ABSTRACT

The current method for composition measurement of an industrial distillation column specifically offline method, is slow, tedious and could lead to inaccurate results. Among the advantages of using online composition designed are to overcome the long time delay introduced by laboratory sampling and provide better estimation, which is suitable for online monitoring purposes. Principal component and partial least square analysis are used to determine the important variables surrounding the column prior to implementing the neural network. It is due to the different types of data available for the plant, which requires proper screening in determining the right input variables to the dynamic model. Statistical analysis is used as a model adequacy test for the composition prediction of n-butane and i-butane in the column. Simulation results showed that the Artificial Neural Network (ANN) can reliably predict the online composition of the column. The major contribution of the current research is the development of composition prediction of n-butane and i-butane using equation based neural network (NN) models. Based on statistical analysis, the results indicate that neural network equation, which is more robust in nature, predicts better than the PLS equation and RA equation based methods. The temperature predictions using neural network equation are also compared with partial least square (PLS) and regression analysis (RA) equations methods. A new technique for nonlinear system, which is based on hybrid neural network modeling, is proposed. The hybrid model consists of combination of residual composition and residual temperature with first principle in terms of mass and energy balance. Hybrid neural network equation performs better than the hybrid neural network, and neural network predictions to estimate composition and temperature for the column. The use of an inverse neural network and forward neural network are used for the direct control of a distillation column. The neural network used for the control strategy to track the set point of the top and bottom temperature. Neural network estimators are used to track the set point of the top and bottom composition together with disturbances. There are two types of controller used for control strategies which are the direct inverse control (DIC) and internal model controller (IMC). Based on the results, IMC and DIC were found to perform better in controlling the temperature with respect to set point changes and disturbances compared to conventional PID controllers.

ABSTRAK

Kaedah semasa untuk mengukur komposisi kolum penyulingan perindustrian kaedah khusus di luar talian, lambat, membosankan dan boleh membawa kepada keputusan yang tidak tepat. Antara kelebihan menggunakan komposisi dalam talian yang direka adalah untuk mengatasi kelewatan masa yang panjang yang diperkenalkan oleh sampel makmal dan memberikan anggaran yang lebih baik, yang sesuai untuk tujuan pemantauan dalam talian. Komponen utama dan sebahagian analisis kuasa dua terkecil yang digunakan untuk menentukan pembolehubah penting sekitar ruang sebelum melaksanakan rangkaian neural. Ia adalah disebabkan oleh pelbagai jenis data yang ada untuk industri, yang memerlukan pemeriksaan yang betul dalam menentukan pembolehubah input yang betul untuk model yang dinamik. Analisis statistik digunakan sebagai ujian kecukupan model ramalan komposisi daripada n-butana dan i-butana dalam ruang. Keputusan simulasi menunjukkan bahawa Rangkaian Neural Buatan (ANN) pasti boleh meramalkan komposisi talian lajur. Sumbangan utama kajian semasa adalah pembangunan ramalan komposisi n-butana dan i-butana menggunakan rangkaian neural (NN) model persamaan berasaskan. Berdasarkan analisis statistik, keputusan menunjukkan bahawa persamaan rangkaian neural, yang lebih teguh dalam alam semula jadi, meramalkan lebih baik daripada persamaan PLS dan persamaan RA kaedah berasaskan. Ramalan suhu menggunakan persamaan rangkaian neural juga berbanding kurangnya separa persegi (PLS) dan analisis regresi (RA) persamaan kaedah. Satu teknik baru untuk sistem tak linear, yang berasaskan pemodelan neural hibrid, adalah dicadangkan. Model hibrid terdiri daripada gabungan komposisi sisa dan sisa suhu dengan prinsip pertama dari segi jisim dan tenaga-kira. Hibrid persamaan rangkaian neural melakukan lebih baik daripada rangkaian neural hibrid, dan ramalan rangkaian neural untuk menganggarkan komposisi dan suhu bagi lajur. Penggunaan rangkaian neural songsang dan rangkaian neural hadapan digunakan untuk kawalan langsung lajur

penyulingan. Rangkaian neural digunakan untuk strategi kawalan untuk mengesan titik set suhu bahagian atas dan bawah. Penganggar rangkaian neural digunakan untuk mengesan titik set komposisi atas dan bawah bersama-sama dengan gangguan. Terdapat dua jenis kawalan yang digunakan untuk strategi kawalan yang kawalan langsung songsang (DIC) dan pengawal model dalaman (IMC). Berdasarkan kepada keputusan, IMC dan DIC didapati prestasi yang lebih baik dalam mengawal suhu berkenaan untuk menetapkan titik perubahan dan gangguan berbanding dengan pengawal PID konvensional

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

AIC	:	Akaike information criterion
ANN	:	Artificial neural network
ANOVA	:	Analysis of variance
BIC	:	Bayesian information criteria
CDC	:	Correct Directional Change
IAE	:	Integral absolute error
ISE	:	Integral square of error
LM	:	Levenberg-Marquardt
MAPE	:	Mean Absolute Percentage Error
MS	:	Mean of square
NARX	:	Nonlinear autoregressive network with exogenous inputs
PCA	:	Principal component analysis
PLS	:	Partial least square
R^2	:	Coefficient of determination
RMSE	:	Root Mean Square Error
SS	:	Sum of square
A_t	:	Actual value
C_p	:	Person correlation co-efficient
D_i	:	Product $y_i \times \overline{y_i}$
E_a	:	Actual value
E_p	:	Predicted value
$\overline{E_a}$	:	Average actual value
$\overline{E_p}$	:	Average predicted value
F_t	:	Predicted value
K	:	Number of free model parameters
MSE	:	Mean square error
N	:	Number of observation
R^2	:	R squared
T	:	Number of parameters
df	:	Degree of freedom
F	:	Statistical F value
$x_{meamsured}$	:	Measure value
$x_{predicted}$	:	Predicted

y_i	:	Difference actual and average actual
$\overline{y_i}$	:	Difference predicted and average predicted
σ^2	:	Variance

LIST OF APPENDICES