

ANALYSIS OF THE PRODUCTION PROCESS OF CALCIUM SODA

Ametova B.Kh.

Doctoral student, TSTU

Scientific supervisor: Boboev G. G.

Ph.D., associate professor (PhD), TSTU

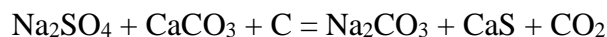
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Abstract. *The authors of the article talk about the production process of calcified soda, methods of production, areas of use. The instability of the conditions in the world market requires high requirements for making management decisions in soda production enterprises. The competitiveness of the products produced by the enterprise and its demand both in the domestic market and in the foreign market can provide a flexible approach to management at this time. This can be achieved by qualitative analysis of the production business process, as well as by analyzing its external environment. Calcined soda is a traditional product with a long history of production and use. Nowadays, it is difficult to find any branch of modern industry where this product is not used. The most important areas of application of soda ash, the largest consumers are chemical, metallurgical and other industries.*

Keywords: *calcined, soda, ammonia method, technology, raw materials, chemical methods, table salt, limestone.*

INTRODUCTION

Soda has been known since ancient times, it was extracted from the ash of sea plants, and the soda product obtained in this way was used in the glass industry and as a laundry detergent. With the development of the industry, the demand for soda products is increasing day by day. In 1775, the French pharmacist Leblanc recommended the production of soda from sodium sulfate according to the following reaction.



Soda was dissolved from the obtained alloy with the help of water, and solid soda was obtained by evaporation of the solution. and CaS was discarded. In countries where there is no natural Na_2SO_4 , Na_2SO_4 is obtained by decomposing table salt with sulfuric acid. In time, the Leblanc method plays a certain role in the development of the chemical industry. To obtain soda using the Leblanc method, natural Na_2SO_4 , or table salt and a large amount of sulfuric acid were needed.

In 1865, the Belgian engineer Solve developed a new method fundamentally different from Leblanc's method. This method is called the ammonia method, and the purity of the obtained product is distinguished by low labor consumption, continuous working technology, and almost zero-waste technology that consumes little energy. Cheap table salt and limestone, which are found in sufficient quantities in nature, are used as raw materials. Thus, the product obtained by the ammonia method is cleaner and cheaper.

This article provides information on the use, scope and production methods of soda ash in the manufacturing process. The main focus is on the production of calcined soda by the ammonia method. Technology of obtaining table salt, its melting, salt water purification, limestone burning technology are considered. The physico-chemical basis of all the main stages of the production of

calcined soda by the ammonia method is considered. The main equipment for the production of soda is described and presented in figures. The article describes the technological schemes of the main departments for the production of soda at the Kungirotd soda plant. The main hazards and safety of soda production and personal protective equipment are described. Ways to develop and improve soda production are considered. Attention is paid to the disposal of soda production waste.

Calcined soda - Na_2CO_3 , sodium carbonate or carbon dioxide, Molecular weight - 106. Sodium carbonate is a white crystalline powder, density 2.53 g/cm³, melting point 853°C, easily soluble in water, mass density 0.5 -0.6 g/cm³. It hydrolyzes in water as a salt of a strong base and a weak acid, and its aqueous solutions have a strong alkaline reaction. $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$, $\text{Na}_2\text{CO}_3 \cdot 7\text{H}_2\text{O}$ and $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ can be crystallized from aqueous solutions in the form of hydrates. Soda is hygroscopic, and during storage it turns into a monolith.

In the CIS countries, the quality of soda ash is determined by the requirements of GOST 5100-85:

Table 1

№	Indicator	A high category of brand quality	B brand 1st grade	QSZ soda quality
1.	Appearance	White granules	Small crystalline white powder	
2.	The content is not less than Na_2CO_3 in %	99,4	99,2	99,2
3.	In terms of NaCl, there are not many chlorides	0,2	0,5	0,2
4.	The mass fraction of iron in Fe_2O_3 not large	0,003	0,003	0,002
5.	The remaining substances are insoluble in water, not much	0,03	0,04	0,04
6.	Mass fraction of sulfates based on Na_2SO_4 no more	0,04	0,05	0,04
7.	Loss of calcification at 270-300° C no more	0,7	0,8	0,8

Kungirotd soda factory, the only one in Central Asia, located in Uzbekistan, uses table salt mined from the Barsakelmes salt mine located on the Ustryurt plateau. The total reserve of table salt in the Barsakelmes mine is 131 million tons. The average amount of NaCl is 96.32%. Upper deposits up to 1.08 m thick are of the best quality and are primarily intended for use.

