Journal for Technology and Science
Homepage : https://journal.antispublisher.com/index.php/IPTEKS
Email : admin@antispublisher.com

e-ISSN : 3047-4337
JOTECH, Vol. 3, No. 2, April 2026
Page 68-74


# Investigation of Zinc Hydroxide Carbonate Formation from Zinc Nitrate Solution by Sodium Carbonate Precipitation

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**DOI : https://doi.org/10.61796/ipteks.v3i2.477**

**Sections Info**

***Article history:***
Submitted: January 07, 2026
Final Revised: February 26, 2026
Accepted: March 18, 2026
Published: April 20, 2026

***Keywords:***
Zinc nitric acid
Sodium carbonate
Zinc hydroxide carbonate
pH
Temperature
Time
Precipitation
Filtration
Physical and chemical properties

**ABSTRACT**

***Objective:*** *This study presents the results of zinc hydroxide carbonate production through precipitation from a zinc nitrate solution using an 18% sodium carbonate solution.* ***Method:*** *The effects of key process parameters on the precipitation efficiency were systematically examined, and optimal operating conditions were determined.* ***Results:*** *The initial zinc nitrate solution contained 13,16% ZnO. The highest precipitation efficiency of zinc hydroxide carbonate was achieved within a pH range of 7,9–8,3 and at a temperature of 65–70°C. Additionally, extending the process duration from 40 to 45 minutes led to an increase in the precipitation degree from 98,79% to 99,96%.* ***Novelty:*** *The effects of key process parameters on the precipitation efficiency were systematically examined, and optimal operating conditions were determined.*

## INTRODUCTION

The growing demand for zinc-based materials across various industrial sectors necessitates the development of efficient and sustainable production technologies [1]. Among these materials, zinc hydroxide carbonate is an important intermediate compound widely used in the production of zinc oxide, adsorbents, catalysts, and other functional materials. Its properties and quality are directly influenced by the synthesis conditions, making the optimization of its production process of significant scientific and practical importance [2].

One of the most effective methods for obtaining zinc hydroxide carbonate is precipitation from zinc nitrate solutions using sodium carbonate. This method is characterized by its simplicity, relatively low energy consumption, and the ability to control the physicochemical properties of the final product by adjusting process parameters such as pH, temperature, and time [3].

At the same time, the increasing focus on the efficient use of secondary resources and industrial waste has made the development of technologies for the recovery of zinc compounds a pressing issue. In this context, the production of zinc hydroxide carbonate from zinc-containing solutions represents an important step toward resource-efficient and environmentally safe manufacturing [4].

**Literature review,** A review of experimental studies reported in the literature indicates that optimal conditions for the precipitation of zinc compounds from zinc nitrate solutions using ammonium carbonate have been established. [5]In these studies, a zinc nitrate solution was introduced into a reactor and maintained at a temperature of 60–70°C, after which an ammonium carbonate solution was gradually added. The formation of basic zinc carbonate was carried out within a pH range of 6,0–7,8 over a period of approximately 1,5 hours under intensive stirring conditions [6].

For the precipitation process, an ammonium carbonate solution containing 153,4 g/dm3 of $CO_2$ and 159,0 g/dm3 of NH4+ was prepared by absorbing carbon dioxide into a 25% ammonia solution. The resulting slurry of basic zinc carbonate was then filtered, and the precipitate was washed until nitrate ions were no longer detected [7].

In subsequent studies, precipitation was performed using a saturated ammonium carbonate solution both with heating up to 80°C and without heating. The completion of precipitation was monitored by pH, which ranged between 8 and 10. It was observed that filtrates obtained under heated conditions contained significantly lower residual zinc (150–170 mg/l) compared to those obtained without heating, where zinc concentrations reached 320–380 mg/L.

The precipitate was further purified by repeated decantation with hot water, ensuring the removal of residual ammonium nitrate and zinc sulfate impurities [8].

## RESEARCH METHOD

Zinc ions were precipitated from a zinc nitrate solution in the form of basic zinc carbonate using a sodium carbonate solution as the precipitating agent, according to the following reaction: [9]

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

Optimal parameters for the precipitation of basic zinc hydroxide carbonate were established, including reagent ratios, process temperature, pH, and reaction time.

