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STUDY OF SIMULATION OF NITRIC ACID PRODUCTION USING HYSYS SIMULATION SOFTWARE

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Abstract

Nitric corrosive creation is a significant substance measure. In our paper, we have created information dependent on the reenactment acted in HYSYS.

This information can assist us with understanding the cycle in various circumstance in modern practice. From this undertaking material and energy streams, estimated unit tasks squares can be utilized to lead monetary appraisal of each cycle and enhance every one of them revenue driven augmentation.

Our created reproduction model can likewise be utilized as a guide for understanding the cycle and the financial matters, and furthermore a beginning stage for more modern models for plant planning and cycle hardware indicating.

Keywords Watchwords: Oswald, recreation, passivation, alkali

INTRODUCTION

The common perception of 'acid' suggests stringency, corrosiveness and something capable of dissolutionofanother substance. However, not all acids are, or can be seen to be thus, except that nitric acid[1–3]mightbeconsideredtobean extremely destructive compound in that it was the basis of explosives and also fertilizers – the almost diametric opposite of an explosive as it helps plants to grow.

However, this versatile acid (there's many nitric acid uses) has found to capable of use in many industrial and chemical processes.As an integral part of explosives manufacture that, although known for a long time, derived from the lack of natural nitrates to fuel the German war effort prior to the First World War. Nitric acid can be used to manufacture components of trinitrotoluene (TNT)[4].

As an agricultural fertilizer where it promotes vigorous growth in plants, there is, however, an unfortunate side effect in that nitrates are very soluble in water and when applied to well-drainingsoil,they leach into the watercourse and eventually reach streams and rivers[5].

Once in the water it stimulates the growth of algae that, in turn, deoxygenates the water to stifle growth in other plant forms and animal life.It can be used as an oxidizing agent in theproductionofsomesolidfuelsforrocketpropulsion;componentofrocket fuel acting as an oxidizer.

As an ageing agent in woodworking where itcanbeusedinverydiluteforms (typically below 10%) to change the appearance of some woods and to produce a color similar to that of oiled or waxed surfaces old.

In the jewelry trade, nitric acid can be used to identify low-grade alloys and assess purity of gold content.It can be used in a solution with alcohol and water to etch metals by removing some surfaces.

Nitric acid is commonly used in the food processing and dairy sectors to remove calcium and magnesium deposited during the manufacturing or conversion processes or which may result from continued exposure to hardwater**[6]**.Most production of nitric acid is caused by the Ostwald process.

The Ostwald process is a chemical process for making nitricacid (HNO_3). Wilhelm Ostwald developed the process, and he patented it in 1902.

The Ostwald process[7] was discovered just in time for the First World War, and it contributed greatly to the extended length of that war. This is because previously Germany had no nitrate deposits of its own from which to make the nitric acid thatwas essential for the production of the explosives used in artillery shells, such as TNT and nitroglycerine.

The Ostwald process is amainstay of the modern chemical industry[8], and it provides the main raw material for the most common type of fertilizer production. Historically and practically, the Ostwald process is closely associated with the Haber process, which provides the requisite raw material, ammonia (NH_3).

In this work a detailed study is performed of the process by means of simulation in Aspen HYSYS v7.1. We will not get real life value through this simulation, but if the process is known and related data are available, it surely is the best way by which we will get ideas of an industrial process without conducting any experiment.

METHODOLOGY

The process of synthesis of ethanol by hydration of ethylene is simulated in simulation software Aspen HYSYS 7.1. Aspen HYSYS is a widely used process simulator which provides quite accurate results compared to the real life result.

It provides comprehensive thermodynamics basis for accurate determination of physical properties, transport properties, and phase behavior. For our simulation we have chosen Peng Robinson fluid package.

Components for this simulation areAmmonia(NH3), Nitrogen(N2), Oxygen(O2), Water(H2O),Nitric-oxide(NO),Nitrogen di-oxide(NO2),Nitric acid (HNO3).

Process Description

Once ammonia has been produced by the Haber process, it can be converted into nitric acid through a multi-step procedure known as the Ostwald process.

