NIRMA LIMITED

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TO WHOMSOEVER IT MAY CONCERN

This is to certify that Ms. Vishwa Darshak Shah has successfully completed internship from 1st May'18 to 11th May'18 in the Soda Ash Production division at Nirma Ltd. Bhavnagar

AND in the Marketing Department for the research topic "MARKET SURVEY OF RETAILERS OF NIRMA ADVANCE DTERGENT POWDER" at Nirma Ltd. Ahmedabad.

During this period of training she was found to be punctual, hardworking & inquisitive.

We wish her every success in life.

For Nirma Limited

Authorised Signatory

INTERNSHIP REPORT

Conducted at:

Nirma Limited,

Kalatalav, Bhavnagar

Submitted by:

Vishwa Darshak Shah

Start Date of Internship: - 01.05.2018

End Date of Internship: - 11.05.2018

ACKNOWLEDGEMENT

The Project is a golden opportunity for learning and self-development. I consider myself very lucky and honoured to have so many wonderful people lead me through in completion of this project.

I am greatly thankful to Mr. Akhil Maheshwari, General Manager Nirma Ltd.,for granting me the permission for taking training in the company.

THANK YOU

EXECUTIVE SUMMARY

The period of my internship involves my time spent at the unit understanding & observing different sections of the soda ash manufacturing plant.

This report gives you the brief information about the products manufactured at Bhavnagar Plant & gives a detailed process for Soda Ash.

The training is being done by observing different sections & specialised people responsible for respective divisions.

DECLARATION

I hereby declare that the following documented Internship Report by me at Nirma Limited, Ahmedabad is an original and authentic work done.

I hereby certify that all endeavours put by me in the fulfilment of the task are genuine and to the best of my knowledge.

PREFACE

Practical training plays an important role in development. Through such training one can easily grasp theoretical knowledge also.

I have prepared this report on Industrial process & plant operations for Soda Ash (Sodium Carbonate) as observed at "NIRMA LIMITED" Bhavnagar which helped me in understanding the complex processes of manufacturing.

LIST OF TABLES

PRODUCTS MANUFACTURED AT NIRMA LTD, BHAVNAGAR

1. Product Name/ Scientific Name: -

    - LAB (Linear Alkyl Benzene)
    - Sulphuric Acid
    - Glycerine
    - Soda Ash – Sodium Carbonate
    - Pure Salt
    - Vacuum Evaporated Iodized Salt
    - SSP (Single Super Phosphate)
    - Sodium Silicate

2. Specification Product wise: -

    - LAB (Linear Alkyl Benzene): -
        - ✓ Investment of Rs. 630 crores
        - ✓ 75,000 TPA capacity
        - ✓ Only second plant in the world with Eco-friendly Non HF technology from UOP, USA
        - ✓ Bio-degradable product
        - ✓ 70 km of integrated pipeline network for feed stock
        - ✓ 8,00,000 TPA of Feed Stock
            - 32% market share DCS controlled fully automatic plant
    - Soda Ash: -
        - ✓ Capacity: -
            - 850,000 TPA
            - 770 m3/hr capacity Sea Water RODM plant

- 40 MW Captive co-generation plant
- 10,000 MT solid handling

✓ Energy efficient technology from AKZO, Netherlands

✓ Only Soda Ash plant in the world with full DCS controls&ICMA award for Best Total Water Management Practices in Chemical Industry Category.

❖ Vacuum Evaporated Iodized Salt: -

✓ Asia's largest salt works

✓ Spread over 30,000 acres

✓ Edible salt capacity of 288,000 TPA

✓ Edible vacuum evaporated salt plant with

✓ Technology from akzo nobel, Netherlands

✓ Tripple effect monel cladded evaporator

✓ Fluidized bed dryer

✓ Human contact free process from water to packaging

❖ Detergent: -

✓ 50,00,000 pieces sold per day

✓ 38% market share

✓ Largest Detergent manufacturer of India

❖ Industrial Salt: -

✓ Asia's largest salt works

✓ Spread over 30,000 acres

✓ Industrial salt capacity of 15,00,000 TPA

3. Chemical Composition: -

➢ Soda Ash: - A 99.5% soda ash is equivalent to 58.2% Na2O (the conversion equation is: % Na2CO3 x0.585 = % Na2O). Sodium carbonate, Na2CO3 is a sodium salt of carbonic acid. It most commonly occurs as a crystalline

heptahydrate, which readily effloresces to form a white powder, the monohydrate.

