PRELIMINARY DESIGN OF MELAMINE PLANT

USING BASF PROCESS WITH CAPACITY OF 30,000 TONS/YEAR

Compiled as a Requirement to Achieve Bachelor Degree in Chemical Engineering

Universitas Muhammadiyah Surakarta

Oleh:

Usman Lehni

D500102004

CHEMICAL ENGINEERING DEPARTMENT

FACULTY OF ENGINEERING

UNIVERSITAS MUHAMMADIYAH SURAKARTA SURAKARTA

2018

APPROVAL SHEET

FINAL PROJECT

PRELIMINARY DESIGN OF MELAMINE PLANT USING BASF PROCESS WITH CAPACITY OF 30,000 TONS/YEARS

SCIENTIFIC PUBLICATION

Presented by:

Usman Lehni

D 500 102 004

Has been reviewed and approved by:

Supervisor

Tri Widayatno, S.T., M.Sc., Ph.D.

NIK. 960

VALIDATION SHEET

PRELIMINARY DESIGN OF MELAMINE PLANT USING BASF PROCESS WITH CAPACITY OF 30,000 TONS/YEARS

Presented by:

Usman Lehni

D500102004

Has been maintained in front of the Examiners Board

Chemical Engineering Department

Universitas Muhammadiyah Surakarta

Day……26 January…….2018

Examiners:

1. Tri Widayatno, S.T., M.Sc., Ph.D. (………………………) (Supervisor)
2. Ir.Herry Purnama, M.T., Ph.D. (………………………) (1^{st}Examiners)
3. Rois Fathoni, ST, M.Sc, Ph.D (………………………) (2^{nd}Examiners)

Dean,

an Wakil Dekan 1.

Dr.Ir.Dhani Mutiari MT.

THESIS AUTHENTIC STATEMENT

UNIVERSITAS MUHAMMADIYAH SURAKARTA

FACULTY OF ENGINNERING

DEPARTMENT OF CHEMICAL ENGINEERING

Hereby, we:

Name	:	Usman Lehni
Student ID	:	D500102004
Study Program	:	Chemical Engineering
Thesis Title	:	Preliminary Design of Melamine Plant Using BASF Process with Capacity of 30,000 Tons/Year

declared in truth that this thesis that we compiled is the result of our own work. Except quotations and summaries that are referenced from the respective sources.

Surakarta, ... January 2018

Author

PRELIMINARY DESIGN OF MELAMINE PLANT

USING BASF PROCESS WITH CAPACITY OF 30,000 TONS/YEAR

ABSTRAK

Desain Pabrik Melamin Menggunakan Proses BASF dengan Kapasitas 30.000 Ton / Tahun diharapkan dapat dioperasikan selama 330 hari per tahun untuk memenuhi kebutuhan melamin di dalam negeri dan luar negeri. Pabrik ini rencananya akan didirikan di kawasan industri Kujang Cikampek, Jawa Barat. Reaksi pembentukan melamin dari urea melalui reaksi dua tahap, tahap pertama penguraian urea menjadi asam isosianat dan amonia, pada tahap kedua asam isosianat berubah menjadi melamin dan karbon dioksida.

Proses ini menggunakan katalis alumina (Al2O30. Reaksinya adalah endotermik yang terjadi pada reaktor unggun terfluidisasi dengan suhu 395 ℃ dan tekanan 3 atm, non-adiabatik, non-isotermal, fase gas-padat, tidak dapat dipulihkan, pemanasan dalam bentuk garam cair Konversi untuk reaksi ini adalah 95% dengan yield 93% Produk yang diperoleh adalah melamin kristal padat. Peralatan utama yang digunakan adalah: melter, tangki penyimpanan, scrubber, reaktor unggun terfluidisasi, separator siklon dan kristalizer. Kebutuhan Urea untuk tanaman ini sebanyak 13.561,55 kg / h Produk melamin sebanyak 7.410,40 kg / jam Unit utilitas melibatkan unit suplai uap jenuh sebanyak 1771.277 kg / jam yang diperoleh dari boiler dengan bahan bakar diesel, dikompres udara sebanyak 100 m ^ 3 / jam, pasokan air sebanyak 1280,18 m ^ 3 / hari yang diambil dari Parungkadali, bendungan dan sungai Cikao, permintaan listrik diperoleh dari PLN dan dua set generator 486,18 kW Sebagai cadangan, dengan bahan bakar sebanyak 1699.312 liter SH. Perseroan adalah Perseroan Terbatas dengan sistem manajemen lini dan staf. Karyawan bekerja sesuai dengan pembagian kerja dan pekerjaan masing-masing dan dibagi menjadi shift pegawai dan non shift.

