



CHAPTER I INTRODUCTION

1.1. Background of the Study

As a developing country, Indonesia have developed projects in many fields. One of them is a project to build the chemical industry. Currently, Indonesia rely on other countries to meet the raw materials of chemical industry, such as Tertiary Butyl Alcohol (TBA).

The development of industry in Indonesia leads to the increase of TBA needs. There are many Indonesian people consume TBA, but there is no plant that produces TBA, so that Indonesia still import TBA from other countries. Therefore, it is appropriate if there are companies that build TBA factories in Indonesia. The purpose is to meet the domestic needs, while also abroad.

The formula of TBA, Trimethyl carbinol or 2-methyl-2-propanol are $(\text{CH}_3)_3\text{COH}$. It is one of the structural isomers, especially which is from the butanol compound. The other isomers are n-butanol (1-butanol), isobutanol (2-methyl-1-propanol), and sec-butanol (2-butanol).

TBA is used as a solvent, for example in the production of Tertiary Butyl Peroxide. TBA can also be used as a base of glycol ether (1-tertiary butoxy-2-propanol), Isobutylene, methyl-tertiary, butyl ether and tertiary butyl phenol. It can also be used as a mixture of oxinol 50 (the mixed gas that consist of methanol and TBA with 1:1 ratio, additives in gasoline, and anti-pollutant of antiknock gasoline. (Mc. Ketta, 1992)

1.2. Design Capacity

Determining the capacity to produce TBA is based on the needs of TBA for the industry in Indonesia as shown in the following table.



Table 1.2.1 Data Import of TBA in Indonesia

No.	Year	Capacity (Ton)
1	2006	12,641
2	2007	9,983
3	2008	12,870
4	2009	17,926
5	2010	20,812
6	2011	21,773
7	2012	23,495

(Source: Biro Pusat Statistik, import data for 2006-2012)

Based on the existing plant in Shell, California; by using the same process (production capacity is 35,000 tons per year), then the design capacity is 80,000 tons per year. It is set as 80,000 tons per year because:

1. It can meet the domestic demand. It is estimated to increase from year to year as a product of the plant.
2. It opens opportunities for other industries that use TBA as a raw material to grow in Indonesia.

1.3. Location

Geography gives a major influence on the success of the industry. Therefore, the determination of the location should be based on a consideration, both technically and economically include: costs of production, the distribution of the raw materials and products, without ignoring the environmental sustainability.

TBA plant in the industrial district of Balongan, Indramayu, West Java is selected following considerations:



1. The Raw Materials

The raw materials that is used to make TBA is Isobutylene and water. The raw materials of Isobutylene is purchased from Pertamina, Balongan, West Java, then water is taken from Cimanuk River. Because of the reason, then we build the plant on that area.

2. Marketing

TBA is used as raw materials of glycol ether, tertiary butyl peroxide, methyl-tertiary butyl ether and tertiary butyl phenol. The location can affect the price and transportation cost. If the plant is near to the central market, then it will be a good consideration for the owner of the plant. Because of the distance, the costumer can reach the product easily.

3. Labor

Because of the plant is located in Java, the plant can get the work force easily.

4. Characteristic of the Location

It is about climate. It includes social society whether they can accept the plant and its expansion.

5. Waste Disposal

If the plant can control the waste well, then the plant doesn't produce dangerous waste. The waste of TBA is low water.

6. Government Policy

In building the plant needs government policy, industrial policy, the case of the work force salary, and its plant.

7. Transportation and Telecommunication

It is relative. We assume that if there is a plant, then the transportation and communication are available.

8. Utility

The main utilities are water, steam, fuel, and electricity. Electricity be gotten from PLN and generator. Fuel can be gotten from Pertamina or other petroleum. Water can be gotten from the river around the plant.



Based on several considerations, then Balongan is the appropriate district as the location of the plant.

