

PRECIPITATION KINETICS OF CALCIUM-PHOSPHONATE (ATMP)



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A Thesis Submitted in Partial Fulfilment of the Requirements
for the Degree of Master of Science
The Petroleum and Petrochemical College, Chulalongkorn University
in Academic Partnership with
Case Western Reserve University, The University of Michigan,
The University of Oklahoma, and Institut Français du Pétrole
2004

ISBN 974-9651-35-9

Thesis Title: Precipitation Kinetics of Calcium-Phosphonate (ATMP)
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ABSTRACT

4571014063 : PETROCHEMICAL TECHNOLOGY
Patcharee Charoensirithavorn: Precipitation Kinetics of Calcium -
Phosphonate (ATMP)
Thesis Advisors: Assoc. Prof. Sumaeth Chavadej, Asst. Prof.
Pomthong Malakul, and Prof. H.Scott Fogler, 43 pp.
ISBN 974-9651-35-9

Keywords : Squeeze Treatment / Scale Inhibitor / Nucleation / Kinetics

Oilfield formation damage by scale formation can occur when incompatible brine streams are mixed during production operation. Scale inhibitors are injected and retained in the reservoir by adsorption and/or precipitation. This study was divided into 2 parts: nucleation kinetics and growth kinetics of scale inhibitor. A model for the induction time, the time between the establishment of supersaturation and the detection of a first precipitate, was applied to scale inhibitor (Amino tri(methylene phosphonic acid), ATMP) precipitation with calcium ions. Experimental data were analyzed by accounting for inhibitor dissociation and cation-inhibitor complexing at different ionic strength. Longer induction times were observed at lower inhibitor concentrations and in the presence of salts. The Ca-ATMP precipitates both formed in the presence and the absence of salts had a Ca:ATMP molar ratio of 1 at a pH of 1.5 and salts did not have significant impact on the morphology of the precipitates. The presence of salts in solution was found to decrease both nucleation and growth rates in the order of $\text{LiCl} < \text{NaCl} < \text{KCl}$. Increases in the nucleation and growth rates delay the inhibitor precipitation kinetics which will be beneficial for effective inhibitor squeeze treatment designs and prevention of reservoir permeability problems resulted from the precipitation in near well-bore region.

บทคัดย่อ

พัชรี เจริญศิริถาวร: จลศาสตร์การตกตะกอนของแคลเซียมฟอสเฟต (เอทีเอ็มพี)
(Precipitation Kinetics of Calcium – Phosphonate (ATMP)) อ. ที่ปรึกษา: รศ. ดร.
สุเมธ ชวเดช, ผศ. ดร. ปมทอง มาลากุล ณ อยุธยา และ ศ. ดร. สกอร์ต์ เอช ฟอกเลอร์ 45 หน้า
ISBN 974-9651-35-9

วิธีการป้องกันปัญหาที่สร้างความเสียหายในระหว่างการขุดเจาะน้ำมันที่เกิดขึ้นเนื่องจากการเกิดการตกตะกอนของการผสมกันของน้ำทะเลและน้ำที่ค้างอยู่ในชั้นหินคือ การฉีดสารยับยั้งการตกตะกอนเข้าสู่ชั้นหิน และค้างอยู่ในชั้นหินโดยการตกตะกอนกับไอออนบวกในชั้นหิน งานวิจัยนี้ แบ่งการศึกษาเป็น 2 ส่วน คือ จลศาสตร์การก่อและการเติบโตของตะกอนแคลเซียมและสารยับยั้งการเกิดตะกอน ซึ่งในการศึกษานี้เลือก Aminotri (methylene phosphonic acid) หรือ ATMP เป็นสารต้นแบบของสารยับยั้งการตกตะกอน แบบจำลองของ ระยะเวลาการตกตะกอน (induction time) ประยุกต์เข้ากับการตกตะกอน ระหว่างแคลเซียมและ ATMP โดยวิเคราะห์รวมถึงผลของการแตกตัวของ ATMP และการเกิดสารเชิงซ้อนระหว่างแคลเซียมและ ATMP ผลการทดลองพบว่า ในสภาวะความเข้มข้นของสารยับยั้งสูง และ/หรือมีเกลือ (โซเดียมคลอไรด์, ลิเทียมคลอไรด์, และ/หรือ โพแทสเซียมคลอไรด์) ในสารละลาย จะมีระยะเวลาการตกตะกอนนานขึ้น ตะกอนจากทั้งที่มีเกลือและที่ไม่มีเกลือในสารละลายพบว่ามีอัตราส่วนโดยโมลของแคลเซียมเท่ากับ ATMP ที่ pH 1.5 และไม่พบการตกตะกอนร่วมของเกลือ นอกจากเกลือจะสามารถยับยั้งการเกิดตะกอนแล้วยังพบว่าเกลือสามารถยับยั้งการเติบโตของตะกอนได้อีกด้วยการเพิ่มอัตราการเกิดตะกอนของสารยับยั้งสามารถป้องกันการอุดตันของตะกอนได้

ACKNOWLEDGEMENTS

This work could not have been completed without the help of a number of individuals and organizations. I would like to express the deepest appreciation for their assistance.

Special thanks are offered to Professor H. Scott Fogler, Assoc. Prof. Sumaeth Chavadej, and Asst. Prof. Pomthong Malakul for giving me a chance to work on this interesting thesis and also for their valuable suggestions and constant encouragement throughout my graduate work.

I would like to thank Asst. Prof. Pramoch Rangsunvigit and Dr. Sirirat Jitkamka for their kind advice and for being on the thesis committee.

I would like to extend my sincere thanks to the member in Porous Media Research Group for their hospitality during my visit to the University of Michigan, especially, Veerapat Tantayakom for his suggestion and help.

Also my thanks are given to all Thai graduate students both in the Department of Chemical Engineering and outside the Department for giving me their very sincere and warm welcome like family.

The Partial financing supports through research grants provided by Postgraduate Education and Research Programs in Petroleum and Petrochemical Technology (PTT consortium). Moreover, the financial support provided by the University of Michigan Porous Media Affiliates Program, including Becker Petrolite, Chevron, Texaco, Conoco Philips, Halliburton, PDVSA, Schlumberger, and Shell Oil.

Also, very special thanks to the generous supporter, Monsanto Company for the chemicals and information used in this study.

Finally, I would like to extend the most important thank to my family for providing their love, hospitality and every thing until I completely finished this thesis.

This Thesis would not have been possible without all these persons and organization above.

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