Investasi Modal Tetap, yang digunakan untuk mendirikan pabrik adalah sebesar Rp 285.479.273.986,62 dengan Modal Kerja Rp 155.816.597.194,14. Biaya produksi yang dibutuhkan adalah Rp 582.855.786.634,71. Analisis ekonomi menunjukkan bahwa laba setelah pajak (Laba Penjualan Setelah Pajak) adalah 10,98%. Return on Investment (ROI) setelah pajak sebanyak 26,60%. Pay out Time (POT) adalah 2,89 tahun. Break Even Point (BEP) sebesar 45,59% sedangkan kapasitas produksi Shut Down Point (SDP) sebesar 29,84%. Arus Kas Discounted dari desain adalah 42,96%

ABSTRACT

Preliminary Design of Melamine Plant Using BASF Process with Capacity of 30,000 Ton/Years is expected to be operated for 330 days per year to meet demand of melamine domestic and abroad. This plant is planned to set up in the industrial area Kujang Cikampek, West Java. Reaction formation of melamine from urea via a two stage reaction, the first *stage of decomposition of urea into isocyanate acid and ammonia,in the second stage isocyanate acid turns into a melamine and carbon dioxide.*

This process uses a catalyst of alumina (Al2O30. The reaction is endothermic which takes place in fluidized bed reactor with a temperature of 395 ℃ and a pressure of 3 atm, non-adiabatic, non-isothermal, gas-solid phase, irreversible, heating in the form of molten salt. Conversions for this reaction is 95% with a yield of 93%. The product obtained is crystalline solid melamine. The main tools used are: melter, storage tank, scrubber, fluidized bed reactor, cyclone separator and crystallizer. Urea requirement for this plant as much as 13,561.55 kg/h. The product is melamine as much as 7,410.40 kg/h. the utility units involves saturated steam supply unit as much as 1771.277 kg/h obtained from the boiler with diesel fuel, compressed air as much as 100 m^3/h, the supply of water is as much as 1280.18 m^3/day taken from Parungkadali, dam and river Cikao, the demand for electricity is obtained from the PLN and two sets of 486.18 kW generator as a backup, with fuel as much as 1699.312 liters/h. the company is Perseroan Terbatas with a system of line and staff organization. Employee working in accordance with the division of labor and the work of each and divided into employee shift and non-shift.

The Fixed Capital Investment, which is used to establish a factory is Rp 285,479,273,986.62 with Working Capital Rp 155,816,597,194.14. The required production cost is Rp 582,855,786,634.71. Economic analysis shows that the profit after tax (Profit on Sales After Tax)is 10.98%. Return on Investment (ROI) after taxes is as much as 26.60%. Pay out Time (POT) is 2.89 years. Break Even Point (BEP) in value of 45.59% while the production capacity of the Shut Down Point (SDP) in the value of 29.84%. Discounted Cash Flow of the design is 42.96%.

1. INTRODUCTION

1.1 Background

Current development in the industrial sector in Indonesia has increased. One of them is chemical industry. Indonesia still imports raw materials or chemical industry products from abroad, so it needs an effort to tackle the import dependence by establishing factories to meet domestic needs. The number of needed industries is quite a lot and is usually obtained by importing from other countries.

Melamine is a raw material produced by the petrochemical industry with the formula of $C_3H_6N_6$ Also known by the name of 2-4-6 1-3-5 triamino triazine. This crystal-shaped monocyclic compound is white. Melamine is used as raw material for the manufacture of melamine resins, organic synthesis, materials mixer paint, coating paper, textiles, leather tanning, and others.

Knowing that the demand of melamine is high, the establishment of a melamine plant is very necessary. This aims to anticipate the demand in the country, to reduce the import of melamine and to open the new workforce.