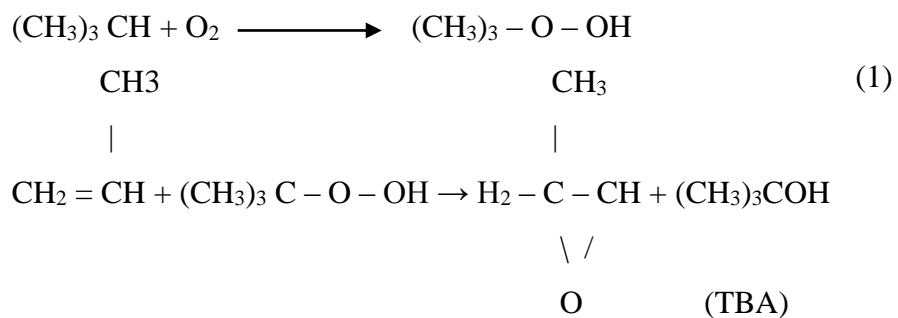
1.4. Literature Review

1.4.1. Process Selection

There are some processes to produce TBA:

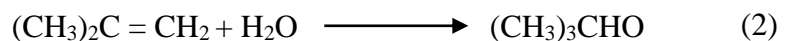
1. Oxirane Process

Producing Propylene oxide from the oxidation of Isobutylene and propylene in liquid phase. This process will produce TBA as second product.



2. Process of Isobutylene Hydration

This is a production process of TBA by added water to Isobutylene. Usually it called by hydration. Then the reaction is:



With a temperature of 70°C and a pressure of 1.4 atm at Isobutylene conversions, then it forms TBA with 85% on the bubble reactor.

It is use Isobutylene hydration process, because:

1. TBA is main product.
2. The conversion Isobutylene to TBA is 85%.
3. Low temperature
4. No bad effect.



1.4.2. The Use of the Product

TBA is used for:

1. Increasing octane without pollution.
2. Dissolving denaturation of ethanol.
3. Stabilizer of Chlorohydrocarbon.
4. The raw materials of methyl methacrylate's oxidation and esterification.
5. The raw materials of ether glycol, tertiary butyl phenol.

(Othmer, 1980)

1.4.3. Physical and Chemical Characteristic of Raw Materials and Products

1.4.3.1. Isobutylene

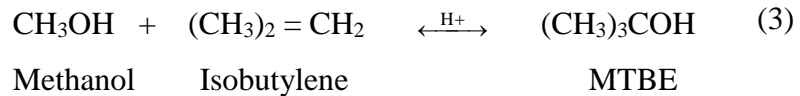
a. Physical Characteristic

Molecular formula	: C ₄ H ₈
Form at 1 atm 25°C	: Gas
Molecular weight, (gr/gr mol)	: 56.11
Boiling point, (°C)	: - 6.75
Freezing point, (°C)	: -140.36
Critical Temperature (°C)	: 144.9
Critical Pressure (Mpa)	: 4.00
Critical density (g/cm ³)	: 0.239
Density of gas (kg/m ³)	: 588.74
Viscosity (cp)	: 0.00816
ΔH _f at 25°C, 1 atm, (kJ/kmol)	: - 16.91
H _{vap} at 25°C, 1 atm, (kJ/kmol)	: 20.27
ΔG _f at 25°C, 1 atm, (kJ/kmol)	: 58.11
cp at 25°C, 1 atm, (J/mol K)	: 90



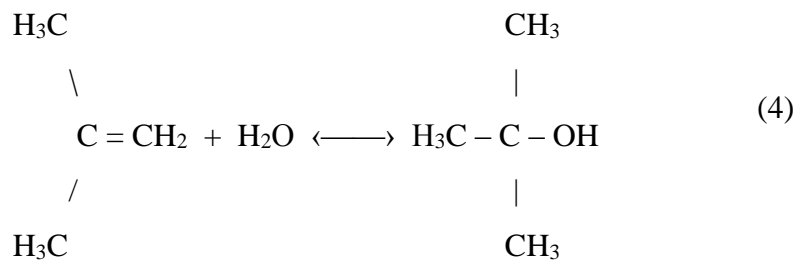
b. Chemical Reaction

1. Isobutylene reacts with ethanol using ion exchanger catalyst at liquid phase forms methyl tertiary butyl ether.

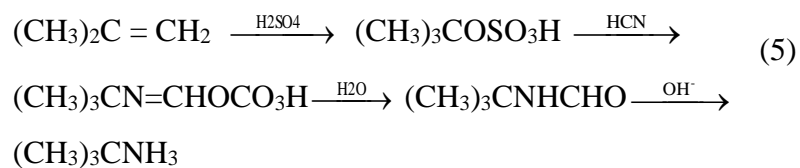


2. Hydration

The reaction of Isobutylene produces TBA.

