

**KINETICS OF MIXED-ION METAL ADSORPTION IN A PACKED ION-
EXCHANGE COLUMN**



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ABSTRACT

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The adsorption kinetics of metal ions on a strong-acid cation resin (Dowex50-x8) from mixed-ion solutions of $\text{Ca}^{2+}/\text{Mg}^{2+}/\text{H}^+$ were investigated in both batch and fixed-bed operations. From batch adsorption experiments, the relationship between the concentrations of metal ions on the resin (q^e) and in the solution (c^e) at equilibrium was developed and the adsorption rate constant (K) was determined. From column dynamic studies in the absence of metal adsorption, the packed column was found to be best as described by a small CSTR connected in series with an ideal PFR. By combining the adsorption parameters with the flow characteristics, the mathematical model was completed and then used to predict the adsorption in a mixed-ion system of Ca^{2+} and Mg^{2+} in fixed-bed operation. The model was shown to adequately describe the metal adsorption in the mixed-ion system. The competitive adsorption of Ca^{2+} and Mg^{2+} ions in a mixed-ion system was also examined. Both batch and column results revealed that Ca^{2+} ions were preferentially adsorbed by the Dowex50-x8 resin. The adsorption rate and adsorbed amount at equilibrium of Ca^{2+} ions were higher than those of Mg^{2+} ions while the desorption rate and desorbed amount of Ca^{2+} ions were significantly lower during regeneration.

บทคัดย่อ

ประภาพรรณ จีรวราพันธ์ : จลนพลศาสตร์ของการดูดซับโลหะผสมในคอลัมน์แลกเปลี่ยนไอออนแบบฟีกเบด (Kinetics of Mixed-Ion Metal Adsorption in a Packed Ion-Exchange Column) อ.ที่ปรึกษา : ศ. เจมส์ โอ วิลส์ (Prof. James O. Wilkes), ดร. ปมทอง มาลากุล ณ อยุธยา และ ผศ. ดร. ปราโมช รังสรรค์วิจิตร 107 หน้า ISBN 974-03-1573-9

งานวิจัยนี้ศึกษาจลนพลศาสตร์การดูดซับของการแลกเปลี่ยนไอออนโลหะผสมระหว่างแคลเซียมไอออนและแมกนีเซียมไอออนบนเรซินที่อิมมัวอยู่ในรูปแบบ (Dowex50-x8) ซึ่งได้ทำการทดลองทั้งระบบแบบกะ (Batch) และ ระบบคอลัมน์แบบฟีกเบด (Fixed-Bed) สำหรับแบบจำลองที่ใช้อธิบายการดูดซับของไอออนโลหะผสมในคอลัมน์แบบฟีกเบดนั้นได้พัฒนามาจากความสัมพันธ์ดังนี้: ส่วนแรกคือ ค่าตัวแปรของการดูดซับ ได้แก่ความสัมพันธ์ระหว่างปริมาณของโลหะไอออนในเรซินและในสารละลายที่สมดุล (q^c และ c^c) และค่าคงที่ของอัตราการดูดซับ (K) โดยค่าตัวแปรต่างๆ เหล่านี้ได้มาจากการทดลองแบบกะ ส่วนที่สองคือ ลักษณะการไหลของของเหลวในคอลัมน์แบบฟีกเบดที่ปราศจากการดูดซับ ซึ่งพบว่าคอลัมน์นั้นสามารถจำลองด้วยการรวมตัวของ CSTR ขนาดเล็ก 1 ตัว และ PFR 1 ตัว เมื่อรวมความสัมพันธ์ข้างต้นนี้ จะได้แบบจำลองซึ่งสามารถใช้คาดเดาพฤติกรรมของการดูดซับของโลหะผสมในคอลัมน์แบบฟีกเบดได้ นอกจากนี้ยังได้ทำการศึกษาการแข่งขันการดูดซับระหว่างแคลเซียมไอออนและแมกนีเซียมไอออนในสารละลายโลหะผสม จากการทดลองพบว่า เรซินที่อิมมัวอยู่ในรูปแบบ (Dowex50-x8) ชอบดูดซับแคลเซียมไอออนมากกว่าแมกนีเซียมไอออน อัตราการดูดซับและปริมาณไอออนที่ถูกดูดซับที่สมดุลของแคลเซียมไอออนมีค่ามากกว่าแมกนีเซียมไอออน นอกจากนี้ระหว่างที่ทำการชะล้างเพื่อที่จะนำเรซินกลับมาใช้ใหม่ (Regeneration) พบว่าอัตราการคายไอออน และปริมาณที่ไอออนคายออกมาจากรเรซินของแคลเซียมไอออนมีค่าต่ำกว่า

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