1.2 Design Capacity

Determination of melamine plant capacity with consideration of the following considerations:

1. Estimated needs of melamine in Indonesia

Development of melamine consumer in several industries, such as molding industry, adhesive industry and surface coatings industry lead to the increasing of the needs of melamine in Indonesia. Indonesia currently has two factories producing melamine ie:

a. PT. Melamine Sri Rejeki (SMR)

PT SMR Began in 1994 with a production capacity of 20,000 tons / year. This plant gets its supply of raw materials from PT Pupuk Sriwijaya Palembang.

b. PT. DSM Kaltim Melamine

PT. DSM Kaltim Melamine started operations in 1996, as a result of cooperation between East Kalimantan Fertilizer Tbk and DSM Holland. Capacity design of this plant was 40,000 tons / year and has been raised to 50,000 tons / year.

The following table shows the data of production and import of melamine in Indonesia from 1997 to 2007.

Table 1. Data of Demand of Melamine In Indonesia from 2010 to 2015 (mcgroup.co.uk)

No.	Year	Import (ton)
1	2010	16,669
2	2011	18,141
3	2012	19,989
4	2013	22,345
5	2014	23,412
6	2015	23,936

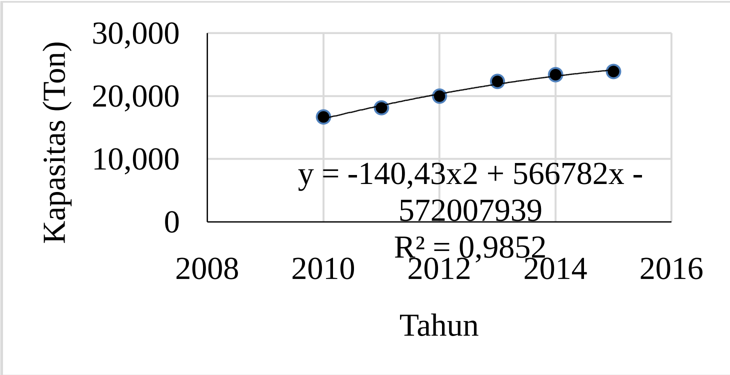


Figure 1. Graph of Relationship between 2010 – 2015 Import Capacity per Year

If polynomial regression is applied with orde 2, equation obtained is:

$y = -140{,}43x2 + 566782x - 572007939$

with: y = amount of melamin needs (ton/year) x = year

So approximately in the year 2020, melamine needed in Indonesia will be ± 28.931 ton/year.

2. Availability of raw materials

Urea is one of raw materials of melamine production, it can be supplied from within the country where the urea production in Indonesia is quite large. It can be seen from the development of urea production in Indonesia that has Increased every year and has been exported in large quantities. The following table shows the data of production of urea and urea export development in Indonesia until the year 2015.

Tabel 2. Growth of Urea Production and Export from 2010 to 2015 (appi.or.id)

Year	Production (ton)	Export (ton)
2010	6,721,948	879,196
2011	6,743,422	750,430
2012	6,907,236	989,612
2013	6,698,349	1,359,109
2014	6,742,366	1,107,880
2015	6,916,563	831,894

From the data above, the establishment of melamine plant is very precise to be conducted in Indonesia.

3. Commercial Capacity

Based on the Data (Ullman, 2003), the capacity of a melamine plant in the world Reaches 10,000 to 90,000 tons / year. Table 3 shows the Data of melamine producer has been running in the world.

Table 3. Data of Production Capacity of Melamine Plant in the World (Ullman, 2003)

Name of Country	Company	Capacity (tons / year)
Germany	BASF	42,000
Netherland	DSM	90,000
United Sates	melamine Chemical	47,000
Japan	Mitsui Toatsu	38,000
Taiwan	Taiwan Fertilizer	10,000

Based on Reviews These three considerations, the design of this melamine plant is set with a capacity of 30,000 tons / year to meet domestic needs and the rest to be exported.

I.3 Determination of Plant Location

The selected location for the establishment of this melamine plant is Cikampek, West Java. Site selection is based on the following considerations:

1. Raw Materials Availability

   Raw material of melamine urea production is the which can be supplied from PT Pupuk Kujang Cikampek in West Java.

2. Market Sector

   Industrial needs of melamine in Java involves PT Arjuna Utama Karya roomates manufactures adhesive materials and others.

3. Fuel and Energy Availability

   Cikampek is an industrial area so that the provision of fuel and energy can be met properly

4. Water Supply

   Water needs for the production process can be obtained from river Parungkadali and river Cikao.

5. Transport

   The transportation is affordable by highway and railway for land, and the harbor for water transportation.

