

TECHNOLOGY OF PRODUCTION OF TECHNICAL SODIUM CHLORIDE AND TABLE SALT BY PROCESSING HALITE WASTE

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<https://doi.org/10.5281/zenodo.8101643>

Abstract. This article provides information on the technology of production of technical sodium chloride and table salt by processing halite waste, researching the process of crystallization and separation of sodium chloride.

Keywords: sodium chloride, potassium chloride, halite, flotation, flotation reagent, sylvinitite, hydroseparator, "Dehghanabad potash fertilizer plant", centrifuge, pulp.

Studying the process of crystallization and separation of sodium chloride

During the processing of sylvinitite containing 25-30% sylvinitite and 66-71% halite, all halites with impurities are removed from the process in the form of waste in the amount of 0.7 t per 1 t of ground rocks to be processed. The Dehghanabad potash plant alone, when operating at full capacity, generates about a million tons of waste annually. Filling the cultivated territory with waste before future implementation, the latter is collected in special soil dump sites, which leads to salinization of land in certain latitudes.

Currently, in practice, a solid flotation method of potassium salt enrichment is used. The Dehghanabad Potash Fertilizer Plant operates in the flotation method with dispersive clay particle slurry.

Table 1

Substances	%
NaCl	91-92
KCl	4,7-5
CaSO ₄	12
MgCl ₂	1,8
Fe ₂ O ₃	0,04
Al ₂ O ₃	0,05
n.n	4

According to the indicated compounds, flotation reagents, often amines, are also found in the waste. The fractional composition of the waste solid phase is of great interest.

Table 2

Granulometric and chemical composition of halite (table salt) soil pile

Corn, mm	Fraction, %	NaCl	KCl	MgCl ₂	CaSO ₄	n.n.
+7	10,10	92,48	1,54	0,06	4,10	1,82
-7+5	5,84	93,27	0,86	0,09	4,18	1,60
-5+3	14,90	95,65	0,30	0,06	2,91	1,08
-3+2	15,04	97,37	0,30	0,07	1,63	0,63
-2+1	21,16	98,19	0,11	0,04	1,19	0,47
-1+0,7	7,75	98,35	0,11	0,07	1,00	0,47
-0,7+0,5	9,14	98,29	0,22	0,03	1,04	0,42
-0,5+0,375	8,08	98,26	0,29	0,06	1,00	0,39
-0,375+0,25	1,93	97,30	1,00	0,03	1,19	0,48
-0,25+0,10	4,19	97,63	0,67	0,03	0,92	0,75
0,10+0,063	0,72	88,73	6,40	0,05	1,47	3,35
-0,063	0,40	46,15	11,45	0,10	8,54	33,75

As can be seen from the table, impurities with a large amount of KCl are mainly in large classes +0.8 mm, in the smallest fraction (0.1 mm) in the smallest fraction (0.1 mm), especially in normal proportion (20%) and anhydrite (3%), the amount is 0.2 and 1% fits. The content in these last classes is in the range of 96-98%.

A review of the chemical composition shows that salt treatment of flotation tailings involves complete removal of potassium chloride and rapid reduction of anhydrite to normal. in which the amount of halites increases. A simple way to completely remove potassium chloride is to treat the effluent (mixed) with sodium chloride solution. The purpose of the indicated process is the high solubility of silvin and halite together. To the size of the duration of complete dissolution of Sylvin grain and saturation of namakob with chlorine.

Loss of impurities and anhydrite in the normal ratio of complexity. Which their main weight is adjusted to the class of 0.1 mm, and the separation of this class leads to a rapid decrease in the content of normal ratio and anhydrite. but this method does not reach the goal, these two compounds are present in the solid phase of all grades adhering to the fine dispersed halite. A process separation of 0.1 mm class is said to be separated from the solid, moving the clean namakob in the flowing stream at a given speed.

To completely remove potassium chloride, the salt separated from the mixture is filtered and washed in a small amount of water. washed and filtered salt goes into drying. The contaminated recirculation is routed to a clarifier for recirculation into the process. When sylvin is

washed with alkali, potassium chloride accumulates in the recirculation tank, so a portion of the recirculation tank must be removed from the process.

Thus, the entire process of processing flotation halite (brine) waste into salt is divided into the following sections.

- Mixing the waste with a rotary mixer to make pulp.
- Alkaline washing of Sylvin.
- Centrifugation after further washing of salt with water.
- Drying salt
- Cleaning contaminated water.

Principle technological scheme of sodium chloride processing

To check the possibility of extracting salt from flotation waste and the processes of all stages of processing in the technological mode (production capacity - 3t/s), the experimental device, which is shown in the picture, was installed.

The flotation waste flows through the filter, which is simultaneously transferred to the counterflow reactor.

From the stream, through the pipeline, the pulp goes with its flow to the tank with the pulp mixer 1. The same mixed pulp is transported by pump to 2 and 3 arc sieves to separate into small classes. The coarse product in arc sieve 2 is transferred to arc sieve 3.

