims to facilitate access to marketing products to consumers.
3. Transportation facilities

Facilities and infrastructure are closely related to the distribution of raw materials and sales product. Thus, the existence of transportation facilities of highways and seaports, it will facilitate the transportation of raw materials and product marketing.

4. Labor

Manpower can be obtained from residential residents around the plant so as to reduce the number of unemployed because it opens employment. Highly educated workers are easily available, from recruitment of university graduates in Java, Borneo and Sumatra.

5. Utilities

Provision of utilities such as water, electricity, and other facilities must be considered for the production process can proceed well

I.3.2 Secondary Factors

1. Land and building prices

   Usually, related to upcoming plans.

2. Climate

   Climate influence can affect the manufacturing process. Such as in a climate that is too hot will result in a cooling for a considerable amount of equipment, while a climate that is too cold will result in a considerable additional construction cost due to the installation of a special protective device for the process. In the area of West Kalimantan, including areas that have high rainfall and dry climate, because of West Kalimantan close to the equator. With some of these conditions make the area of West Kalimantan suitable for the location of methanol plant.

3. Service facilities are available
4. Possible expansion of factory

1.4 Review Library

Coal is a solid hydrocarbon rock formed from plants in an oxygen-free environment, and the effects of pressure and heat that last very long. So that coal can be regarded as fossil fuel. The main elements contained in coal are carbon, hydrogen, and oxygen.

In general, coal is classified as 5 levels (in order of quality) are anthracite, bituminous, sub-bituminous, lignite, peat (peat). While the classification of coal based on calorific value is divided into 3 groups, namely as follows:

Table 1.4.1 Group of Coal based on Calor Content

(Sukandarrumidi, 2005)

Group	Calor Content (kkal/kg)	Type
High Quality	± 8300	Antrasit
Medium Quality	7000 - 8000	Bituminus
Low Quality	6000	Sub-Bituminus
	1500-4500	Lignit

1.4.1 Kinds of Processes

There are several methanol making processes:

1. Process of making methanol with wood distillation
2. In the 1830s to the middle ages of 1920, the method used in the manufacture of methanol was the use of wood distillation, where it used heat to produce charcoal and methanol from wood, after the wood was heated, is slowly burned and released methanol gas. The gas is then condensed for liquid methanol. On 1923, the manufacture of methanol reach 30,000 tons/year, by using more than 6 tons of wood as raw materials. This makes an impact on forest ecosystem degradation with abundance of logging (Mc Ketta, 1983).
3. Hydrocarbon Oxidation

   This process uses a hydrocarbon compound as the main raw material. In the hydrocarbon partial oxidary process, the product containing paraffin gas is methanol, formaldehyde, acetone, acetaldehyde, aldehyde, ketone, high alcohol. This process runs at a pressure of 20.27-30.4 bar with a temperature of 8000C, using nickel, palladium, copper, and oxidari catalysts of the metals. The disadvantage of this process is to use hydrocarbon materials that can spur the emergence of greenhouse gases (Mc Ketta, 1983).

4. Methanol Making Process from Coal Gasification

   Making methanol can use synthesis gas, through gasification, synthesis gas can be obtained from various raw materials, such as coal, biomass waste, urban waste. In the manufacture of methanol, there are 2 steps, namely:

   A. The first step

      Convert raw materials into synthesis gas consisting of CO, CO_2, H_2O, H_2. Usually achieved by the catalytic reforming of feed and vapor gases.

   B. Step two

      Synthesis catalytic of methanol is from synthesis gas.

      The advantage of this process is that raw materials are easy to obtain, and the utilization of low quality coal types is more optimal (www.Metanol.org).

Of the several processes available, then the selection of processes that are considered suitable in terms of availability of raw materials in sufficient long-term process is the process of gasification.

