SOLVING TWO-DIMENSIONAL GROUNDWATER FLOW EQUATION USING ALTERNATING DIRECTION IMPLICIT METHOD

NORAIN BINTI AHMAD NORDIN

UNIVERSITI TEKNOLOGI MALAYSIA

SOLVING TWO-DIMENSIONAL GROUNDWATER FLOW EQUATION USING ALTERNATING DIRECTION IMPLICIT METHOD

NORAIN BINTI AHMAD NORDIN

A dissertation submitted in partial fulfillment of the

requirements for the award of the degree of

Master of Science (Mathematics)

Faculty of Science

Universiti Teknologi Malaysia

JUNE 2014

To my beloved mother, Suziana binti Sidek, my father, Ahmad Nordin bin Abdullah,
My brothers Muhammad Muizzuddin and Muhammad Luqma'nul Hakim
Thank you for all of your greatest support and everlasting love

Lastly, millions of thankful to my supervisor
Tuan Haji Hamisan Bin Rahmat

ACKNOWLEDGMENT

Alhamdulillah, first of all, I would like to thank Allah SWT the Lord of Almighty, for giving me health and strength in completing this dissertation.

I wish to express my deepest gratitude to my supervisor, Tuan Haji Hamisan Bin Rahmat for his patience and perseverance. He helped in bringing out the intuition and motivation behind my dissertation. Your constant patient and tolerant in guiding me during the process of completing this project is so much appreciated.

I would also like to thank to Encik Che Rahim Bin Che for helping me throughout this project especially on Matlab programming, sharing ideas and giving encouragement.

My gratitude also goes to all my beloved persons especially my parents that inspire me and motivate me throughout all the hard works while carrying out this research. Last but not least, also special thanks for those who involved directly or indirectly helping me in completing this report. My thesis would not have proceeded smoothly without the supports from all of you. Thank you.

ABSTRACT

Groundwater model can be described as a mathematical model and the equation of groundwater is governed by partial differential equation. In order to solve the groundwater flow equation, numerical method such that Finite Difference Method (FDM) is used. In this research, a two-dimensional transient groundwater flow equation for a confined, nonleaky, and homogeneous with mixed boundary conditions is solved using Alternating Direction Implicit (ADI) method where ADI method is one of the FDM. The algorithm of ADI method has been developed for three different types of boundary conditions that is Dirichlet condition, Neuman condition and Mixed condition. The transient groundwater flow equation has been derived and was solved using ADI method by Matlab software. Then, the results obtained were compared to analytical solution. Since the solutions from numerical method provide the small error when compared to the analytical solutions, it therefore can be concluded that ADI method provides good approximations in solving two-dimensional groundwater transient flow problem.

ABSTRAK

Model air bawah tanah boleh digambarkan sebagai model matematik dan persamaan air bawah tanah diwakilkan oleh persamaan pembezaan separa. Bagi menyelesaikan persamaan aliran air bawah tanah, kaedah berangka digunakan iaitu Kaedah Beza Terhingga. Dalam kajian ini, persamaan aliran air bawah tanah dua dimensi yang terbatas, tiada kebocoran, dan homogen dengan syarat bercampur diselesaikan menggunakan kaedah Lelaran Tersirat Berarah (LTB). Kaedah ini merupakan salah satu kaedah beza terhingga. Algoritma kaedah Lelaran Tersirat Berarah telah dibangunkan untuk tiga jenis syarat sempadan iaitu syarat Dirichlet, syarat Neumann dan syarat bercampur. Persamaan aliran air bawah tanah mantap telah diperolehi dan telah diselesaikan dengan kaedah LTB serta perisian Matlab. Kemudian, keputusan yang diperolehi dibandingkan dengan penyelesaian analisis. Oleh kerana penyelesaian berangka memberikan ralat yang kecil apabila dibandingkan dengan penyelesaian analitikal, kaedah Lelaran Tersirat Berarah dapat memberikan penyelasaian yang baik bagi menyelesaikan masalah aliran dua dimensi air bawah tanah.