In 2000, soda production in the world exceeded 40 million tons. In addition, since 1980, there has been a steady increase in production, which amounted to more than 40% in 20 years. The largest producer of soda in the world is the USA, which produces more than 10 million tons of soda per year. However, American soda is not produced by the ammonia method, but from natural sources of soda ash. This soda is much cheaper than the soda obtained by the ammonia method.

Calcined soda is widely used in various fields, in particular: chemical industry, glass production, non-ferrous metallurgy, petrochemical industry, food industry, meat and dairy industry, light industry, medicine, pulp and paper industry, ferrous metallurgy, is used. It is widely used in the production of synthetic detergents, in everyday life, in water and salt water purification, etc.

In the chemical industry, chemical methods are used to obtain caustic soda, sodium bicarbonate (food or tea soda), detergents, chromium compounds, sulfides, sulfates, fluorides (sodium silicate fluoride, sodium fluoride, creolize), nitrites, and sodium nitrates.

The capacities of some large plants for the production of calcined soda using the ammonia method:

Table 2

Country	City	Power, thousand tonn
England	Winnington	1000
Italy	Rozinyans	950
Spain	Torrelavega	700
French	Dombal	1300
Russia	Sterlitamak	2100
Russia	Berezniki	1200
Ukrain, Crimea	Krasnoperekopsk	698
Bulgary	Devnya	1200
China	Shanghai	800

Demand for soda in Uzbekistan:

Table 3

Consumer	Consumption, tn
Uzkurilishmateriallar	100.000*
Uzkimyosanoat	15.000
Yog-moy kombinat	8.000
Uzbekenergo	7.000
Qizilkumredmetzoloto	2.500
Maxsus qotishma	7.500
Uzselxozsnabremont	1.500
Uzplodovoshvinprom	4.500
Uzmetkombinat	1.500
Uzbeklegprom	1.500

Uzbekneftegaz	600
Other consumers	22.400
Total	170.000

*Note- the need for the joint-stock company "Uzskurilishmaterialari" is indicated taking into account the planned expansion of production at glass factories.

52% of soda production in the world is in the glass industry, 17% - in the chemical industry, 9% - in the production of detergents, and 22% is for all other industries and other consumers. However, the bottle industry is experiencing strong competition from alternative manufacturers of other packaging materials such as metal cans, cartons and plastic products.

Currently, calcified soda is produced by the following methods:

1. Ammonia method (Solva method)
2. From natural carbonated water
3. Carbonation of sodium hydroxide (caustic soda)
4. In the complex processing of nepheline.

Calcined soda is produced using the ammonia method at the Kungyrot Soda Plant, the only one in Central Asia.

Until recently, the ammonia method was the monopoly method of producing soda, which produced 100% soda, and now its share is about 60% of the world's soda production.

Advantages of this method:

- 1) availability, distribution, large reserves and cheapness of raw materials (salt and limestone);
- 2) the main reactions, in addition to burning limestone, continue at low (up to 100 ° C) temperatures and atmospheric pressure;
- 3) stability of technological processes;
- 4) high quality products,
- 5) relatively cheap soda water.

Disadvantages:

- 1) low use of raw materials (only two-thirds of sodium is used, and calcium and chlorine are not used at all),
- 2) a large amount of solid and liquid waste requiring disposal, disposal or long-term storage;
- 3) significant consumption of energy resources;
- 4) large specific capital investments, in connection with this, the payback period of the enterprises built is long.

Disadvantages of this method of soda extraction are becoming more significant due to the complex use of raw materials and the stricter requirements for environmental protection.

Raw materials for soda production are table salt (NaCl) and limestone (CaCO₃). In addition, auxiliary materials - ammonia, fuel, water, steam, electricity are used.

Nowadays, the instability of conditions in the world market requires high requirements for making management decisions in the enterprise. The competitiveness of the enterprise and the demand for its products both in the domestic market and in the foreign market can currently provide a flexible approach to management. This can be achieved by qualitative analysis of the production business process, as well as by analyzing its external environment.

Table 4

Methods of processing waste from the ammonia method for the production of calcined soda - advantages and disadvantages.

