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Production of Sodium Nitrite from Purge Liquor

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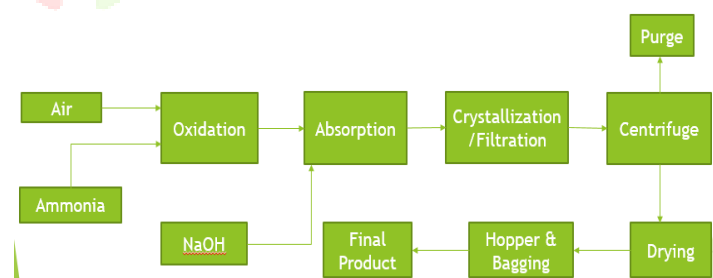
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Abstract: : In chemical Industries there are many companies who is producing Sodium Nitrite as their desired product. Sodium Nitrite is used in Pharmaceutical industry, Dyes and pigments, Textile industry, Metal coating, Rubber Industry, Heat transfer salt, Anti-freeze Fluids. Three major steps of sodium nitrite plant are as: 1) Oxidation section 2) Absorption section 3) Salt section. In Salt Section crystallization process take place and from this waste liquid is coming which is known as Purge Liquor. This liquor contains NaNO_2 , NaNO_3 & water. This purge liquor is harmful for the environment so, companies can't throw it without treating and it is totally wastage. This wastage can be Reduce by re-producing Sodium Nitrite from purge Liquor which requires 4 steps. 1) Reaction section 2) Absorption section 3) Crystallization section 4) drying section. Reaction is occurred between purge liquor and Nitric acid to form NO_x . Then NO_x went to absorption column for further process. In absorption section NO_x is Absorb by NaOH which gives Sodium Nitrite in Liquid form but in market Sodium nitrite is required in Solid form. So, further process is required. In crystallization section liquid NaNO_2 is converted into crystals and then drying process is carried out. Finally get sodium nitrite as desired product in Solid form.

Index Terms - Sodium Nitrite, Absorption column, Crystallization, Drying, Purge Liquor, NO_x (gas), Caustic Solution (NaOH), Nitric Acid.

I. INTRODUCTION

Sodium Nitrite is an inorganic compound with Chemical formula NaNO_2 . It is a white to Slightly Yellowish Crystalline Powder that is very soluble in water and is Hygroscopic. From an industrial perspective, it is the most important Nitrite salt. Characteristics of Sodium Nitrite are as: Molar Mass- 68.99 gm/Mole, Density- 2.17 gm/cm³, Boiling point- 115° C , Melting Point- 271° C , Freezing point-519.8° F. Many Companies are Producing Sodium Nitrite in Large amount. They are following the procedure as follows:



Flow sheet I

Overall Procedure is divided into mainly three section sections:

- 1) Oxidation section: The raw material ammonia and air are pre-heated and mixed in venture-mixer which produces NO_x .
- 2) Absorption section: NO_x is absorbed by sodium hydroxide solution and form sodium nitrite solution.
- 3) Salt section: Sodium nitrite solution went to centrifugation followed by crystallizer and passed to dryer. From that got desired product.

From the Crystallizer, waste Liquid is coming out which gives negative impact on Environment.

3.1 Population and Sample

From the sodium nitrite manufacture company waste liquor is coming out which contains 40% sodium nitrite (NaNO_2), 10% sodium nitrate (NaNO_3) and 50% water (H_2O). Density of this liquor is 1200 g/cm^3 .

The study comprised of Utilization of waste liquor coming out from sodium nitrite plant.



(Waste liquor)

Figure I

3.2 Data and Sources of Data

For this study secondary data has been collected from the sodium nitrite plant and different journal papers. For Performing this experiment we required these chemicals purge liquor from the plant, concentrated nitric acid, sodium hydroxide solution {36-40% w/w}.

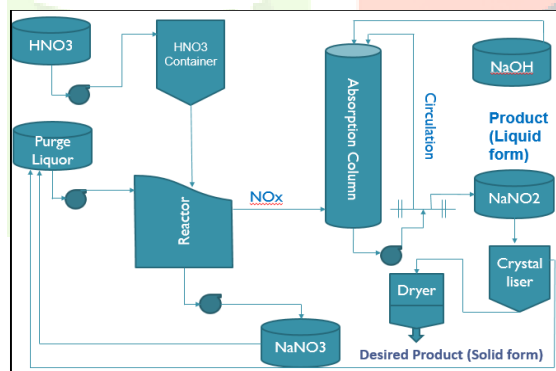
3.3 Theoretical framework

Giant companies are actively participating in the production of Sodium Nitrite worldwide and supplying it to various countries. Companies are concerned about the Purge liquor coming from the Crystallization unit which contains 40% NaNO_2 , 10-12% NaNO_3 , 48-50% water. So, this liquor is harmful for the environment.