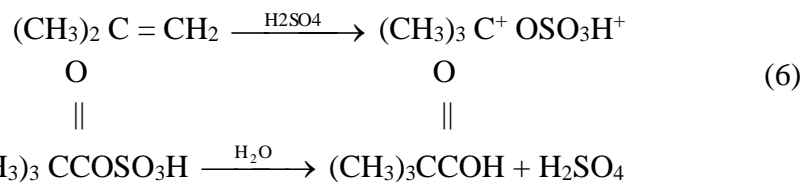


3. Tertiary butyl amine is produced from the reaction of Isobutylene with sulfuric acid followed by reaction with cyanide.

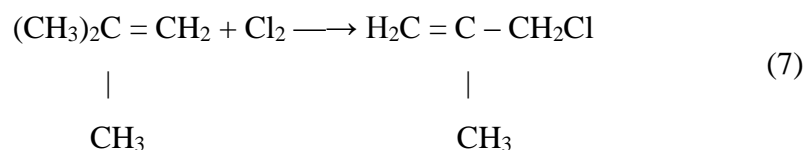


4. Hydrocarboxylation

The reaction of Isobutylene with carbon dioxide and strong acid as H_2SO_4 or HF produce pivalic acid. Generally, the reaction conditions are at a pressure of 2-10 MPa (about 20-100 atm) and temperature of 40-150°C.



5. Isobutylene reaction with chlorine are produce methyl allyl chloride.





6. Polymerization

In an inert solvent at temperature of 10-100°C, the polymerization of Isobutylene produce high-purity of poly-Isobutylene. The polymerization of Isobutylene in a mixture of butane by AlCl_3 at temperatures of 10-80°C, produces poly-Isobutylene, a little n-butene, and Isobutylene as chain terminator. At the molecular weight of 300-2500 and 80-95% purity the Isobutylene is converted to polymer.

7. Oligomerization

Oligomerization of Isobutylene done with Isobutylene and a mixture of butane extraction. It uses 65-70% of the weight of H_2SO_4 by heating to 100°C. This process is called cold acid process. Other processes use acidic ion-exchange resin. Mostly, the product of oligomers Isobutylene are 2.2.4-trimethyl pentene.

1.4.3.2. Tertiary Butyl Alcohol

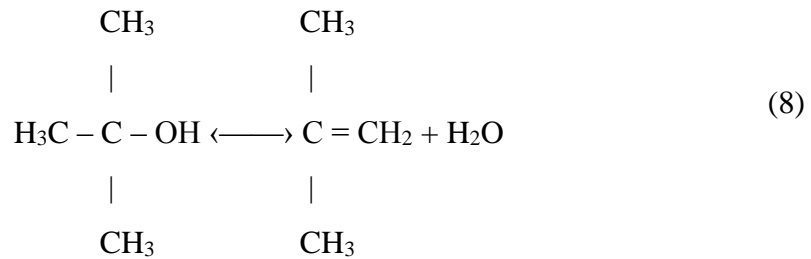
a. Physical Characteristics

Molecular formula	: $\text{C}_4\text{H}_9\text{O}$
Form at 1 atm, 25°C	: Liquid
The molecular weight, (gr/gr mol)	: 74.2
Boiling point, (°C)	: 82.5
Freezing point (°C)	: 25.66
Critical pressure, (kPa)	: 3973
Critical Temperature, (°C)	: 233.06
Specific volume, (m^3/kgmol)	: 0.275
Density of Liquid 25 °C, (kg/m^3)	: 782.28
Viscosity, (cp)	: 3.3
Solubility in water	: soluble in all comparison