Processing method	Advantages	Disadvantages
Obtain anhydrous calcium peroxide	Obtaining calcium peroxide in the form of a commercial product	Use of reagents: hydrogen peroxide and ammonia solution. Generation of wastewater containing ammonium and sodium chlorides.
For customers in oil wells	No complicated technical design is required	The need to place a soda plant in oil production areas
Taking calcium chloride	Obtaining calcium chloride in the form of a commercial product	Multi-stage production, complex technological equipment, high energy consumption.
Getting calcium hydroxide, sodium hydroxide and chlorine	A simple way of processing, reducing energy consumption, is to obtain calcium hydroxide, sodium hydroxide and chlorine in the form of salable products. Obtaining purified water from calcium chloride and sodium chloride water.	Advanced technological equipment

Soda products occupy one of the highest positions in basic chemical technology. The calcination of NaHCO_3 to Na_2CO_3 is one of the energy-consuming steps in the production of soda ash. The high energy consumption is partly due to the moisture content of NaHCO_3 . The purpose of this process is to evaluate the energy efficiency of the sodium hydrogen carbonate calcination process in the production of soda ash with a moisture content of NaHCO_3 from 18 to 14%, reducing the steam consumption by 110 kg / t. Calcified soda is produced, if 1.5 million tons of soda are produced per year, 165,000 tons of steam will be saved for 1 year. The energy efficiency of the calcination process was 63.5%, which indicates that the analyzed process is relatively thermodynamically perfect. It was found that reducing the parameters of the preheated steam supplied by the power plant to certain values (P and T) required in the calcination process leads to additional and significant exergy losses of the soda production line, which leads to a decrease in exergy efficiency up to 59.7%.

The chemical industry is one of the leading and main sectors of the economy of Uzbekistan. Therefore, it is natural that our state pays great attention to the development of this sector. "Kongirov Soda Factory" JV is the only enterprise producing soda in Central Asia. Based on the decision of the President of the Republic of Uzbekistan dated April 3, 2019 "On measures to further reform the chemical industry and increase its investment attractiveness", 51% of the authorized capital of LLC was sold to a foreign investor. As a result, the scale of production has expanded, the economic situation of the enterprise has improved, which serves to further improve

product quality and strengthen the social protection of workers. The unique production technology of the plant consists of several complex stages. The main raw material is lake salt from the Barsakelmes mine located on the Ustyurt plateau. The limestone used in production is also of high quality.

Currently, the plant produces 200,000 tons of soda per year. The products are used as a basic chemical additive in glass production, detergents, non-ferrous metallurgy, light industry, and water treatment. Due to non-stop operation of the factory, as well as the unusability of the main part of the factory equipment, it was observed that the daily production capacity decreased to 450-470 tons in the following years. - At the initiative of specialists and investors of "Uzkimyosanoat" and "Uzkimyosanoatloyikha" joint-stock companies, a plan of measures was developed to eliminate these shortcomings. Thus, modernization of production facilities, technical and technological re-equipment was carried out.

As a result, the volume of product production increased by 34.7% in the first half of 2021. In particular, after the modernization works carried out in September-November last year, 12 thousand 516 tons of products worth 33.5 billion soums were produced, and a significant amount of raw materials and materials were saved. By the end of the year, products worth 488.8 billion soums were produced. A net profit of 48.5 billion soums is expected, which is 14.1 times more than at the end of 2020. Currently, 600 tons of products are being produced.

Material and heat balances of the calcination process are performed using production data and at three levels of moisture in sodium hydrogen carbonate (14, 15.9, and 18%). The steam consumption required to cover the endothermic process is determined. A decrease in the moisture content of sodium hydrogen carbonate from 18 to 14% leads to a reduction of steam consumption by 110 kg per 1 ton of soda produced. If 1.5 million tons of soda are produced per year, 165,999 tons of steam will be saved per year. Such a reduction in the amount of consumed steam leads to a reduction in the consumption of the primary energy source in the power plant and a reduction in carbon dioxide emissions, which have a certain environmental impact. The obtained energy efficiency was 63.5%, which indicates that the analyzed process is thermodynamically perfect. The reason for this is the use of steam with low parameters as a heat carrier. It was found that moisture in sodium hydrogen carbonate practically does not affect the energy efficiency of the calcination process, because it changes the amount of steam, its parameters (temperature and pressure) remain the same. It was also found that the reduction of the parameters of the casting process causes significant energy losses to the soda production plant, which leads to a decrease in the energy efficiency coefficient of up to 59.7%.

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