6. Labor

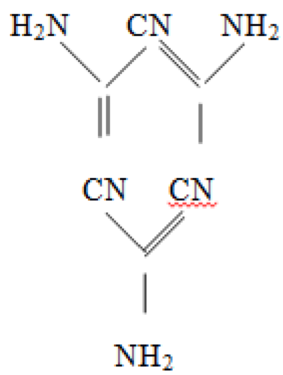
   Cikampek district is located not far from Jakarta area which is loaded with formal educational institutions that have the potential of experts and non-experts in terms of both quality and quantity.

7. Site characterization

   Cikampek is an industrial area so as to the establishment of a plant will be easier.

1.4 Literature review

Melamine was first studied by Leibig in 1834 (Ullman, 2003). At that time Leibig get melamine from the smelting process between potassium thiocyanate with ammonium chloride. Then in 1885 AW Von Hoffman published the molecular structures of melamine, as follows:



Melamine is often found in industrial applications for the production of melamine formaldehyde resin. In about 1960, melamine was produced from dicyanamid (Ullman, 2003). This process takes place in an autoclave at a pressure of 10 MPa and a temperature of 400^{o}C in the presence of ammonia gas.

In early 1940, Mackay found that melamine can also be synthesized from urea at a temperature of 400^{o}C with or without a catalyst. Since then melamine begin production of the raw material urea (Ullman, 2003).

1.4.1 **Miscellaneous Process**

According to Ullman, (2003) melamine can be synthesized from urea at temperature of 350 - 400^{o}C with equation (1.1) as follows:

$$6\ H_2N - CO - NH_2 \longrightarrow C_3N_3(NH_2)_3 + 6\ NH_3 + 3\ CO_2 \text{..............(1.1)}$$

The reaction is endothermic requires 629 kJ / mol melamine. Broadly speaking, the process of making the melamine can be classified into two:

1. Low pressure process (1MPa) by using a catalyst.
2. High pressure process (≥8 MPa) without using a catalyst.

Each process consists of three stages, namely stage of the synthesis, recovery and purification of melamine and flue gas treatment.

Low Pressure Process by Using Catalyst,

Low pressure process with catalysts uses fluidized bed reactor at atmospheric pressure of 1 MPa at a temperature of 390 - 410^{o}C. Fluidizing gas used is pure ammonia or a mixture of ammonia and carbon dioxide formed during the reaction. The catalysts used are silica and alumina.

Melamine leaves the reactor in the form of gas along with the fluidizing gas. Then it is separated from ammonia and carbon dioxide gas quenching using water (followed by crystallization) or sublimation. The first step is the decomposition of urea into ammonia acid isocyanate and then converted into melamine. Reaction mechanism:

$$6\ (NH_2)_2CO \longrightarrow 6\ NH{=}C{=}O + 6\ NH_3 \qquad \Delta H = 984 kJ / mol\text{...(1.2)}$$

$$6\ NH{=}C{=}O \longrightarrow C_3N_3(NH_2)_3 + 3\ CO_2 \quad \Delta H = -355\ kJ / mol\text{..(1.3)}$$

$$6\ (NH_2)_2CO \longrightarrow C_3N_3(NH_2)_3 + 6\ NH_3 + 3\ CO_2 \quad \Delta H = 629\ kJ / mol\text{…(1.4)}$$

yield obtained reaches 90-95%.

There are three processes at low pressure, namely:

BASF (Badische Anilin and Soda Fabric)

According to Ullman, (2003) BASF process uses a single stage reactor, where molten urea is fed to the fluidized bed reactor at a temperature of 395 - 400^{o}C at atmospheric pressure. The catalyst used is alumina with a fluidizing gas such as ammonia and carbon dioxide. Reactor temperature circulation is maintained by using a molten salt heating coils. The products coming out of the reactor is a gas composed of a mixture of melamine, unreacted urea, biuret, ammonia and carbon dioxide. The catalyst that brought the gas flow was detained on the cyclone separator in the reactor. The gas mixture is cooled in a cooler until the dew point temperature of the product gas mixture.

The gas mixture then enters into crystalizer then mixed with the off gas which has direcycle at a temperature of 140^{o}C to crystalline melamine. More than 98% of the melamine can crystallize (Ullman, 2003). The resulting melamine crystals are separated from the gas mixture by using a cyclone. Recycle gas from the cyclone flowed into the scrubber or washing tower to take urea out of action, and the gas is used as fluidizing gas to the reactor and the cooling medium in crystalizer. This process can result in melamine with a purity of 99.9%.

