DEVELOPMENT OF FLOW-BASED TECHNIQUES FOR THE DETERMINATION OF SOME HEAVY METALS IN ENVIRONMENTAL SAMPLES

SUPUNNEE DUANGTHONG

DOCTOR OF PHILOSOPHY IN CHEMISTRY

Copyright GRADUATE SCHOOL CHIANG MAI UNIVERSITY AUGUST 2004 ISBN 974-658-633-5 S e r v e d

DEVELOPMENT OF FLOW-BASED TECHNIQUES FOR THE DETERMINATION OF SOME HEAVY METALS IN ENVIRONMENTAL SAMPLES

SUPUNNEE DUANGTHONG

A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN CHEMISTRY

Copyright GRADUATE SCHOOL CHIANG MAI UNIVERSITY AUGUST 2004 A I I i g h ISBN 974-658-633-5 S e r v e d

DEVELOPMENT OF FLOW-BASED TECHNIQUES FOR THE DETERMINATION OF SOME HEAVY METALS IN ENVIRONMENTAL SAMPLES

SUPUNNEE DUANGTHONG

THIS THESIS HAS BEEN APPROVED TO BE A PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN CHEMISTRY

EXAMINING COMMITTEE CHAIRPERSON Assoc. Prof. Dr. Kate Grudpan MEMBER Assoc. Prof. Dr. Prasak Thavornyutikarn MEMBER Dr. Jaroon Jakmunee MEMBER Assoc. Prof. Dr. Udom Sriyotha MEMBER Asst. Prof. Dr. Yuthsak Vaneesorn MEMBER Assoc. Prof. Dr. Hans Mosbaek 23 August 2004 © Copyright by Chiang Mai University

ACKNOWLEDGEMENTS

The author expresses deep gratitude and is much indebted to Assoc. Prof. Dr. Kate Grudpan, her supervisor for his kind advice, suggestions and encouragement.

The author is grateful to Dr. Jaroon Jakmunee, Assoc. Prof. Dr. Prasak Thavornyutikarn and Dr. Ponlayuth Sooksamiti, her co-advisors, for their kind advice and criticism. The author also acknowledges Dr. Somchai Lapanantnoppakhun for his valuable comments and suggestions.

The author would like to express her sincere thanks to Assoc. Prof. Dr. Hans Mosbæk, her host and co-advisor in Denmark, for his valuable suggestions, guidance and kindness including his taking cares during her stay in Denmark.

The author is also indebted to the Development and Promotion of Science and Technology Talent Project (DPST) for the scholarship for her Ph.D. study. The author would like to acknowledge the Thailand University Consortium for Environment and Development-Industry and Urban Areas (TUCED-I&UA) and the Danish University Consortium for Environment and Development-Industry and Urban Areas (DUCED-I&UA) for their support of the scholarship to perform research in Denmark. The author is sincerely grateful to the Thailand Research Fund (TRF) and the Postgraduate Education and Research Program in Chemistry (PERCH) for partial supports. The author

acknowledges the Graduate school and Faculty of Science, Chiang Mai University for partial support for attending national and international conferences.

The author thanks the Department of Chemistry, Faculty of Science, Chiang Mai University for laboratory facilities provided.

Thanks are also due to FBA group members in Chiang Mai University for their suggestions and assistance. Finally, the author especially thanks to her family for their love and cares.

Supunnee Duangthong

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่ Copyright © by Chiang Mai University All rights reserved

S C MAI