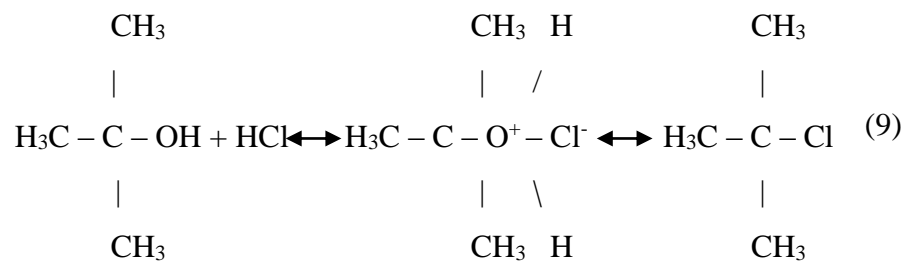


b. Chemical Characteristics

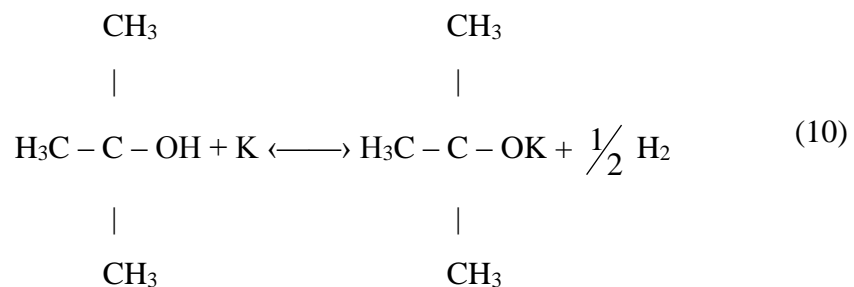
1. The dehydration of TBA produces Isobutylene



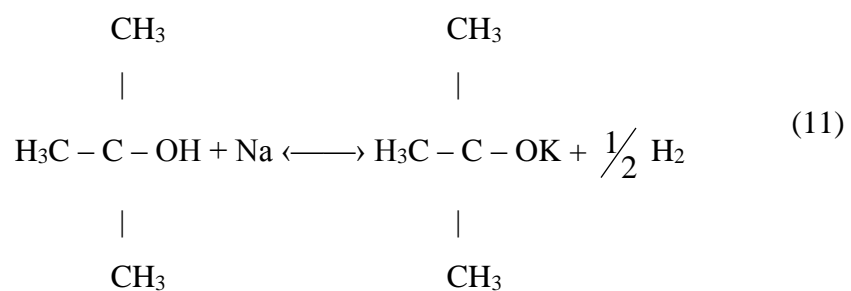
2. Reaction of TBA with halogen acid (ex: HCl) produce tertiary alkyl halide



3. Reaction of TBA with potassium metal produces tert-butoxide and hydrogen.



4. Reaction of TBA with sodium metal produce sodium tertiary butoxide and hydrogen.





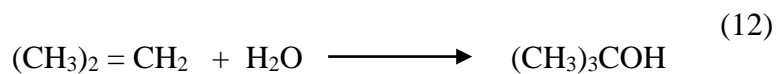
1.4.3.3. Butyl Alcohol

a. Physical and Chemical Properties

Chemical Formula	:	C ₄ H ₉ OH
Form at 25°C	:	Liquid
Melting Point (°C)	:	-89.9
Boiling Point (°C)	:	117.6
Density at 25°C (g/cm ³)	:	0.809-0.811
Vapor Pressure at 25°C	:	0.56
Solubility at 20°C	:	66
Viscosity (cP or mPa at 25°C)	:	2.947

1.4.4. Process Review

The reaction of the formation of TBA is hydration reactions. The reaction is



Operating conditions at a temperature of 70°C and a pressure of 1.4 atm with the conversion of Isobutylene form TBA 85%.

In the liquid phase, it has a value of standard enthalpy change – 19.667 kJ/kmol = - 4698.4463 kcal/kmol, so this reaction is exothermic.