A zinc nitrate solution containing 13,16% ZnO and a sodium carbonate solution with a concentration of 18% were preheated to a temperature range of 70–75°C. Under laboratory conditions, the precipitation process was carried out by simultaneously introducing the heated zinc nitrate and sodium carbonate solutions into the reactor from separate funnels while maintaining continuous stirring.

During the precipitation stage, the pH was maintained within the range of 7,9–8,3 to ensure complete formation of zinc hydroxide carbonate. The duration of the process was 40–45 minutes [10].

Upon completion of the reaction, the precipitated basic zinc hydroxide carbonate was separated from the sodium nitrate mother liquor, and the composition of the liquid phase was analyzed.

The resulting precipitate was then washed with distilled water to remove residual nitrate ions. The content of zinc hydroxide carbonate was determined in the washed and dried product [11].

## RESULTS AND DISCUSSION

For the effective implementation of the zinc hydroxide carbonate precipitation process, it is essential to consider the physicochemical properties of the intermediate products. Zinc ions were precipitated using a sodium carbonate solution under controlled conditions, maintaining a pH range of 7,9–8,3, a temperature of 65–70°C, and a reaction time of 40–45 minutes with continuous stirring. The analytical results of zinc hydroxide carbonate formation from the zinc nitrate solution are presented in Table 1.

**Table 1.** Influence of pH on zinc hydroxide carbonate formation kinetics

| 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 | 30,38 |
| 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 | - | 98,79 |
| 8,0 | 3,411 | 2,701 | - | 19,266 | - | 99,96 |
| 8,3 | 3,260 | 2,582 | - | 19,694 | - | 99,97 |

The data indicate that increasing the pH and extending the process duration lead to a significant improvement in the precipitation efficiency. Raising the pH from 4,9 to 8,3 at a temperature of 70°C enhances the precipitation degree of zinc hydroxide carbonate from 30,38% to 99,96% [12].

Table 2 presents the results demonstrating the effect of process time on the precipitation efficiency of $ZnCO_3 \cdot Zn(OH)_2$, as well as the chemical composition of the resulting pulp at intervals of 15, 30, and 45 minutes within a pH range of 7,9–8,3.

**Table 2**. Influence of process duration on zinc hydroxide carbonate formation from zinc nitrate

| № | 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 |

| № | τ, min | Salt composition of the liquid phase, mass % | | | | Degree of precipitation, % |
|---|---|---|---|---|---|---|
| | | $ZnCO_3$ | $Zn(OH)_2$ | $Zn(NO_3)_2$ | $NH_4NO_3$ | |
| 3 | 45 | 3,288 | 2,604 | 0,003 | 10,152 | 99,96 |

The results indicate that the precipitation efficiency reaches its maximum within a time interval of 40–45 minutes. Extending the process duration from 15 to 45 minutes at a temperature of 70°C and a pH range of 7,9–8,3 leads to a significant increase in the precipitation degree of zinc hydroxide carbonate, rising from 33,32% to 99.96%.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 (7,9-8,3). The results are shown in table 3 [13].

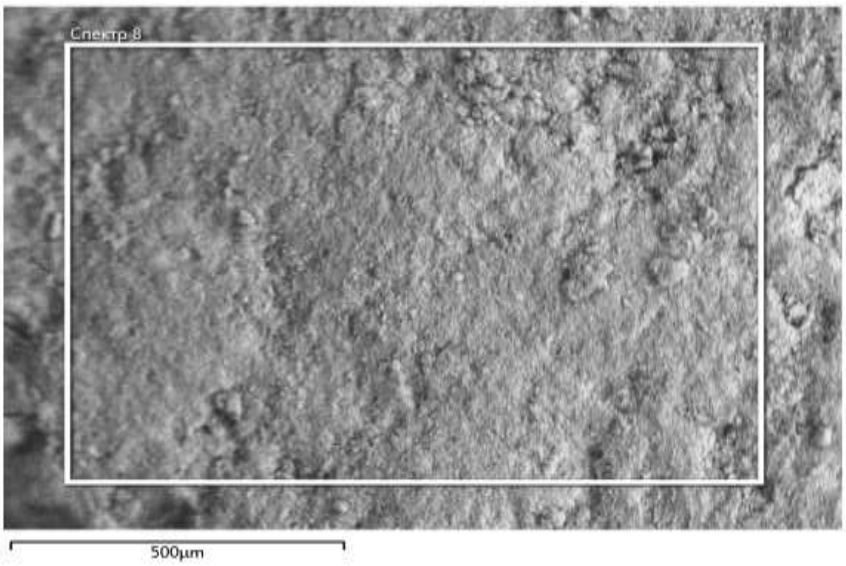
**Table 3.** Role of temperature and duration in zinc hydroxide carbonate precipitation

| № | 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 | 42,85 |
| 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 | 99,96 |

