

OPTIMAL DESIGN OF WATER NETWORK WITH IMPROVED OPERABILITY

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IMPROVED OPERABILITY

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A dissertation submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Engineering (Chemical)

Faculty of Chemical Engineering
Universiti Teknologi Malaysia

JULY 2013

This dissertation is dedicated to my beloved mother and father for their endless support and encouragement.

ACKNOWLEDGEMENT

First and foremost, I would like to express heartfelt gratitude to my supervisors Assoc. Prof. Ir Dr. Sharifah Rafidah Bt. Wan Alwi and Dr. Mohd. Kamaruddin bin Abd. Hamid for their constant support during my study at UTM. They inspired me greatly to work on this project. Their willingness to motivate me contributed tremendously to our project. I have learned a lot from them and I am fortunate to have them as my mentors and supervisors.

Besides, I would like to thank the authority of Universiti Teknologi Malaysia (UTM) for providing me with a good environment and facilities to complete this research.

ABSTRACT

A suitable water network for any water using process can help reduce the amount of fresh water usage. Many researchers have investigated water recovery network for multiple contaminants using mathematical programming. However, operability problems and complex network design have made the actual implementation of the design impractical. In this research, a MINLP mathematical model to design new water recovery network with improved operability is presented. The method considers tanks for intermittent streams based on capacity, omitting small flow rates, preferring more economical streams for cost minimization purposes piping reduction. The approach has been successfully implemented for both industrial and urban cases. CCM Chemicals has been chosen for industrial case study and Sultan Ismail Mosque in UTM as an urban case study. The result shows 17.6% saving on freshwater usage and 53.8% reduction of wastewater generation in CCM Chemicals, giving an approximate saving of RM 34,942 per year on freshwater consumption. Moreover, 3 tanks have been considered in water system and 18 reuse streams have been removed for simplification of water network. This resulted in reduction of piping requirement for water reuse. For SIM case study, freshwater consumption is reduced by 14.56% wastewater generation is reduced by 22.9%. It gives a monetary saving of RM 1,250 per year on freshwater cost. In addition, 2 tanks for intermittent streams are considered and 3 small streams are deleted from the water network. This elimination caused reduction of piping requirement for water network.

ABSTRAK

Satu air sesuai rangkaian untuk sebarang air menggunakan proses dapat menolong mengurangkan jumlah penggunaan air tawar. Banyak penyelidik menyiasat rangkaian pemulihan air untuk bahan-bahan cemar berbilang menggunakan pengaturcaraan matematik. Halangan di jaringan pemulihan air seperti masalah-masalah operability, pengawal kompleks reka bentuk, dan sistem perpaipan kompleks membuat pelaksanaan sebenar reka bentuk tidak praktis. Dalam penyelidikan ini, satu pemulihan air baru reka bentuk rangkaian dan pengawal telah disampaikan. Dalam pendekatan ini, dengan penurunan gangguan-gangguan pengawal dengan pemudahan rangkaian air, mempertimbangkan air kelabu (GW) menggunakan semula, mempertimbangkan sistem penuaian air hujan untuk rangkaian air, satu rangkaian pemulihan air dan pengawal yang mana lebih sesuai dan praktikal telah direkabentuk. Pendekatan telah berjaya dilaksanakan untuk kedua-dua kes-kes perindustrian dan bandar. Ccm Chemicals telah dipilih untuk kajian kes perindustrian dan Sultan Ismail Mosque di UTM sebagai satu kajian kes bandar. Keputusan menunjukkan 17.6% menjimatkan penggunaan air tawar dan 53.8% pengurangan generasi air buangan di CCM Chemicals, memberi satu simpanan kasar RM 34942 setiap tahun di penggunaan air tawar. Juga, kerana kajian kes MSI pengurangan 14.56% di penggunaan air tawar dan 22.9% di generasi air buangan. Keputusan memberi RM 1250 setiap tahun di kos air tawar di kajian kes MSI. Model menunjukkan pengurangan di penggunaan air tawar dan generasi air buangan, kurang masalah gangguan dan operability di reka bentuk pengawal, pertimbangan GW dan sistem-sistem penuaian air hujan di kedua-dua kajian kes perindustrian dan bandar.