In the first step in this reaction, ammonia andoxygengas catalytically react to form nitrogen monoxide.The reaction is quite exothermic.In the commercial reaction, the catalyst used in aplatinum-rhodium metal gauze, that is heated to about 900 $^{\circ}$C. However, even a hot copper wire can catalyze the reaction in the laboratory.

Once the reaction hasstarted, the energy it produces is enough to keep the catalyst hot enough to sustain the reaction.In the next step, the NO[9] reacts with oxygen to produce NO_2.

No catalyst is required for this reaction, as it will occur in air at room temperature[10].The NO_2 can be compressed and cooled which will make it dim raze into N_2O_4, which can then be used as an oxidizer for rocket fuel.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) + 58\ KJ$$

FromleChâtelier'sprinciplewecan predict that at high pressures the equilibrium will be shifted to the right, since there are less molecules of gas in the products.

Similarly, at lower temperatures the reaction will shift to the right.Instead of storing the NO_2, we can use it to producenitricacid.

TheNO_2(g)reacts with water to produce nitric acid (HNO_3) and NO.The nitric acid is separated by distillationandthe NO canbe recycled through reaction.

$$4NO_2(g) + 2H_2O(l) + O_2(g) \rightarrow 4HNO_3(aq)$$

Figure 1 shows the simplified block diagram of Ostwald process for nitric acid production.

Reactions Involved

There are three main reactions:

(a) Oxidization of ammonia to form nitric oxide

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_20(g)$; nH = Δ906 kJ

(b) Oxidization of nitric oxide to form nitrogen di-oxide

$4NO(g) + O_2(g) \rightarrow 4NO_2(g)$

(c) Conversion of nitrogen di-oxide into nitric acid

$4NO_2(g) + 2H_2O(l) + O2(g) \rightarrow 4HNO_3(aq)$

Figure 2 shows the HYSYS flow diagram of this process.