An increase in temperature and process duration significantly enhances the precipitation efficiency of $ZnCO_3 \cdot Zn(OH)_2$. Raising the temperature from 30°C to 70°C, while maintaining a pH range of 7,9–8,3 and a reaction time of 45 minutes, leads to a substantial increase in the precipitation degree from 42,85% to 99,96%.

Figure 1 presents an SEM image of basic zinc carbonate, accompanied by energy-dispersive X-ray analysis used to determine the quantitative composition of the elements present in the sample. The results indicate that the predominant elements are zinc, oxygen, and sulfur, with contents of 62,6%, 37,1%, and 0,3%, respectively.

During the precipitation process from purified leach solutions obtained by nitric acid treatment of zinc oxide, nitrate salts of impurity elements and basic zinc carbonate are formed. At pH values up to 8,3, zinc remains in solution in the form of zinc nitrate. Since nitrate salts are highly soluble in water, the precipitated basic zinc carbonate was washed with water to remove these impurities [14].




| Element | Zn | O | S | Summa: |
|---|---|---|---|---|
| Weight, % | 62,6 | 37,1 | 0,3 | 100,00 |
| Sigma Weight, % | 0,71 | 0,71 | 0,20 | |

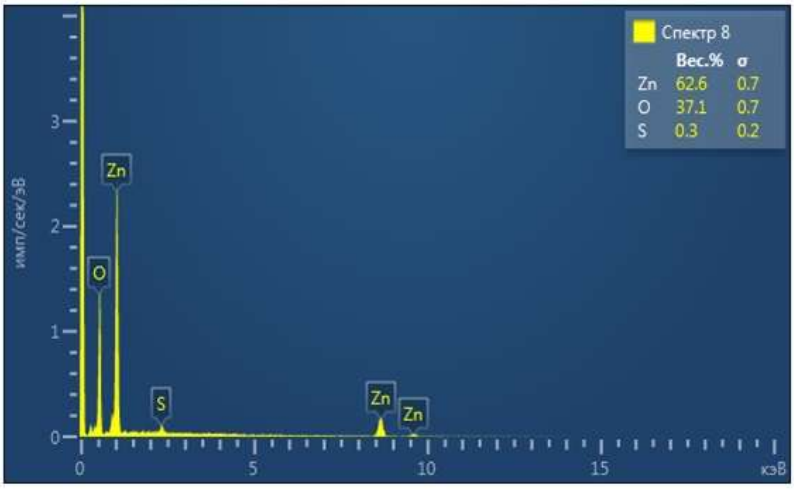



**Figure 1.** Scanning electron microscopy image of basic zinc carbonate

## CONCLUSION

**Fundamental Finding:** Laboratory studies were carried out to determine the optimal conditions for producing basic zinc hydroxide carbonate through precipitation using sodium carbonate. The experiments confirmed the effective formation of zinc hydroxide carbonate from zinc nitrate solutions when soda ash was used as the precipitating agent [15]. The optimal precipitation conditions were established as follows: The temperature of both zinc nitrate and sodium carbonate solutions was maintained within the range of 65–70°C. Precipitation was performed by the simultaneous addition of the reactant solutions from separate funnels while maintaining the pH within 7,9–8,3. The duration of the process was set at 40–45 minutes. Under these conditions, the resulting suspensions exhibited good filtration properties. The composition of the suspension included 5,842% basic zinc hydroxide carbonate and 19,694% sodium nitrate,

while the precipitation efficiency reached 99,96%. **Implication:** The use of a sodium carbonate solution as a precipitating agent for obtaining basic zinc carbonate offers several advantages: The precipitating reagent maintains a stable concentration during the process. Nearly complete precipitation of zinc hydroxide carbonate is achieved, with residual zinc ion concentrations in the sodium nitrate mother liquor remaining within acceptable limits. This allows the mother liquor to be further processed, for example, by evaporation and use as an alkaline fertilizer. The formed precipitate is easily filtered and can be effectively washed to remove residual impurities [16]. **Limitation:** Precipitation was performed by the simultaneous addition of the reactant solutions from separate funnels while maintaining the pH within 7,9–8,3. The duration of the process was set at 40–45 minutes. **Future Research:** This allows the mother liquor to be further processed, for example, by evaporation and use as an alkaline fertilizer.