Melamine Chemicals Process

This process produces melamine with a purity of 96 to 99.5%. Molten urea is converted into melamine in a tubular reactor at a temperature of 370 - 425^{o}C and a pressure of 11-15 MPa, the liquid melamine is separated from the off gas in the gas separator where melamine products will be collected at the bottom. The products are out in-quenching with liquid NH_3 in refrigeration units, the resulting conversion is 99.5%. The molten urea is fed to the reactor at a temperature of 150^{o}C. The reaction mixture leaving the reactor into the quencher then is quenched with liquid NH3 and CO_2 to precipitate melamine. NH3 and CO_2 is separated at the top quencher direcycle to the urea plant.

.

1.4.2 **Product usability**

Usefulness of melamine which can be used as raw material for the manufacture of melamine resins, organic synthesis materials, tannery, and others. Here are some of the industries that use melamine as raw materials.

1. Adhesive Industry

   An industry that produces adhesive for industrial uses such as industrial woodworking plywood, blackboard industry, industrial particleboard.

2. Molding Industry

An industry of which generate household appliance.

3. Surface Coating Industry

Is an industry that produces paints, thinners, putty.

4. Laminates Industry

Industry that produces furniture.

Table 4 shows the percentage of data use melamine some developed countries in the world.

Table 4. Percentage of the use of melamine in some countries (Ullman, 2003)

Use	Europe (%)	United States of America (%)	Japan (%)
Laminates	47	35	6
Glue, adhesive	25	4	62
Molding industry	9	9	16
Coating	8	39	12
Paper and textiles	11	5	3
Etc	-	8	1

1.4.3 The physical and chemical properties of raw materials and products

a. The physical and chemical properties of raw materials.

The physical properties of urea (Ullman, 2003):

- Molecular formula : NH_2CONH_2
- Molecular weight : 60.06 g / mol
- Melting Point (1 atm) : 132.7 ^oC
- Boiling point (1 atm) : 195^oC
- Form : colorless crystals
- Bulk density : 0.74 g / cc
- Density (ρ) : 1.335 g / cc

➢ The chemical properties of urea (Ullman, 2003):

- Reacts with formaldehyde to form monometilourea and dimetilourea depending on the ratio of urea and formaldehyde

- In the vacuum pressure and a temperature of 180 - 190°C will sublimate into ammonium cyanat (NH_4OCN)
- At high pressure and the presence of ammonia will change to cyanic acid and acid cynuric

$$3\ (NH_2)_2CO \longrightarrow 3\ HOCN + 3\ NH_3$$
$$3\ HOCN \longrightarrow (NCOH)_3 \quad \text{.......(1.10)}$$

b. The physical and chemical properties of the product

The physical properties of melamine (Ullman, 2003):

- Molecular formula : $C_3N_6H_6$
- Molecular weight : 126.13 g / mol
- Melting Point (1 atm) : 350°C
- Heat of formation (25°C) : 71.72 kJ / mol
- Heat of combustion (25°C) : -1976 kJ / mol
- Sublimation heat (25°C) : -121 kJ / mol
- Density (ρ) : 1.573 g / cm^3
- Heat capacity (Cp)
  - At 273 -353K : 1470 J kg^{-1} K^{-1}
  - At 300 - 450K : 1630 J kg^{-1} K^{-1}
  - At 300 - 550K : 1720 J kg^{-1} K^{-1}

- Solubility at 300°C in g / 100 ml
  - Ethanol : 0.06 g / 100 cc
  - Aceton : 0.03 g / 100 cc
  - Water : 0.5 g / 100 cc
- Entropy (25°C) : 149 JK^{-1} mol^{-1}
- Energy gibs (25°C) : 177 kJ / mol
- Entropy formation (25°C) : -835 $JK^{-1}mol^{-1}$
- Critical temperature : 905.56°C
- Critical pressure : 99.47 atm

❖ Melamine chemical properties: (Ullman, 2003)

- Hydrolysis with a base, when reacted with NaOH to form Ammeline / ammelide
- Salt formation

  Melamine is a weak base which will form salts by reaction with organic or inorganic acids. Where the salt solubility of melamine is not too high when compared with melamine-free.
- The reaction with the aldehyde, melamine reacts with the aldehyde to form an assortment of the most important product is the reaction with formaldehyde to form a resin.