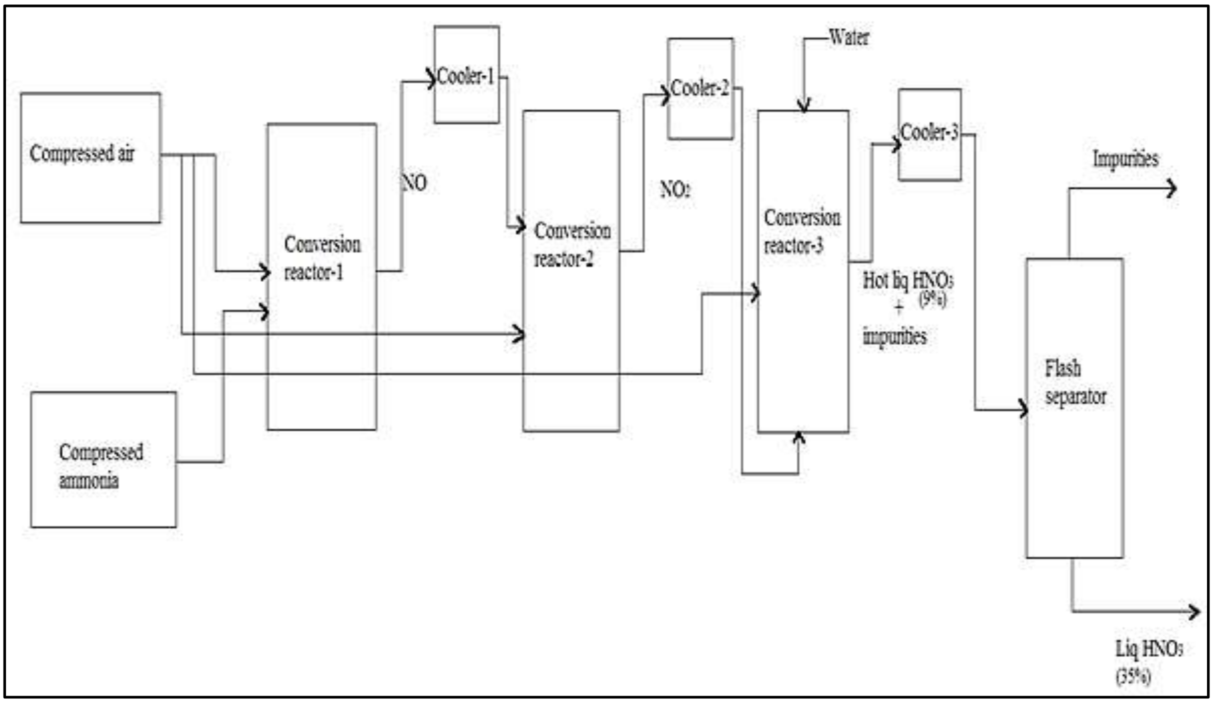

Fig.1: *Simplified Block Diagram of Ostwald Process for Nitric Acid Production.*

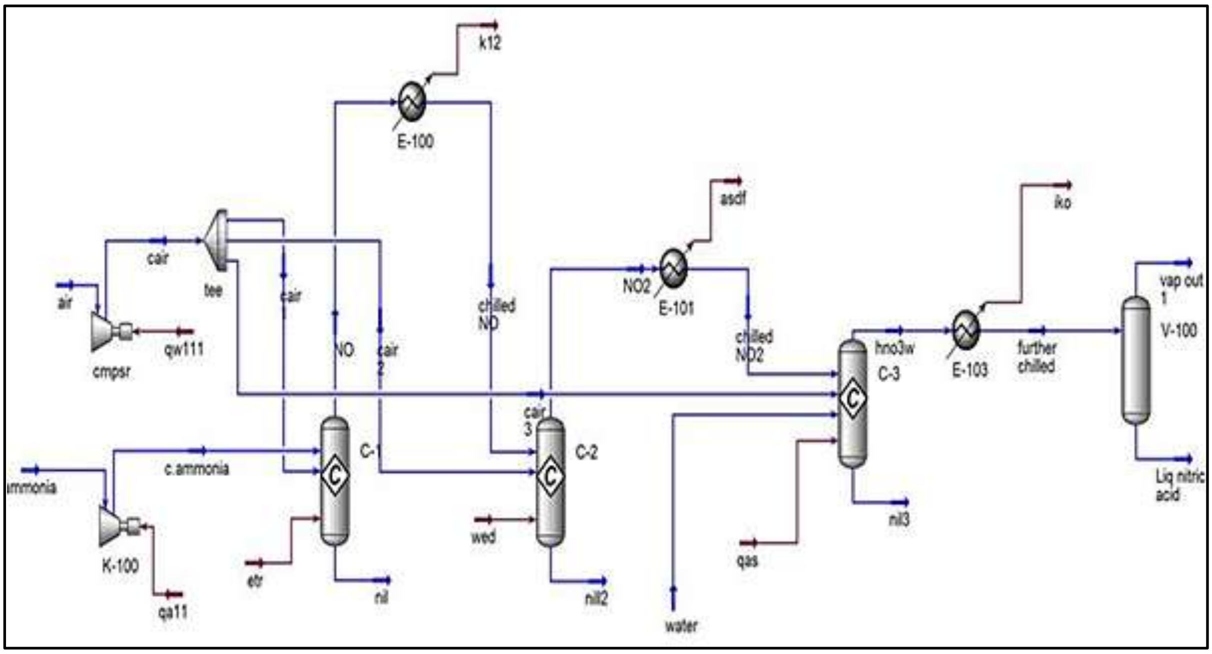

Fig. 2: HYSYS Flow Diagram of Ostwald Process for Nitric Acid Production.

CONCLUSIONS

Nitric acid has been known and esteemed for a long time. Most nitric acid is used in making ammonium nitrate. Its direct applications include photoengraving, metal pickling and passivation and the parting of gold and silver. Here the Oswald process is used to produce nitric acid. This process is simulated using HYSYS simulation software. The purpose of this simulation was to observe the thermodynamic properties of the process. We also observed the changes which will occur if the properties of different unit were changed. By performing simulation 35.3% aqueous HNO3 is obtained for 11020 lbm/hr air and 500 lbm/hr ammonia input flow.

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