PRELIMINARY PLANT DESIGN OF 60 / WEIGHT NITRIC ACID USING TUBULAR MEMBRANE REACTOR CAPACITY 22,000 TONES/YEAR

No. INDUK
TGL
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DEPARTMENT OF CHEMICAL ENGINEERING
FACULTY OF ENGINEERING
WIDYA MANDALA CATHOLIC UNIVERSITY
SURABAYA

2006

NATIONAL PLANT DESIGN COMPETITION 2006

The Use of Domestic Natural Resources for The Purpose of Creating Self Established Country

HIMPUNAN MAHASISWA TEKNIK KIMIA

INSTITUT TEKNOLOGI BANDUNG, INDONESIA, 24th-25th March 2006

Certificate is awarded to

Mario Ardianto

In recognition of his/her achievement as

The 2nd Winner of Category A

(Chemical Plant Design for National Defense Industry)

Chairman of Himpunan Mahasiswa Teknik Kimia ITB

Lintang Adi Pradana

Chairman of National Plant Design Competition 2006

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Certificate is awarded to

Devarly Prahas

In recognition of his/her achievement as

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Dexalindo

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APPROVAL SHEET

The Final Project

Preliminary Plant Design of 60% Weight Nitric Acid

Using Tubular Membrane Reactor Capacity 22,000 Tones/Year

Prepared and submitted by:

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Surabaya, 12 June 2006

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ABSTRACT

The defensive industry is one of the most important industries in Indonesia. One of them is explosive industry, which needs ammonium nitrate. Nitric acid is one of the strategic materials for defensive industry and also used as an oxidizing agent and as a highly active acid for fertilizer, plastics, pharmaceuticals, dyes, synthetic fibers, insecticides, and fungicides.

Nitric acid can be produced from weak acid process and concentrated acid process. Nitric acid in explosive industries only needs concentration about 59% weights. Therefore, this preliminary plant doesn't have concentrated acid process, which can produce nitric acid up to 100% concentration. Weak acid process with single pressure is used in this preliminary plant. The pressure that is used is a medium pressure (7 atm). The reason for choosing weak acid process is because it is suitable for small or medium capacity plants (nitric acid that is produced which is less than 600 tones/day)

Ammonia liquid is used as raw material in the making of nitric acid. The brief of description process is as follows; ammonia liquid as raw material is vapored using vaporizer then part ammonia vapor formed reacts with oxygen in the air and another part reacts with tail gas formed in the absorber. Reaction between ammonia and oxygen occurs inside the membrane reactor with lanthanum perovskite catalyst. Then gas product flows to heat exchanger network system and reaction between gas product from reactor with water form nitric acid is occurred all the way to heat exchanger network system. Nitric acid with 40% concentration is formed after partial condensation inside cooler condenser. This nitric acid then flows to the bottom of absorber to react and be absorbed with water to form nitric acid with 60% concentration all at once. Uncondensed vapor in cooler condenser then flows to the middle of absorber to be reacted and absorbed by H_2O to form nitric acid with 60% concentration all at once. To reduce tailgas emission that is produced, tailgas will be reacted with NH_3 inside SCR reactor to form N_2 and O_2.

This preliminary plant design has following properties:

Raw material : NH_3
Raw material capacity : 492.0658 kg/hour
Nitric acid capacity : 2777.78 kg/hour
Purity : 60%
Utility :
- Water : 75 m^3/ day
- Electricity : 44 kW
- Fuel : 9.0874 lb/hour

Amount of employees : 111 people
Plant location : Cikampek, West Java.
Land area : 6400 m^2
Process area : 1600 m^2
Building area : 1354 m^2

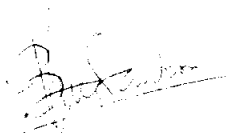
Economic analysis:

1. IRR
   Before tax = 41.09 %
   After tax = 24.48 %
2. ROE
   Before tax = 52.81 %
   After tax = 32.74 %
3. POT
   Before tax = 2 years and 7 months
   After tax = 3 years and a month
4. NPV = Rp. 125,259,394,761.98
5. ROI = 46.30 %
6. BEP = 30.796 %

DECLARATION SHEET

I declare that this preliminary plant design is my own work and not others' work, some parts or all except be written in text. If it is known that this preliminary plant design is others' work, I aware and accepts the consequences that this preliminary plant design cannot be used as one of the requirements to achieve Bachelor of Engineering degree.