1.4.2 Product Uses

Methanol can be referred to as methyl alcohol, wood alcohol, or spirtus. Methanol is a chemical compound that has the chemical formula CH_3OH which is the simplest alcohol. Here are some areas that utilize methanol:

1. Used as raw material for the manufacture of other chemicals, such as formaldehyde and methyl esters.
2. Methanol is a mixture of anti-frozen ingredients in cooling water, whose temperature can reach 0^oC
3. Methanol is used as raw material for cleaning liquids, such as glass cleaners.
4. Methanol is used as raw material for the manufacture of MTBE (Methyl Tertiary Butyl Ether), which is a fuel addictive substance to improve the combustion process.
5. Approximately 40% of methanol is converted to formaldehyde, and from there to a variety of products such as plastics, plywood, paint, explosives, and textiles.
6. Methanol is widely used as a solvent.

7. Methanol is the feedstock for the manufacture of dimethyl ether, as aerosol liquid and used as a mixture for the manufacture of LPG.
8. In some wastewater treatment plants, a certain amount of methanol is used to waste water as a carbon food for denitrification of bacteria, which converts nitrates to nitrogen.
9. Methanol is now being developed as a fuel cell for laptops, even vehicles.

1.4.3 Physical and Chemical Properties

A. Raw Materials

- **A.1. Coal (Sukandarrumidi, 2005)**

Physical properties

Compounds:

C (Carbon)	: 80% weight
H (Hydrogen)	: 5.5% weight
N (Nitrogen)	: 1.6% weight
S (Sulfur)	: 0.67% weight
O (Oxygen)	: 12.20% weight
Molecular weight	: 119.17 kg/kmol
Density	: 1.350 kg/m^3
Heat value	: 21.35 - 25.54 MJ/kg
Density	: 1.760 kg/m^3
Specific heat	: 1.1 kJ/kg.K
Heat ignition	: 126.67 – 185°C
Flash point	: 260°C

Chemical properties

Reaction:

$C + O_2 \rightarrow CO_2$

$C + ½ O_2 \rightarrow CO$

$H_2 + ½ O_2 \rightarrow H_2O$

$S + O_2 \rightarrow SO_2$

To prevent excessive CO formation, the amount of oxygen in combustion must be adjusted for complete combustion.

- **A.2. Oxygen (Perry, 2007)**

Physical properties

Phase : Gas

Molecular formula : O_2

Molecular Weight : 31.9988 kg/kmol

Boiling Point : -183°C

Critical Temperature : -118.6^{o}C

Thermal Conductivity : 0.026 W/m^{o}C

Chemical properties :

- Highly reactive oxidizers
- Air separation using liquification and distillation methods.

- **A.3 Water (Othmer, 1981)**

Physical properties

Phase : Liquid

Molecular formula : H_2O

Molecular weight : 18.02 kg/kmol

Density : 0.99747 kg/m^3

Boiling Point : 100°C

Dew Point : 0^oC

Heat capacity : 4178.43 kJ/kg,K

Thermal conductivity : $6.04026x10^{-3}$ kW/m,K

Chemical properties :

- Has neutral properties (pH = 7)
- React with potassium, magnesium, sodium, and other reactive metals liberating H_2
- React with potassium oxide, sulfur oxide to form a base
- Potassium and sulfuric acid
- React with carbon to produce methane, hydrogen, carbon doikside, carbon monoxide to form synthesis gas (in the process of coal gasification)

B. Products

- **Methanol**

Physical properties

Phase : Pure Liquid

Molecular formula : CH_3OH

Molecular weight : 32 kg/kmol

Density : 0.786 kg/m^3

Boiling Point : 65^oC

Melting point : - 97^oC

Critical temperature : $239,43^oC$

Specific heat : 0.5945 cP

Specific gravity : 0.7915

Chemical properties :

- Includes toxic chemicals

- Has no strong additive properties
- Is a good solvent for organic compounds
- Oxidation with strong oxidizers ($KmnO_4$ in acid) produces formic acid and can oxidize further to form CO_2 and H_2O
- Chlorine and brom substitute H atoms of methanol
- React with Na to form H_2 gas and Na salt