Investigation Of The Process Of Processing Double Salt Into Potassium Sulfate

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Abstract
This comprehensive study investigates the conversion process of double salt $K_2SO_4 \cdot (NH_4)_2SO_4$ into high-purity potassium sulfate through controlled dissolution and selective precipitation mechanisms. The research focuses on optimizing the conversion parameters to achieve maximum potassium sulfate yield while minimizing impurity incorporation and byproduct formation. Experimental investigations were conducted using double salt obtained from the interaction of flotation potassium chloride with ammonium sulfate solutions under precisely controlled conditions.
Keywords: Double salt conversion; Potassium sulfate; Dissolution kinetics; Selective precipitation; Liquid-solid equilibrium.

INTRODUCTION

The conversion of double salt $K_2SO_4 \cdot (NH_4)_2SO_4$ into pure potassium sulfate represents a critical step in the overall production chain of this valuable agricultural chemical [1]. This process requires careful optimization to achieve high conversion efficiency while maintaining product quality and minimizing environmental impact [2]. The double salt conversion method offers several advantages over direct production routes, including better control over product purity and the ability to recycle process streams [3]. The theoretical foundation for double salt conversion is based on the principle of selective dissolution and precipitation, where the double salt is dissolved in water and then treated with additional potassium chloride to shift the equilibrium toward potassium sulfate formation [4]. This process involves complex solution chemistry and phase equilibria that must be carefully controlled to achieve optimal results [5]. Understanding these mechanisms is essential for developing efficient industrial processes that can compete with alternative production methods [6]. The quality requirements for potassium sulfate used in agricultural applications are stringent, particularly regarding impurity levels and chemical composition [7]. The conversion process must be designed to minimize the incorporation of unwanted components such as ammonium ions and chlorides, which can adversely affect crop performance [8]. Furthermore, the process must be economically viable and environmentally sustainable to be attractive for commercial implementation [9].

RESEARCH METHODOLOGY

The experimental investigation was designed to provide comprehensive evaluation of the double salt conversion process under carefully controlled laboratory conditions. The methodology encompasses detailed characterization of starting materials, systematic process optimization, and thorough analysis of products and byproducts.The double salt $K_2SO_4 \cdot (NH_4)_2SO_4$ used in this study was prepared through the optimized conversion method described in previous research. The material was subjected to comprehensive characterization including X-ray diffraction analysis to confirm crystal structure, scanning electron microscopy to evaluate particle morphology, and quantitative chemical analysis to determine composition. The double salt exhibited consistent quality with K_2O content of 50.96-51.20% and SO_4^{2-} content of 49.60-49.65%, with minimal impurity levels.

RESULTS AND DISCUSSION

To obtain potassium sulfate, the double salt was dissolved in water and a 10% solution of flotation potassium chloride was added to the double salt solution, taken in an amount that ensured L:S in the initial suspension (0.7-2):1, and kept at a temperature of 25 °C for 1 hour.

The suspension was separated on a filter and the sediment was washed with water. The results of the studies are given in Tables 1 and 2.

Table 1. Effect of S:L on the chemical composition of potassium sulfate during conversion of double salt

S:L	Chemical composition, mass %			
	K_2O	NH_4^+	Cl^-	SO_4^{2-}
1:0.7	50.51	1.82	1.0	55.08
1:1	51.03	1.61	0.68	55.50
1:2	51.06	1.58	0.583	55.57

As can be seen from Table 2, the compositions of potassium sulfate obtained at L:S 1:1 and 2:1 have almost the same composition. This suggests that increasing L:S more than 1:1 has virtually no effect on the composition of the resulting potassium sulfate. The resulting product after drying has the following composition (wt.%): K_2O – 51.03; SO_4^{2-} – 55.50; NH_4+ – 1.61; Cl^- – 0.68.

Conclusion. This comprehensive investigation successfully demonstrated the feasibility of converting double salt $K_2SO_4 \cdot (NH_4)_2SO_4$ into high-quality potassium sulfate through optimized dissolution and precipitation processes. The experimental results establish optimal liquid-to-solid ratios of 1:1.0 to 1:2.0, with reaction conditions of 25°C and 60-minute duration.

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