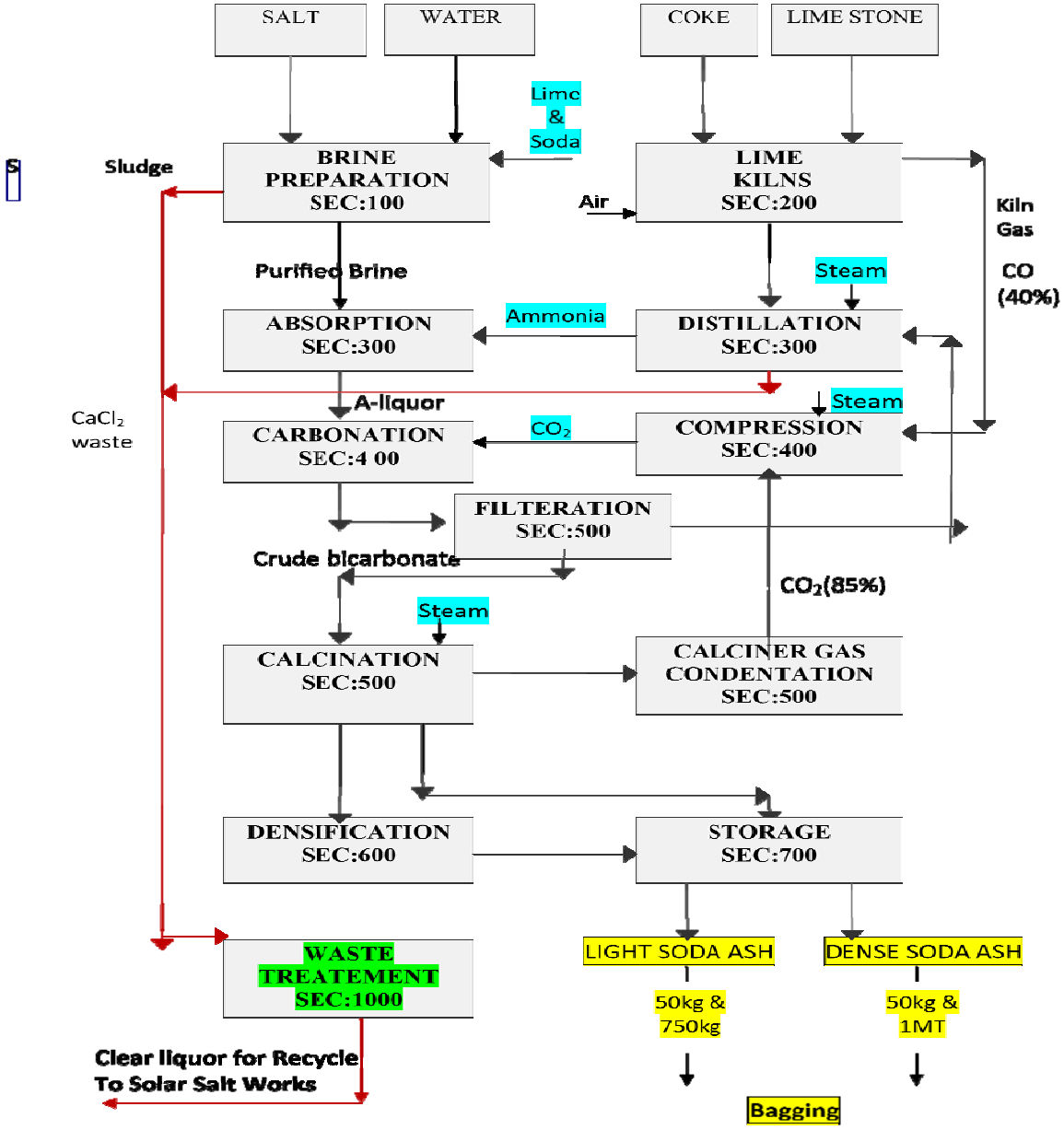
- LAB (Linear Alkyl Benzene): - Linear alkyl benzene is a family of organic compounds with the formula C6H5CnH2n+1. Typically, n lies between 10 and 16, although generally supplied as a tighter cut, such as C12-C15, C12-C13 and C10-C13, for detergent use.