For this we make a pilot plant and we do experiment on it to recover sodium nitrite from the plant waste.

I. RESEARCH METHODOLOGY

The Utilization of Purge Liquor to obtain Sodium Nitrite is essential. We propose to develop a proto-type Model which recover the Sodium Nitrite from the Purge Liquor. For Proto-type Model the Flow sheet considered as below.



Flow sheet II

In which there are mainly four Sections: 1) Reactor Section 2) Absorption Section 3) Crystallization Section 4) Dryer Section.

A. Unit Operations

The Whole Process is carried out in these four Sections. These are Unit operations which is necessary for the process.

- Reactor: A device Used to introduce an Industrial Chemical reaction. Here CSTR Reactor is Required with Continuous Stirring operation. That has Two Inlets and one Outlet.
- Absorption Column: gas absorption columns are units that will used in the separation of gases by scrubbing and washing gas mixture. In this case, use a suitable liquid to help in scrubbing and washing impurities from absorption column. Here Packed bed absorption column is used in which random packing are used.
- Crystallizer: A Crystallizer is a vessel in which a hot solution is allowed to cool and form crystals.
- Dryer: A device for removing moisture by using heat or air a clothes dryer.

B. Characteristics of Purge liquor

- Waste liquor contains 40% NaNO₂(M.W=69g /mol), 50% water (M.W=18 g/mol) and 10% NaNO₃(M.W= 85 g/mol)
- Specific gravity of waste liquor is 1.2
- Density of waste liquor 1200 kg/m³

C. Reactions

- 1) $2\text{NaNO}_2 + 2\text{HNO}_3 \rightarrow 2\text{NaNO}_3 + \text{NO}_2 + \text{NO} + \text{H}_2\text{O}$
- 2) $2\text{NaOH} + \text{NO} + \text{NO}_2 \rightarrow 2\text{NaNO}_2 + \text{H}_2\text{O}$
- 3) $2\text{NaOH} + 2\text{NO}_2 \rightarrow \text{NaNO}_2 + \text{NaNO}_3 + \text{H}_2\text{O}$

D. Procedure

- Raw material:
 - 1) purge liquor from the plant
 - 2) nitric acid concentrated
 - 3) sodium hydroxide solution {36-40% w/w}
- PH: 7.5-7.6
- Temperature: 298k
- Pressure: Atmospheric

Mixed Purge liquor and HNO₃ both in the reactor and stirred it properly at 1atm pressure and room temperature. Which gave products NO_x and NaNO₃. NaNO₃ can recycle and NO_x is further used in Packed bed absorption column. In packed bed Column Random packing is required to increase the efficiency of product. NO_x in Reactor outlet stream is absorbed in Sodium Hydroxide solution (36% w/w) and forming sodium nitrite liquor solution. PH is maintained at 7.6 -7.7 during the whole process of absorption. If at a certain point of time pH goes below 7.5 then liquor becomes acidic and the reaction selectivity changes such that the major product formed after absorption of NO_x is sodium nitrite as opposed to SNI. Alkalinity of SNI liquor needs to be less than 1. The product SNI liquor has a specific gravity of around 1.285- 1.295 depending on the w/w% of caustic solution used. If the caustic solution is 1.38, 1.39, 1.4% w/w then it has specific gravity of 1.285, 1.29, and 1.295 respectively. Alkalinity goes on decreasing as NO_x gets absorbed. In market Sodium Nitrite is required in Solid Form, for that need to goes through multiple effects crystallizer followed by centrifugation. In which a crystals grown form a liquid and Waste again recycled. This Crystals have some Moisture that needs to remove, for that Dryer is Required. In dryer maintain Temperature around 70-100 °C for 10-12 min then got final desired product Sodium Nitrite in Solid form that is slightly yellowish crystalline powder.

E. Material Balance

Specific Gravity is near to 1.12 to 1.28 So, we can consider in volume basis also.

⇒ Molecular weight of components:

1. NaNO₂ – 69
2. NaNO₃ – 85
3. HNO₃ – 63
4. H₂O – 18

As liquor contain 40% of NaNo₂ and remaining of NaNo₃ 10-12% and H₂O 48-50%.

NaNo₂ in Liquor

40 100

138 ?

$$\frac{138 \times 100}{40} = 345 \text{ ml liquor}$$

40

NO_x generation

76 ml in gas form

205 ml of NaNo₃

remaining balance water

Total Feed = 345 + 126

= 471 ~ 500 (HNO₃ in excess)

F. Identification of NO_x (gas)

NO_x is a radish-orange-brown gas with a characteristic pungent odour corrosive and highly oxidizing.