The slurries from the two arc sieves are sent to the condenser 12, the slurries from the sieves (powdery product) and the slurries from the sieve 3 partially freed from the small fractions of salt fall into 4-6 chans installed with a contact cascade to the alkaline treatment by self-flow. It is established in the work process that it is possible to abandon the use of arc sieves for the quality of undamaged salt.

As a result of pulp mixing in contact powders, complete alkaline washing of silvins in the solid space was carried out. The treated pulp is directed by self-flow from the dust 6 to the dewatering hydroseparator 7, which is provided with a clean water inlet pipe to form its inlet. At the same time in the hydroseparator, the mixer 8, which has completed the removal of slurry and the thickening of the pulp, falls into the vessel with $J:T = 07 \div 1.0$ and is transported to the vessel 9 by a pump. Here, the blast salt is washed with water and further dried, then it falls on the belt conveyor 11 and is transferred to the warehouse.

In the filtrate centrifuge 10, the thickener 12 is directed to the hydroseparator 7, the thickener 13, and the starch solution to dilute the intensification process. The clean brine from the thickener 12 and 13 enters the sump tank 14 and is pumped back into the pressure tank 15.

Depending on the level of collection in the sludge thickeners, the last ones are discharged and the thick mud-salt slurry is transported to storage by means of a pump with a mixer 16 in the tank.

The first stage of the processing process of the separation of flotation waste from high namakob waste does not require any explanation, only the $J:T$ ratio in the pulp is kept at $2 \div 2.5$. Deviation of the pulp density from the specified values only affects the performance of the device and does not affect the results of the next steps.

Material balance for obtaining technical sodium chloride by reprocessing halite waste

Alkaline washing of Sylvin. We calculate the time required for complete melting and pulp mixing of all silvin grains as needed.

$$\frac{dl}{d\tau} = K_0 F (C_T - C_x) \quad (1)$$

where $\frac{dl}{d\tau}$ - is the amount of dissolved substance in a given time interval.

K_0 - coefficient of solution work rate, rev/minute.

F - the surface of the solute.

C_T - saturation concentration (in KCl) gr/sm³.

C_x - concentration by moment of time, τ , gr/sm³.

For practical calculations, it is inconvenient to use equation (1), because the magnitudes of F and C_x change with time. In such conditions, it is convenient to calculate the time of calculation of the melting of silvin grains at the linear melting rate. When loading silvin grains and sodium chloride solutions at intervals, the layer $d\tau$ dissolves dh in thickness. The entire molten layer is equal to.

$$F \cdot dh \cdot p = dl$$

p - sylvinite density, gr/sm³.

Calculating this equation together with equation (1), we get the following:

$$\frac{dh}{d\tau} = \frac{K_0 (C_T - C_x)}{1} \quad (2)$$

$dh/d\tau$ magnitude indicates the linear rate of dissolution. Denoting it, we write equation (2) in the following form:

$$v = \frac{K_0 \cdot C_T}{p} \left(1 - \frac{C_x}{C_T} \right)$$

C_x/C_T the degree of saturation of the solution in terms of the equilibrium soluble component (KCl) C_x/C_T denote by S . In this case, equation (3) is written in the following form:

$$v = \frac{K_0 \cdot C_T}{1} (1 - S) \quad (4)$$

v size $S=0$ when v_0 is determined by and is called the coefficient of the linear rate of dissolution, in other words v_0 absolute linear rate of dissolution of potassium chloride in pure solvent (pure saturated sodium chloride solution).

For further calculations $\varphi = 2h/h_{\max}$ let's enter the size, here h - variable quantity of maximum importance equal to the acceptable grain radius. φ the size characterizes the reduction of the grains of silvin to a certain extent.

Using the differential expression

$$d\varphi = \frac{2dh}{d_{\max}}$$

It is not difficult to adopt the formula for the melting time for calculation convenience.

$$\tau = \frac{d_{\max}}{2v_0(1-S)}$$

That is, when the quantity S is constant or varies in a non-wide range, this formula is true as follows. In our case, the concentration of KCl changes in the circulating salt water before and after the alkaline wash up to 1%.

According to the literature, the coefficient of the dissolution rate of sylvin is 0.524 in a saturated sodium chloride solution at a temperature of 25⁰C. $KCl - NaCl - H_2O$ for the balance system, at 250S, the ST coefficient is 0.1374 gr/cm³ (11.15%), the density of sylvin is $\rho = 1.99$ gr/cm³.

We find the indicated values by putting them into equation (4).

$$v_0 = \frac{0,524 \cdot 0,1374}{1,99} = 0,03618 \text{ cm} / \text{сек}$$

According to the experimental data, the diameter of sylvin grains reaches 1.2 mm. For warranty $d_{\max} = 1,5 \text{ mm}$ / can be accepted. The concentration of KCl should not exceed 6% according to practical considerations in the circulation system.

So our event is:

$$S = \frac{6}{11,15} = 0,538$$

We put the found data into the formula (5).

$$r = \frac{0,15}{2 \cdot 0,03618 \cdot (1 - 0,538)} = 4,5 \text{ minute}$$

The presence of clay slurries in the pulp, which increases the viscosity of salt water, the actual time of melting is 20-30% more than the theoretical one. In practice, the mixing of the pulp during the alkali washing stage takes up to 10-15 minutes.