- Caustic Soda: -Sodium hydroxide, also known as lye or caustic soda, has the molecular formula NaOH and is a highly caustic metallic base. It is a white solid available in pellets, flakes, granules, and as a 50% saturated solution.

DIVISIONS/ DEPARTMENTS AT NIRMA LTD, BHAVNAGAR: -

1. Procurement
2. Health & Safety
3. HR & Personnel
4. Administration
5. Legal
6. Quality Assessment
7. Maintenance
8. Electrical
9. Mechanical
10. Dispatch
11. Production
12. Training & Development

BLOCK DIAGRAM OF SODA ASH MANUFACTURING PROCESS



Soda Ash Process:

The global theoretical equation for the production of soda ash, involving salt and limestone, is as follows:

$$2NaCl\ (Salt) + CaCO_3\ (Limestone) \longrightarrow Na_2CO_3\ (Soda\ Ash) + CaCl_2\ (Calcium\ Chloride)$$

But, in practice, the reaction is not possible and needs the participation of other substances and many different process steps to get the final product.

The first reaction involves absorption of ammonia in salt solution, followed by reaction of ammoniated brine with carbon dioxide to obtain ammonium carbonate followed by continuous introduction of carbon dioxide and cooling the solution, precipitation of sodium bicarbonate is achieved and ammonium chloride is formed. The chemical reactions of the process are given below:

$$NaCl\ (Salt) + H_2O\ (Water) + NH_3\ (Ammonia) \xrightarrow{\cancel{NaCl}} (Salt) + NH_4OH\ (Ammonium\ hydroxide)$$

$$2NH_4OH\ (Ammonium\ hydroxide) + CO_2\ (Carbon\ dioxide) \longrightarrow (NH_4)_2CO_3\ (Ammonium\ carbonate) + H_2O\ (Water)$$

$$(NH_4)_2CO_3\ (Ammonium\ carbonate) + CO_2\ (Carbon\ dioxide) + H_2O\ (Water) \longrightarrow 2NH_4HCO_3\ (Ammonium\ Bicarbonate)$$

$$2\ NH_4HCO_3\ (Ammonium\ Bicarbonate) + 2\ NaCl\ (Salt) \longrightarrow 2\ NaHCO_3\ (Sodium\ Bicarbonate) + 2\ NH_4Cl\ (Ammonium\ Chloride)$$

Sodium Bicarbonate crystals are separated from the mother liquor by filtration, followed by thermal decomposition to obtain sodium carbonate, water and carbon dioxide. Sodium carbonate, thus formed is called “light soda ash” because its bulk density is around 650 kg/m^3.

$2NaHCO_3$ (Sodium Bicarbonate) $\longrightarrow$ Na_2CO_3 (**Soda Ash**) + H_2O (Water) + CO_2 (Carbon dioxide)

CO_2 is recovered in the carbonation step & liquor containing ammonium chloride is treated to recover ammonia, by reacting with dry lime followed by steam stripping, in the form of gaseous ammonia, which is recycled to absorption step.

$2NH_4Cl$ (Ammonium Chloride) + H_2O (Water) + CaO (Lime) $\longrightarrow$ $CaCl_2$ (Calcium Chloride) + $2NH_3$ (Ammonia) + $2H_2O$ (Water) Chemistry

The Solvay process results in soda ash (predominantly sodium carbonate, Na_2CO_3) from brine (as a source of sodium chloride, NaCl) and from limestone (as a source of calcium carbonate, $CaCO_3$).

The overall $2NaCl + CaCO_3 \longrightarrow Na_2CO_3 + CaCl_2$

The actual implementation of this global, overall reaction is intricate. A simplified description can be given using the four different, interacting chemical reactions illustrated in the figure. In the first step in the process, carbon dioxide (CO_2) passes through a concentrated aqueous solution of sodium chloride (NaCl) and ammonia (NH_3).