  $Me(NH_2)_3 + 6\ CH_2O \longrightarrow Me(N(CH_2OH)_2)_3$ ……………………………….(1.11)

  Me is a molecule of melamine in which all the hydrogen atoms contained in the melamine was replaced with the group methyloland produce products from Monomethylol to hexamethylol melamine. Methylolmelamin slightly soluble in most solvents and highly unstable because it was followed by a reaction resinification / condensation.

  Reaction:

  $MeNHCH_2OH + H_2N\text{-}Me \longrightarrow MeNHCH_2NHMe + H_2O$

  $2\ MeNHCH_2OH \longrightarrow MeNHNH_2OCH_2NHMe + H_2O$ ………………(1.12)

  In the melamine condensation product has special properties that are resistant to heat and water well.

1.4.4 **Process Overview**

Raw materials such as urea prill which is melted at melter then flowed into the tank. From the tank, the molten urea is used partly to absorb the off gas and partially fed to the reactor through a nozzle. The catalyst used is alumina, while the medium used for the fluidization use recycled gas preheated to a temperature of 400^{o}C. Heating coil in the reactor is used to maintain a constant temperature of the reactor at a temperature of 395^{o}C.

Urea is injected through a nozzle to evaporate spontaneously and the reaction will occur as follows:

$6\ (NH_2)_2CO \longrightarrow C_3N_3(NH_2)_3 + 6\ NH_3 + 3\ CO_2$ ……………….(1.14)

Conversion reaction of about 95% and 93% process yield. Melamine, unreacted urea, biuret, ammonia and carbon dioxide is formed out of the reactor together. During the reaction, no additional catalyst for catalyst deactivation occurred during 3 years.

2. METHOD

2.1 Concept of Process

Reaction formation of melamine from urea takes place via two-stage reaction. The first step is the decomposition of urea into isocyanate acid and ammonia, the second stage turned into a melamine isocyanate acid and carbon dioxide. This process uses a catalyst of alumina oxide (Al_2O_3).

The mechanism of the reaction is as follows:

1. Decomposition of urea into ammonia and acid isocyanate

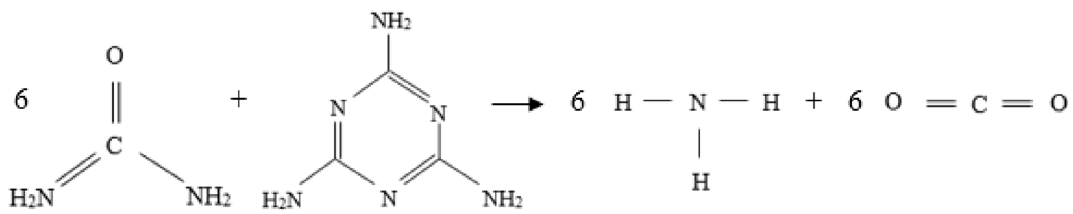
   $6\ (NH_2)_2CO \longrightarrow 6\ NH = C = O\ + 6\ NH_3$......................................(2.1)

2. Acid isocyanate transformed into melamine and carbon dioxide

   $6\ NH = C = O \longrightarrow C_3N_3(NH_2)_3 + 3CO_2$ .... (2.2)

   $6\ (NH_2)_2CO \longrightarrow C_3N_3\ (NH_2)_3 + 6NH_3 + 3CO$ .... (2.3)

Mechanism Structural Formula:



The manufacturing process from raw material urea melamine is executed on the condition:

- Reactor : fluidized bed reactor
- Temperature : 395^oC
- Pressure : 3 atm
- Catalysts : Al_2O_3

2.2. Overview of Thermodynamics

The concept of a review of thermodynamics in reaction with melamine forming reaction is intended to equation (2.2):

$6(NH_2)_2CO(g) \longrightarrow 6NH{=}C{=}O + 6NH_3$ .... (2.4)

$6\ NH{=}C{=}O \longrightarrow C_3N_3(NH_2)_3 + 3CO_2$ ....(2.5)

$6(NH_2)_2CO \longrightarrow C_3N_3(NH_2)_3 + 6NH_3 + 3CO_2$ .... (2.6)

This reaction is a reversible reaction seen from the value of K (constant equilibrium of the reaction) which can be calculated from equation (Smith - Van Ness, 1996):

2.3 Kinetics Overview

Reaction formation of products:

$6(NH_2)_2CO \longrightarrow C_3N_3(NH_2)_3 + 6NH_3 + 3CO_2$ .... (2.7)

Surveys kinetics can be seen from the melamine forming reaction residence time at temperature T = 395°C. The reactor used is a fluidized bed reactor so that the temperature can be considered uniform although for correcting highly exothermic (Ullman, 2003). So apply equation (Levenspiel, 1999):

For Melamine Plant with BASF process with T = 395°C Data obtained:

The residence time = 1800 seconds (US. Patent, 7.153.962.BI)

Conversion of urea = 95% (Ullman, s, 2003)

Reaction rate equation:

3. RESULT

3.1 Reactor

Code	: R-101
Function	: Reacting urea into $C_3H_6N_6$, CO_2 and NH_3
Type	: Fluidized bed reactor
Amount	: 1
Total height	: 13.347 m
Volume reactor	: 8,336.190 m^3
Total disengaging head	: 5.68 m
Reaction zone height (Lf)	: 4.77 m
Lower head height (Lh)	: 0.68 m
Freeboard diameter (Df)	: 3.52 m
Reaction zone diameter (Dt)	: 2,3 m
Thickness	: 0.0086 m (0.34 in)
Construction material	: SA 30 grade steel plate Firebox A
Operating conditions	: T = 395^{o}C, P = 3 atm

3.2 Compressor

Code	: G-101
Function	: Raise the exit gas pressure of scrubber (D-101) of P = 1.25 atm to 3.8 atm
Type	: Centrifugal compressors
Flow rate	: 30961.69 m3 / h
Construction material	: Stainless steel type 302
Theoretical work	: 3,802.56 kJ / hr
Actual work	: 5,432.22 kJ / hr
Power	: 2318.64 HP
Motorcycle	: 3,000 HP

3.3 Crystalizer

Code	: X-101
Function	: crystallizing $C_3H_6N_6$ as much 52,919.166 kg / hr
Type	: Swanson Walker Crystallizer
Operating conditions	: T sign = 270^{o}C, T out = 200^{o}C, P = 1 atm
	ΔT_{LMTD} : 107,62^{o}F = 59,789^{o}C
Dimension	: 1. Wide : 1.2192 m
	2. Long : 3.048 m
	3. Diameter : 0.9144 m
Rotary speed	: 8 rpm
Jacket thickness	: 14 in (0.3556 m = 1.1667 ft)
Uc	: 39.2671 Btu / (hr) (ft2) (oF)
UD	: 32.8230 Btu / (hr) (ft2) (oF)
Extensive heat transfer	: 49.844 ft^2
Volume	: 49.455 ft^3
The residence time	: 0.5 hours
Motor power	: 2 HP
Construction material	: Stainless steel
Amount	: 1 piece

3.4 Process Supporting Unit

Process supporting unit or utility is the unit in charge of providing support facilities to ensure a smooth production process. In preliminary design of melamine plant, utilities required include:

1. Steam supply unit
   This unit serves to meet the needs of the steam used in the production unit. Steam production unit serves as the heating medium melter.
2. Supply and water treatment unit
   This unit serves to provide clean water as cooling water, boiler feed water, sanitation and water hydrant.
3. Power plant unit

As a provider of electrical power for propulsion and process equipment for lighting. Electricity is supplied from PLN and as a backup diesel generators.

4. Fuel procurement unit

   As a provider of fuel for the process equipment.

5. Compressed air provider unit

   Providing compressed air to run the instrument in all areas of process and utility.

6. The wastewater treatment unit

   This unit serves to process the waste produced by the plant, both waste from the production process and outside of the production process before being discharged into the environment.

3.5 Laboratory

The existence of the laboratory in a factory is very important to control the quality of production. The analysis carried out in the framework of quality control includes the analysis of raw materials, process analysis and analysis of product quality.