Complete alkalization of sylvin from the solid phase during pulp mixing has been confirmed by most experimental data.

As standard equipment that ensures intensive mixing of the pulp, contact dusters, which are well recommended in practice, are more appropriate.

Loss of pulp slurry. As mentioned above, the removal of sludge from the pulp was carried out in a hydroseparator in the inlet stream of clean namakob after alkaline treatment. In the hydroseparator, the salt water flow at the input speed should ensure that all 0.1 mm grains are removed to the upper layer. A linear grain size of 0.1 mm settles quickly.

$$\omega = \frac{d^2(\gamma_\tau - \gamma)}{18\mu}$$

Here $d = 1 \cdot 10^{-4}$ - grain diameter, m;

$\gamma_\tau = 2170$ - density of halite, kg/m³;

$\gamma = 1210$ - salt water density, kg/m³;

$\mu = 1,83 \cdot 10^{-4}$ - salt water viscosity, kg.сек/m²

Substituting the values shown in this formula, we find a value equal to m/sec, or 9.9 m/s. Thus, it is necessary to maintain the exit flow in the hydroseparator at less than 9.9 m/s when removing all grains with a linear size of 0.1 mm and less. In the pilot plant, the inlet flow velocity was 10-10.5 m/s, which provided very effective sludge removal.

Excellent pulp thickening was achieved in the hydroseparator along with slurry loss. On the basis of long experiments and as a result of numerous records, J:T from the released pulp fluctuates within the limits of 0.7÷1.0, which allows it to be sent for centrifugation without additional thickening.

Centrifuging the salt and washing it with water. AG-800 centrifuge was used in the experimental device. All processes of centrifugation consist of the following operations: placement of pulp, automatic control of layers by thickness, centrifugation (30sec), washing with salt water, drying of salt (30sec), release of salt (8-10sec). The final moisture did not exceed 3.5% when the yield of centrifugation and production of finished salt was 2.5-3 t/s in the specified mode.

One of the last and most basic operations for cleaning salt from potassium chloride is washing the salt with water.

Based on a large number of analytical analyzes, the finished salt content is characterized by indicators (%) according to the method indicated by the flotation waste.

This salt does not correspond to its chemical standard food salt (GOST 153-92) due to the high content of insoluble residues, but it can be successfully used for technical purposes.

Table 3

COMPOSITION OF TECHNICAL SODIUM CHLORINE OBTAINED

Substance	%
NaCl	98,5-98,7
KCl	0,08-0,09
MgCl ₂	0,01
CaSO ₄	0,2
Э.к.	1,0-1,2

Circulating salt water treatment. Starch is used as a coagulant to intensify the fermentation process. Namakob, which is considered to be practically illuminated, in which the concentration of insoluble impurities should not exceed 0.2 g/l.

Below is the experimental data showing the relative performance of the starch consumption area.

The results of the tests on the experimental device fully confirmed the data of the laboratory experiments.

When 0.5 kg of starch was used at a normal rate of 1 t in a thickener on an area of 10 m², the spillage of the lit namakob was 17 m³.

Table 4

Starch consumption, 1 t.n.n.	Asking the relative productivity of the area m ³ /(m ² .s)
0	0,3
0,1	1,0
0,2	1,1
0,3	1,2
0,4	1,4
0,5	1,7

For 1 t of finished salt, the amount of circulating water in the system is equal to 7 m³.

Knowing the relative productivity of the search area and the relative consumption of the namakob, it is possible to find the work output given the required search area.

A mixture of salt and amines. A large number of spectrophotometric analyzes established that the amount of amines in flotation effluents is 8 g/t, but there are no amines in the salty fraction, and their amount is 1t n.n. in the oily fraction. is 325 grams. Thus, amines are completely adsorbed in clay slurries and therefore are not found in ready technical salt.

CONCLUSION.

The results of the above research allowed us to draw the following conclusions:

1. The chemical composition of halite waste with the following composition was determined by the method of physico-chemical analysis at the UP "Dehkanabad Potash Fertilizer Plant":

- a) NaCl 91-92
- b) KCl 4,7-5
- v) CaSO₄ 1,2
- g) MgCl₂ 1,8
- d) Fe₂O₃ 0,04
- e) Al₂O₃ 0,05
- j) n.n. 4

2. 66%>1mm, +5+7mm-44%<1mm with a spheroid analysis of fractional composition of stored halite waste installed.

3. As a result of experimental studies conducted obtaining technical sodium chloride from waste, the following optimal technological parameters have been established:

- a) NaCl 98,5-98,7
- b) KCl 0,08-0,09
- v) MgCl₂ 0,01
- g) CaSO₄ 0,2
- d) n.n. 1,0-1,2

4. Physico-chemical and commercial characteristics of the obtained technical sodium chloride were studied.

An optimal technological scheme for obtaining sodium chloride from halite waste has been developed at UP "Dehkanabad Potash Fertilizer Plant".

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