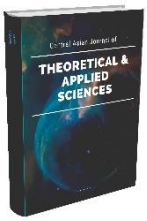

CENTRAL ASIAN JOURNAL OF THEORETICAL AND APPLIED SCIENCES

Volume: 04 Issue: 05 | May 2023 ISSN: 2660-5317
https://cajotas.centralasianstudies.org

Investigation of the Process of Obtaining Zinc Hydroxide Carbonate by Precipitation From a Solution of Zinc Nitric Acid with a Solution of Sodium Carbonate

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Received 4th Mar 2023, Accepted 6th Apr 2023, Online 18th May 2023

Abstract: *The results of studies on the preparation of zinc hydroxide carbonate by precipitation from a zinc nitrate solution with an 18% sodium carbonate solution are presented. The influence of technological factors on the degree of precipitation of zinc hydroxide carbonate was investigated and the optimal parameters of the process were established. The zinc nitrate solution contains 13,14% ZnO. The maximum degree of precipitation of zinc hydroxide carbonate is observed at pH medium (7,9-8,2), temperature 65-70°C. At the same time, an increase in the duration of the process from 40 to 45 minutes increases the degree of precipitation of zinc hydroxide carbonate from 98,78% to 99,97%.*

Keywords: *zinc nitric acid, sodium carbonate, zinc hydroxide carbonate, temperature, pH, precipitation, time, filtration , physical and chemical properties.*

Introduction. The chemical industry makes a significant contribution to the development of the economic condition of Uzbekistan. Therefore, the President of the country pays great attention to the development of the chemical industry, as evidenced by the Decree of the President of the Republic of Uzbekistan № DP 4947 of February 7, 2017 "Strategy of action in five priority areas of the Republic of Uzbekistan in 2017-2021", resolution № OP 3236 of August 23, 2017 "On Program for the Development of the Chemical Industry for 2017-2021" and № OP 3983 dated October 25, 2018 "On Measures for the Accelerated Development of the Chemical Industry of the Republic of Uzbekistan".

The development concept of the Republic of Uzbekistan provides for raising the industry to a qualitatively new level, further intensifying production based on the deep processing of waste raw materials, and mastering the production of new types of products.

Literature review. From the literature review of experimental work, the optimal conditions for the deposition of zinc nitrate with ammonium carbonate were determined. *To do this, a solution of zinc nitrate was poured into the reactor, kept at a temperature of 60-70°C, and an ammonia-carbonate solution was added. Precipitation of the basic zinc carbonate was carried out at pH 6-7,8 for 1,5 hours, with vigorous stirring. For precipitation, an ammonia-carbonate solution was used containing 153,4 g/dm* ^{3} CO_2 *, 159,0 g/dm* ^{3} NH_4^+ *obtained by absorbing carbon dioxide with a 25% ammonia solution.*

The pulp of basic zinc carbonate was filtered, the precipitate was washed until the absence of nitrate ions [1]. In the next work, the precipitation was carried out with a saturated solution of ammonium carbonate heated to 80°C and without heating. The end of precipitation was determined by pH, its value was 8-10. The filtrates after precipitation with heating contained less zinc carbonate than without heating and amounted to 150–170 mg/l with heating, and almost 2 times more than 320–380 mg/l without heating. The precipitate was washed by repeated decantation with hot water, thoroughly washed from traces of ammonium nitrate and zinc sulfate [2–3].

Research methodology. Precipitation of zinc ions from a solution of zinc nitrate in the form of basic zinc carbonate was carried out with a precipitant - a solution of sodium carbonate according to the following reaction:

$$2Zn(NO_3)_2 + 2Na_2CO_3 + H_2O \rightarrow ZnCO_3 \bullet Zn(OH)_2 + 4NaNO_3 + CO_2\uparrow$$

The optimal conditions for precipitation of the basic zinc hydroxide carbonate were selected (reagent ratios, process temperature, pH, precipitation time).

A solution of zinc nitrate, with a mass fraction of zinc oxides – 13,14% and a solution of sodium carbonate, with a mass fraction of 18%, were heated to a temperature of $(70\text{-}75)^0$C. Under laboratory conditions, tests were carried out on the precipitation of zinc hydroxide carbonate from a solution of zinc nitrate was carried out by simultaneously feeding heated solutions of zinc nitrate and sodium carbonate into the precipitator from different heated separating funnels with continuous stirring. In the process of precipitation, the pH was selected in the pH range (7,9-8,2), achieving the complete precipitation of zinc hydroxide carbonate, the precipitation was carried out for 40-45 minutes.

At the end of the precipitation process, the precipitate of the basic zinc hydroxide carbonate was separated from the mother liquor of sodium nitrate. The content of the components was determined in the mother liquor.

The precipitate, the main zinc hydroxide carbonate, was washed from nitrate ions with distilled water. The content of zinc hydroxide carbonate was determined in the washed and dried precipitate.