Surabaya, 12 June 2006



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(Benny Santoso / 5203003025)

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Surabaya, 12 June 2006

The undergraduate student

(Devarly Prahas / 5203003047)

PREFACE

Feeling happy and relieve upon completing this preliminary plant design, first and most of all, the writers would like to thank God, for His grace and blessing that have enabled the writers to accomplish this preliminary plant design which entitled "Preliminary Plant Design of 60% Weight Nitric Acid Using Tubular Membrane Reactor Capacity 22,000 Tones/Year". This preliminary plant design is one of the requirements to get Bachelor of Engineering degree in Chemical Engineering Department, Engineering Faculty, Widya Mandala Catholic University Surabaya.

The writers recognize that this success of preliminary plant design is supported by some people, so the authors would like to say thanks to:

1. Suryadi Ismadji, Ir., M.T., Ph.D. as the supervisor of this preliminary plant design;
2. Aylianawati, S.T., M.Sc., Ph.D., Nani Indraswati, Ir. and Wenny Irawaty, S.T., M.T. as the examiners of this preliminary plant design;
3. The other lecturers who helped the authors in conducting this preliminary plant design;
4. Our parents and family for giving the sincere love;
5. Our friends whose supports can not be forgotten;
6. The others, who can't be mentioned one by one, who helped us since the beginning of this preliminary plant design till the report making.

The writers realize that this report is still imperfect. Therefore, the writers will accept any critics and recommendations to complete this report. At last, the writers hope that this report will be useful for all the readers who need information from this report.

Surabaya, 12 June 2006

The writers

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EXECUTIVE SUMMARY

The defensive industry is one of the most important industries in Indonesia. One of them is explosive industry, which needs ammonium nitrate. Niric acid is one of the strategic materials for defensive industry and also used as an oxidizing agent and as a highly active acid for fertilizer, plastics, pharmaceuticals, dyes, synthetic fibres, insecticides, and fungicides.

At the moment, the needs for nitric acid in Indonesia can be fulfilled domestically and also from abroad. The domestic supplier is PT MNK (Multi Nitrotama Kimia). This preliminary plant is expected to help the development of nitric acid industry in Indonesia so that in the future our country can supply this nitric acid by itself, without importing them.

There are two processes in making nitric acid, which are weak acid process and concentrated acid process. Concentrated acid process can produce nitric acid with concentration up to 100%. Ammonium nitrate industry only needs nitric acid with 59% weight concentration as raw material. Therefore, weak acid process is enough to make nitric acid as ammonium nitrate raw material.

Weak acid process can be divided as single-pressure process and dual-pressure process. This preliminary plant design uses single-pressure process with medium-pressure (7 atm) with the production capacity 22000 tones/year or 40 tones/day. This process is chosen because it is suitable for plant with production capacity below 600 tones/day. The main reactor used in this process is a modified catalytic reactor. This reactor uses lanthanum ferrite perovskite membranes catalyst. There are two main advantages by using this catalyst. It has high NO selectivity and there is no formation of N_2O or commonly called as laughing gas. Thus, it reduces plant gas emissions.

In this nitric acid preliminary plant, energy is used efficiently. Energy produced from the process with high-pressure is re-used as source of energy of the compressor. This can be done with the use of steam turbine and tail-gas expander turbine. Steam that is produced from waste heat boiler is a high-pressure steam. The high-pressure steam and tail-gas flowing out from abatement reactor are then expanded with steam turbine to