$NaCl + CO_2 + NH_3 + H_2O \longrightarrow NaHCO_3 + NH_4Cl$ (I)

In industrial practice, the reaction is carried out by passing concentrated brine through two towers. In the first, ammonia bubbles up through the brine and is absorbed by it. In the second, carbon dioxide bubbles up through the ammoniated brine and sodium bicarbonate ($NaHCO_3$) precipitates out of the solution. Note that, in a basic solution, $NaHCO_3$ is less water-soluble than sodium chloride. The ammonia (NH_3) buffers the solution at a basic pH; without the ammonia, a hydrochloric acid by-product would render the solution acidic, and arrest the precipitation. The necessary ammonia "catalyst" for reaction (I) is reclaimed in a later step, and relatively little ammonia is consumed. The carbon dioxide required for reaction (I) is produced by heating (calcination) of the limestone at 950-1100°C. The calcium carbonate ($CaCO_3$) in the limestone is partially converted to quicklime (calcium oxide, CaO) and carbon dioxide (CO_2):

$CaCO_3 \longrightarrow CO_2 + CaO$ (II)

The sodium bicarbonate ($NaHCO_3$) that precipitates out in reaction (I) is filtered out from the hot ammonium chloride (NH_4Cl) solution, and the solution is then reacted with the quicklime (calcium oxide, CaO) left over from heating the limestone in step (II).

$2NH_4Cl + CaO \longrightarrow 2NH_3 + CaCl_2 + H_2O$ (III)

CaO makes a strong basic solution. The ammonia from reaction (III) is recycled back to the initial brine solution of reaction (I). The sodium bicarbonate ($NaHCO_3$) precipitates from reaction (I) is then converted to the final product, sodium carbonate (Na_2CO_3), by calcination (160-230^{0}C), producing water and carbon dioxide as by products:

$2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$ (IV)

The carbon dioxide from step (IV) is recovered for re-use in step (I). When properly designed and operated, a Solvay plant can reclaim almost all its ammonia, and consumes only small amounts of additional ammonia to make up for losses. The only major inputs to the Solvay process are salt, limestone and thermal energy, and its only major by product is calcium chloride.

The production of soda ash involves a number of operations which have been grouped into following sections:

Section	Description	Activity
100	Brine Preparation	Salt is dissolved in water to prepare saturated solution of salt, called as Brine. This brine is purified further using Lime & Soda to remove calcium & Magnesium impurities.
200	Lime Kiln	Limestone is converted into lime and carbon dioxide by burning with coke.
300	Lime grinding, Distillation and Absorption	Lump Lime generated in Lime Kiln is taken for grinding & reacted with filtrate from filtration to recover ammonia.
400	Compression and Carbonation	Salt solution is ammoniated first to facilitate CO_2 absorption using compressed gas. Ammonia is not consumed by the process but recovered after use and recycled. Absorption of CO_2 in the ammoniated brine results in precipitation of bicarbonate.
500	Filtration and Calcination	The precipitated bicarbonate is filtered and transformed into light soda ash by calcinations. CO_2 formed by calcination is recovered and used for carbonation.
600	Densification	The light soda ash is converted into dense soda ash by densification.
700	Soda Ash Storage and Bagging	Both Light Soda Ash (LSA) & Dense Soda Ash (DSA) is packed in 50kg bags. Additionally, LSA is packed in 750kg jumbo bags & DSA is packed in 1MT Jumbo bags for specific customers.

Section	Description	Activity
Utility	Boilers & Turbines	Generation of Steam & Power required for Process Requirement of Steam is as follows: 2.5 Bar Steam 0.87 MT per MT SA 35 Bar Steam 1.56 MT per MT SA Electricity 93 KwH per MT SA

The Equipment involved in the manufacture of Soda Ash is grouped into following sections:

Section	Description	Equipment	Make/Supplier	Capacity
100	Brine Preparation	Salt Dissolver Settler	Comtech Services Hindustan Dorr-Oliver	3 x 218 M^3/hr 3 x 2930 M^3
200	Lime Kiln	MIXED FIRED – VERTICAL LIME KILNS	FFEM, Chennai with IPZ Technology	6 x 335 TPD
300	Lime grinding Distillation Absorption	LIME GRINDING MILLS Fix Ammonia Still Free Ammonia Still Absorber Tower Gas Scrubber	NEUMAN & ESSER, Germany ISGEC ISGEC JOHN THOMPSON ISGEC JOHN THOMPSON	3 x 28 TPH 4 x 188 M^3/hr 3 x 225 M^3/hr

			Chemical Process Equipment Ltd	3 x 90 M^3/hr 3 x 75 M^3/hr
400	CO_2 Compressor Carbonation	Axial Screw Type CO_2 Compressors (4no.s) Carbonating Tower	GHH Boring, Germany CAS, Germany ISGEC, Yamuna agar	35700 M^3/hr 34000 M^3/hr 34160 M^3/hr 35700 M^3/hr 8 x 250 TPH 2 x 250 TPH
500	Filtration Calcination	Rotary Drum Vacuum Filter Calciner Calciner	Eimco KCP, Germany CAS, Germany KEL, Bombay	5 x 480 TPD 3 x 480 TPD 2 x 550 TPD
600	Densification	Hydrator Fluidized Bed Dryer	KILBURN SULZER (I) Ltd	600 TPD 33.6 TPH

700	Soda Ash Storage & Bagging	Light Soda Ash Bunker Dense Soda Ash Bunker 50kg Soda Ash Bagging M/c 750kg LSA Bagging M/c 1 MT DSA Bagging M/c	Jay Shar Group Jay Shar Group Chronos Richardson Chronos Richardson Chronos Richardson	8 x 600 TPD 2 x 800 TPD 6 x 15 TPH 15 TPH 15 TPH

Section	**Description**	**Equipment**	**Make**	**Capacity**
Utility	Boilers	CFBC BOILER	LURGI LENTJES ENERGIETECHNIK, Germany	3x 100 TPH
		CFBC BOILER		1x 100 TPH
		CFBC BOILER	ISGEC JOHN THOMSON, Noida	1 x 200 TPH
			ISGEC JOHN THOMSON, Noida	
	Turbines	STEAM TURBINE		2 x 16.34 MW
		STEAM TURBINE	TOYO DENKI, Japan with mixed extraction set up	1 x 6.5 MW
		STEAM TURBINE	BHEL, India with fixed extraction set up	1 x 22 MW
	Air Compressors	Reciprocating Compressors	GREENSOLE, China	2 x 1250 M^3/hr
		Reciprocating Compressors	K.G.Khosla	3 x 1250 M^3/hr
		Screw Compressors	Ingersoll Rand	
		Screw Compressors	Atlas Copco Ingersoll Rand	3 x 7200 M^3/hr 3 x 141 M^3/hr

Uses of Soda Ash:

Soda ash is used in many industrial processes, and its production is sometimes used as an indicator of economic health. The principal current uses include:

Glass Making: More than half the worldwide production of soda ash is used to make glass. Bottle and window glass (Soda-lime glass) is made by melting a mixture of Soda Ash, calcium carbonate and silica sand (silicon dioxide, SiO_2).

Water Treatment: Sodium carbonate is used to soften water (precipitates out Mg^{2+} and Ca^{2+} carbonates). This is used both industrially and domestically (in some washing powders).

Making Soaps and Detergents: Often sodium carbonate is used as a cheaper alternative to Caustic Lye (Sodium Hydroxide, NaOH).

Paper Making: Sodium carbonate is used to make sodium bisulfite ($NaHSO_3$) for the "sulphite" method of separating lignin from cellulose.

Use as common alkali in many chemical factories because it is cheaper than NaOH and far safer to handle.

Making Sodium Bicarbonate: NaHCO3 is used in baking soda and fire extinguishers. Although NaHCO3 is produced in the Solvay process, heating it to remove the ammonia it is contaminated with decomposes some NaHCO3, so it is actually cheaper to react the finished Na2CO3 product with CO2.

Removing Sulphur Dioxide (SO_2) from flue gases in Power Plants: This is becoming more common, especially where stations have to meet stringent emission controls.