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Modeling of Phosphoric Acid Purification by Liquid-Liquid Extraction

By *Bendada Ahlem, Menai Abdeslam-Hansen*, and Benchekik Lehocine-Mouzaib*

Phosphoric acid is an important industrial chemical. It is mainly produced by the wet process which consists of an attack of the phosphate rock by sulphuric acid leading to a complex solution containing a large number of impurities such as metal ions like Fe^{2+} , Al^{3+} , Mg^{2+} , Cd^{2+} etc., which can effectively be recovered by solvent extraction process. In this present work a model of the liquid-liquid extraction process is presented. It is mainly based on thermodynamics, where two different routes have been tested for the modeling of the complexation process. The method has been tested using a model system with Al^{3+} as the contaminant, dodecyl naphthalene sulphonic acid (HDNSA) as the complexing agent and kerosene as the diluent. The study has also investigated the influence of various parameters such as the pH of the aqueous phase and the initial concentration of the phosphoric acid.

1 Introduction

Phosphoric acid is an important industrial chemical, which has several important uses such as an intermediate for the fertilizer industry, for surface treatment in the metal industry and also as an additive in the food industry. It is mainly produced by two different routes: the wet processes or the thermal processes, with the former being the most widely used. It is known as the WPA process and it consists of an attack by sulphuric acid of the phosphate rock, which is the principal source of the dissolved and suspended impurities. This will lead to a complex solution containing a large number of organic and inorganic species, particularly metal ions, the chief ones being Fe^{2+} , Al^{3+} , Mg^{2+} , Cd^{2+} etc. Consequently, the presence of these impurities can induce serious limitations for the use of the phosphoric acid and hence one can see the importance of efficient purification processes such as solvent extraction, which can effectively recover the ionic species.

In this work, an attempt to model the phosphoric acid purification process by liquid-liquid extraction is presented.

2 Description of the Model

The proposed approach is based on a complex formation between ionic species present in the solution, using a judiciously selected complexing agent diluted in an inert organic solvent such as kerosene, chloroform etc., followed by a phase separation, where a part of the amount of the complexes formed migrate into the organic liquid layer, to ensure phase equilibria.

During this process and at $T = 298 \text{ K}$, the following coupled equilibria take place⁽¹⁾:



The K 's express the dissociation or hydrolysis reactions equilibrium constants. In this work, the additional reaction is that between the metallic cation and the selected complexing agent which is the HDNSA for the contamination with Al (III). For this case only one single reaction has been determined from experimental measurements, as reported in [1], which is expressed as follows:



R denotes the DDNSA radical.

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(1) List of symbols at the end of the paper.

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Table of Contents Papers Of Production Of Phosphoric Acid

1. Understanding the eBook Papers Of Production Of Phosphoric Acid
 - The Rise of Digital Reading Papers Of Production Of Phosphoric Acid
 - Advantages of eBooks Over Traditional Books
2. Identifying Papers Of Production Of Phosphoric Acid
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Papers Of Production Of Phosphoric Acid
 - User-Friendly Interface
4. Exploring eBook Recommendations from Papers Of Production Of Phosphoric Acid
 - Personalized Recommendations
 - Papers Of Production Of Phosphoric Acid User Reviews and Ratings
 - Papers Of Production Of Phosphoric Acid and Bestseller Lists

5. Accessing Papers Of Production Of Phosphoric Acid Free and Paid eBooks
 - Papers Of Production Of Phosphoric Acid Public Domain eBooks
 - Papers Of Production Of Phosphoric Acid eBook Subscription Services
 - Papers Of Production Of Phosphoric Acid Budget-Friendly Options
6. Navigating Papers Of Production Of Phosphoric Acid eBook Formats
 - ePub, PDF, MOBI, and More
 - Papers Of Production Of Phosphoric Acid Compatibility with Devices
 - Papers Of Production Of Phosphoric Acid Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Papers Of Production Of Phosphoric Acid
 - Highlighting and Note-Taking Papers Of Production Of Phosphoric Acid
 - Interactive Elements Papers Of Production Of Phosphoric Acid
8. Staying Engaged with Papers Of Production Of Phosphoric Acid
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Papers Of Production Of Phosphoric Acid
9. Balancing eBooks and Physical Books Papers Of Production Of Phosphoric Acid
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Papers Of Production Of Phosphoric Acid
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Papers Of Production Of Phosphoric Acid
 - Setting Reading Goals Papers Of Production Of Phosphoric Acid
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Papers Of Production Of Phosphoric Acid
 - Fact-Checking eBook Content of Papers Of Production Of Phosphoric Acid
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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