Analysis and results. For the implementation of the technological process of deposition of zinc hydroxide carbonate, the physicochemical characteristics of the intermediates are necessary. The precipitation of zinc ions was carried out with sodium carbonate pH 7,9-8,2 at a temperature of 65-70°C, interaction time 40-45 minutes and constant stirring. The results of analyzes of the precipitation of zinc hydroxide carbonate from a solution of zinc nitrate are shown in table 1.

Table-1. Influence (pH) on the rate of precipitation of zinc hydroxide carbonate

pH	Salt composition of the liquid phase, mass %					Degree of precipitation, %
	$ZnCO_3$	$Zn(OH)_2$	$Zn(NO_3)_2$	$NaNO_3$	HNO_3	
4,9	1,772	1,404	12,125	3,785	3,170	30,37
6,1	2,855	2,261	5,349	9,708	0,298	61,43
6,8	3,120	2,471	3,047	12,977	-	75,34
7,2	3,405	2,697	1,494	15,595	-	87,18
7,9	3,439	2,724	0,127	18,846	-	98,78
8,0	3,411	2,701	-	19,266	-	99,96
8,2	3,260	2,582	-	19,694	-	99,97

The table shows that increasing the pH of the duration of the process contributes to an increase in the degree of precipitation. An increase in pH from 4,9 to 8,2 increases the degree of precipitation of zinc carbonate hydroxide from 30,37% to 99,97% at a temperature of 70°C.

Table 2 shows the data on the influence of the duration of the process on the degree of precipitation of $ZnCO_3 \cdot Zn(OH)_2$ and the chemical composition of the pulp at 15, 30 and 45 min. pH value (7,9-8,2).

Table-2. Influence of time duration on the degree of precipitation of zinc hydroxide carbonate from zinc nitrate solution

№	τ, min	Salt composition of the liquid phase, mass %				Degree of precipitation, %
		$ZnCO_3$	$Zn(OH)_2$	$Zn(NO_3)_2$	NH_4NO_3	
1	15	1,096	0,868	6,571	3,384	33,32
2	30	2,192	1,736	3,287	6,768	66,65
3	45	3,288	2,604	0,003	10,152	99,97

The table shows that the degree of precipitation passes through a maximum in the time interval of 40-45 min. Increasing the duration of the deposition process from 15 min. up to 45 min. increases the degree of precipitation of zinc carbonate hydroxide from 33,32% to 99,97% in the temperature range of 70°C at a pH of the medium (7,9-8,2).

Further, we studied the influence of temperature duration on the degree of precipitation of zinc hydroxide carbonate from a solution of zinc nitrate with a solution of sodium carbonate and the chemical composition of the pulp in the time interval of 45 minutes at different temperatures pH of the medium (7,9-8,2). The results are shown in table 3.

Table-3. Effect of duration temperature on the degree of precipitation of carbonate hydroxide

№	Temperature, °C	Salt composition of the liquid phase, mass %				Degree of precipitation, %
		$ZnCO_3$	$Zn(OH)_2$	$Zn(NO_3)_2$	NH_4NO_3	
1	30	1,644	1,302	5,632	4,351	42,84
2	40	2,192	1,736	4,225	5,801	57,13
3	50	2,740	2,170	2,818	7,251	71,41
4	60	3,288	2,604	1,410	8,701	85,69
5	70	3,293	2,676	0,003	10,152	99,97

Increasing the temperature of the duration of the process contributes to an increase in the degree of deposition of $ZnCO_3 \cdot Zn(OH)_2$. Increasing the temperature from 30℃ to 70℃ increases the rate of precipitation of zinc carbonate hydroxide from 42,84% to 99,97% in the time interval of 45 minutes at a medium pH (7,9-8,2).

Conclusion / Recommendations . Work has been carried out on the selection of optimal conditions for obtaining basic zinc hydroxide carbonate by precipitation with sodium carbonate in laboratory conditions. Positive results were obtained for the precipitation of zinc hydroxide carbonate from a solution of zinc nitrate by a precipitant - a solution of soda ash.

The optimal deposition conditions are as follows:

1. The temperature of the solution of zinc nitrate and soda ash during the precipitation process is maintained in the range of $65\text{-}70^0$C.
2. Precipitation is carried out by simultaneous supply of solutions of zinc nitrate and a solution of soda ash from different separating funnels at pH (7,9-8,2).
3. In this case, the deposition time is (40-45) minutes.

The resulting suspensions are well filtered. The mass fraction of the basic zinc hydroxide carbonate is 5,842%, sodium nitrate is 19,694% in suspension, while the degree of precipitation is 99,97%.

To obtain basic zinc carbonate, it is necessary to use a solution of soda ash as a precipitant.

Advantages of precipitation with this reagent:

1. Precipitator - soda ash solution has a constant concentration.
2. Complete precipitation of zinc hydroxide carbonate is achieved, in the mother solution of sodium nitrate, the content of zinc ions does not exceed the permissible limits, and therefore the mother solution of sodium nitrate can be evaporated and used as an alkaline fertilizer.
3. The precipitate is well filtered and washed from the mother liquor.

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