Laboratory work programs generally include:

1. Analyzing raw materials and auxiliary materials to be used
2. Analyzing the product to be marketed
3. Conducting experiments in connection with the production process
4. Checking the levels of substances that can cause pollution in the factory effluent

4. CONCLUSION

Factory Melamine BASF process 30,000 tons per year capacity plant is classified low risk, because the atmospheric operating conditions, the supply of raw materials close by, and an export commodity. The results of the economic feasibility analysis is as follows:

1. Profit before tax of Rp 108,500,213,365.29 per year.
   Profit after tax Rp 75,941,399,355.70 per year.
2. ROI (Return On Investment) before taxes 38.01%
   ROI (Return On Investment) after tax 26.60%
   ROI before taxes for low-risk plant a minimum of 11%.
3. POT (Pay Out Time) before tax 2.17 years.
   POT (Pay Out Time) after tax of 2.89 years.
   POT before taxes for low-risk plant 5 years maximum before tax.
4. BEP (*Break Even Point*) Amounted to 45.59%and SDP (Shut Down Point) amounted to 29.84%. BEP for chemical plants generally range between 40% - 60%.
5. DCF (Discounted Cash Flow) amounted to 42.96%. DCF acceptable to be greater than the interest on the loan at the bank, the bank rate is currently around 25%.

Economic analysis of the calculation of the above can be concluded that the plant BASF's melamine process capacity of 30,000 tons per year is feasible to set up.

REFERENCES

Ahyari, A, 1983, *Managemen Produksi : Perencanaan Sistem Produksi*, ed 3, BPFE, Yogyakarta.

Aries and Newton, 1995, *Chemical Engineering Cost Estimation*, Mc. Graw Hill Book Company, New York.

Anonim, 2007, Badan Pusat Statistik.

Anonim, 2003, Chemical Engineering Magazine,*Chemical Engineering Plant CostIndex*.

Bird B., Stewart, W.E, and Lighfoot, E.N, 1960, *Transport Phenomena*, John Wiley and Sons, Inc, Madison Wisconsin, USA.

Brown, G.G., 1978, *Unit Operation*, Modern Asia Edition, Charles E. Tuttle Company, Inc, Tokyo, Japan.

Brownell and Young, 1978, *Process Equipment Design*, John Wiley and Sons, Inc, New York.

Coulson, J.M and Richardson J.F, 1965, *An Introduction to Chemical Engineering Design*, Vol 6, Pergamon Press, Oxford.

Foust, A.S, 1980, *Principle of Unit Operation*, 2nd ed, John Wiley and Sons, Inc, New York.

Holman, J.P, 1997, *Perpindahan Kalor*, ed. 6, PT. Erlangga, Jakarta. http://www.matche.com/EquipCost/.htm

http://www.freepatentsonline.com/result.html?query_txt=melamine+BASF+process&sort=relevance&srch=top&search=
http://www.wartakotalive.com/mobile

http://www.icis.com/home/default.aspx

Kern, D.Q, 1965, *Process Heat Transfer*, International Student Edition, Mc. Graw Hill Co, Inc, Tokyo.

Kirk, R.E and Othmer, D.F, 1981, *Encyclopedia of Chemichal Technology*, 3rd ed, A Willey Interscience Publication, John Wiley and Sons, Inc, New York.

Kunii, D. and Levenspiel, O., 1977, *Fluidization Engineering*, Original Edition, Robert E/ Krieger Publishing Co. New York.

Levenspiel, O., 1999, *Chemical Reaction Engineering*, 2nd ed, John Wiley and Sons, Inc, New York

Perry, R.H and Green, D.W., 1997, *Perry's Chemical Engineer's Hand Book*, 3thed, Mc. Graw Hill Book Co, Inc, Tokyo.

Peters, M.S and Timmerhause, K.D, 1991, *Plant Design and Economics for Chemical Engineering*, 4th ed, Mc. Graw Hill Book Co, Inc, New York.

Rase, F. Howard, 1977, *Chemical Reactor Design Process Plant*, Vol 1, John Wiley and Sons, Inc, New York.

Severn, et all, 1994, *Steam, Air and Gas Power*, John Wiley and Sons, Inc, New York.

Smith, J.M and Van Ness, H.C 1996, *Introduction to Chemical Engineering Thermodynamics*, 5th ed, Mc. Graw Hill Book Company, Singapore.

Swastha, B, 1996, *Asas-asas Managemen Modern*, Liberty, Yogyakarta.

Treyball, R.E, 1981, *Mass Transfer Operation*, 3rd ed, Mc. Graw Hill Book Co, Inc, Tokyo.

Ullman, 2003, *Encyclopedia of Industrial Chemistry*, Vol A 21, VCH, Germany.

Ulrich, G.D, 1984, *A Guide to Chemical Engineering Process Design and Economics*, John Wiley and Sons, Inc, New York.

Yaws, C.L, 1999, *Thermodynamics and Physical Property Data*, Mc. Graw Hill Book Co, Inc, New York