## REFERENCES

[1] Sh. Kh. Tavashov, B. I. Farmanov, and A. T. Dadakhodjaev, "Investigation of the process of obtaining zinc nitrate from spent zinc catalysts," Universum: Technical Sciences, no. 10(91), pp. 28–31, 2021.

[2] Sh. Kh. Tavashov and B. I. Farmanov, "Research of the preparation of an absorber based on zinc oxide," International Journal of Advanced Research in Science, Engineering and Technology, no. 7(52), pp. 18324–18327, 2021.

[3] Sh. Kh. Tavashov, Kh. Ch. Mirzakulov, and A. T. Dadakhodjaev, "Absorbers of sulfur compounds from spent catalysts," Chemical Technology and Engineering, pp. 89–90, 2020.

[4] T. S. Khuzhakhmatovich, D. A. Tursunovich, and M. K. Chorievich, "Recycling of zinc oxide scavengers," Asian Journal of Multidimensional Research (AJMR), vol. 9, no. 3, pp. 152–159, 2020.

[5] T. S. Khuzhakhmatovich, D. A. Tursunovich, and M. K. Chorievich, "Technology development production of a zinc oxide scavenger," ACADEMICIA: An International Multidisciplinary Research Journal, vol. 10, no. 4, pp. 714–724, 2020.

[6] Sh. Kh. Tavashov, B. I. Farmanov, and R. Yorbobaev, "On the issue of intensifying the processing of spent zinc absorbers," Journal for Innovative Development in Pharmaceutical and Technical Science (JIDPTS), vol. 4, no. 4, pp. 5–8, 2021.

[7] B. I. Farmanov and Sh. Kh. Tavashov, "The effect of Ca-containing components and heat treatment modes on corundum catalyst supports," in Technical and Technological Modernization of Russia, 2020.

[8] B. I. Farmanov and Sh. Kh. Tavashov, "Development of a technology for obtaining strong carriers and nickel catalysts for primary reforming of natural gas," Universum: Engineering Sciences, no. 5-5, pp. 17–20, 2021.

[9] F. B. Ilkhomovich, T. S. Khujakhmatovich, and I. F. Sabirovich, "Development of production of natural gas primary reforming catalyst," International Journal on Integrated Education, vol. 3, no. 9, pp. 264–266.

[10] B. F. Ilkhomovich and T. S. Khujakhmatovich, "Method of nickel extraction from industrial waste and its application in production," Academia Open, vol. 6, 2022, doi: 10.21070/acopen.6.2022.4730.

[11] Sh. Kh. Tavashov, "Study of the process of producing zinc nitrate from secondary raw materials," Information Horizons: American Journal of Library and Information Science Innovation, vol. 3, no. 4, pp. 1–3, 2025.

[12] Sh. Kh. Tavashov, "Research of the physical and chemical indicators of zinc absorber," Miasto Przyszłości, vol. 59, pp. 1–4, 2025.

[13] Sh. Kh. Tavashov, "Problems of regeneration of used zinc catalysts," Journal of Intellectual Property and Human Rights, vol. 4, no. 4, pp. 1–4, 2025.

[14] Sh. Kh. Tavashov, "Investigation of the physical and chemical properties of spent zinc catalysts and processing with nitric acid," American Journal of Engineering, Mechanics and Architecture, vol. 3, no. 4, pp. 1–4, 2025.

[15] Sh. Kh. Tavashov, "Study of the process of obtaining basic zinc carbonate from spent zinc absorber," Innovative: International Multi-Disciplinary Journal of Applied Technology, vol. 2, no. 10, pp. 1–4, 2024.

[16] Sh. Kh. Tavashov, "Method for obtaining zinc absorber from local raw materials," American Journal of Technology Advancement, vol. 2, no. 4, pp. 1–4, 2025.

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