G. Identification of NaNO₂ sodium nitrite

1. Take salt of sodium Nitrite(NaNO₂) in test tube and concentrated Hydrochloric acid in it by decomposition of salt nox is generated.

2 Take salt of sodium Nitrite in test tube and dissolved with water then add concentrated H₂SO₄ NO_x is generated. if we add potassium permanganate solution, violate colour disappears.

H. calculation

(1) Calculation of Alkalinity:

% w/v Alkalinity =

$\frac{\text{Burette reading} \times 2 \times \text{Normality H}_2\text{SO}_4 \times 53 \times 100}{\text{Ml of sample} \times 1000}$

MI of sample * 1000

= Burette reading * 0.106

= 8.8 * 0.106

= 0.9328%

(2) % Recovery = $\frac{\text{Moles of NaNO}_2 \text{ formed} \times 100}{\text{Moles of NaNO}_2 \text{ feed}}$

Moles of NaNO₂ feed

Moles of NaNO₂ formed = 34.4/69 gm mole

Moles of NaNO₂ feed = 138/69 gm mole

% Recovery = (34.4/138) * 100

= 24.9%

IV. RESULTS AND DISCUSSION

Table I

Sr no.	Reactant (gm)	Product(gm)	% Recovery
1	138	15.2	11.01
2	138	15.9	11.5
3	138	24.34	17.63
4	138	28.2	20.0
5	138	34.4	24.92

% Recovery of NaNO₂ (sodium nitrite) is 24.9.

By performing this experiment approximate 25 percentage of sodium nitrite is recovered from the waste liquor

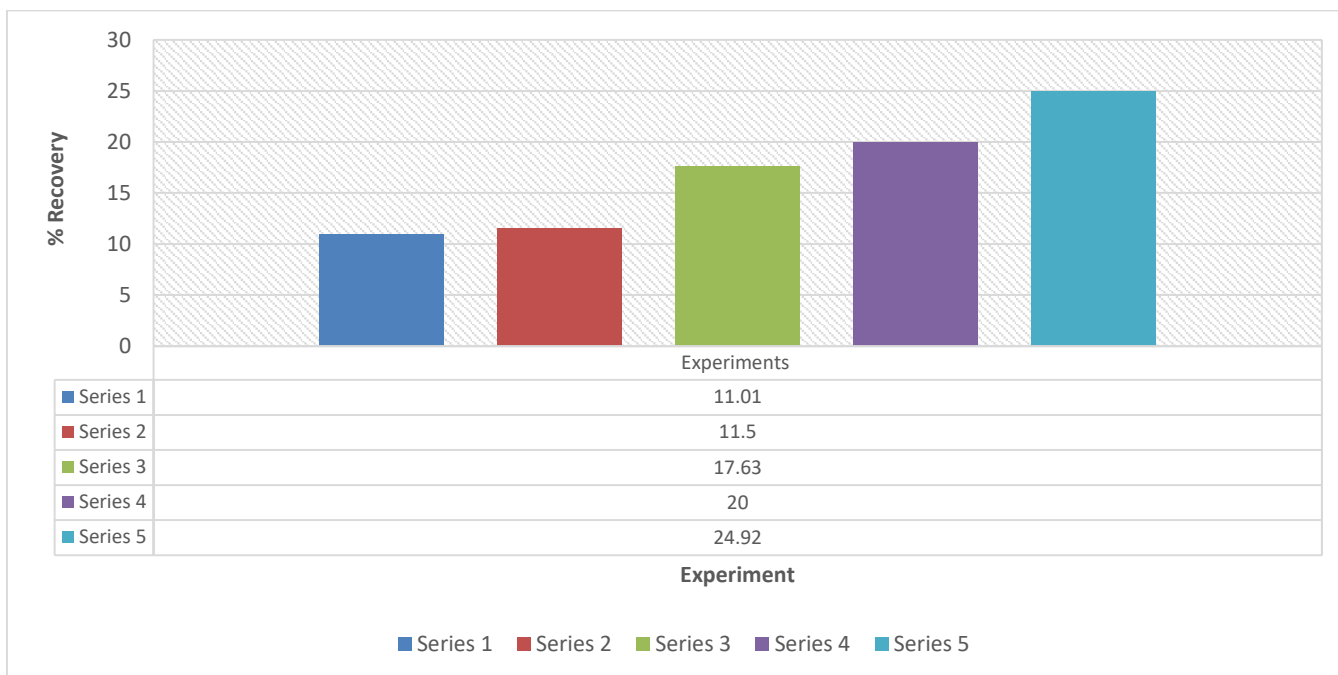


Figure II

This project will be a fulfilment of technical material in the subject of safety and environment. Moreover, we will produce our product from the waste raw material so that our product will be cheaper and useful for companies. This project is appropriate for small scale production.

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