IMPLEMENTING A SIMULATOR FOR A PROCESS PLANT WITH A CONTROL SYSTEM

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Degree of Master of Science in Sustainable Process Development

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DECLARATION OF THE CANDIDATE & THE SUPERVISOR

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Abstract

Intention of this research study is to develop a simulator with LABVIEW for a reactor/flash/recycle plant which is described in Edgar et al. (2003). The material balances, component balances and energy balances for each unit were used to develop this simulator. Plant wide control system was proposed in reference book Process Dynamics and Control (Edgar et al., 2003) was simulated to find out best control parameters for the plant. PID controllers are used to control required parameters and PID controllers were tuned using Good Gain method and trial and error as appropriate. The dynamic mathematical models are based on differential equations which are developed for the reactor, flash unit, and recycle tank and for the heat exchangers. The holdup condition was assumed when developing differential equations in the Edgar et al. (2003) but mathematical model developed for this research work eliminated that assumption and further developed the ODEs. These developed equations are solved using the Second Order Runge-Kutta method, in the library function of Lab VIEW software. The steady state values given in the reference book was used to check the accuracy of the simulator and the simulated plant reached steady state output for the relevant inputs. Instead of PID controllers some of the logical controllers were used for smooth operation of the plant. Special functions of LABVIEW were used to speed up the simulator to reach steady state conditions very fast which in actual time will take of more than one day. This simulator is really a good option to find different conditions of the reactor/ flash/ recycle plant, which are impossible to check in an actual plant which can create very unsafe conditions and damages for the equipment and people.

Key words: LabVIEW, Plantwide control, Simulator, PID controllers, Dynamic model

DEDICATION

This thesis is dedicated to

my Mother, Father and

beloved Wife

who encouraged me

to complete the research

work

and to all the lectures and

teachers

who gave me knowledge

to achieve the success.

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LIST OF ABBREVIATIONS

Abbreviation	Description
LabVIEW	Laboratory Virtual Instrument Engineering Workbench
PID	Proportional Integral Deferential
VI	Virtual Instruments
I/O	Input Output
DAQ	Data Acquisition
GPIB	General Purpose Interface Bus
ODE	Ordinary Differential Equations

LIST OF SYMBOLS

Subscript R – Reactor

Subscript F – Flash unit

Subscript T - Recycle tank

V_I - Volume of unit I (I = R, F, T)

$X_{I, N}$ - Mass fraction of N component at unit I (I = R, F, T & N=A, B, C, D)

$X_{I, N}$ - Mole fraction of component N at I stream (I= 1, 2, 3, 4…. & N= A, B, C, D)

W_I - Flow rate of stream I (I= 1,2,3,4 …..)

T_I - Temperature of Unit (I = R, F, T)

T_I - Temperature of I stream (I = 1, 2, 3….8)

H_I - Liquid level of the unit I (I = R, F, T)

A_I - Cross section area of the unit I (I = R, F, T)

ρ - Fluid density

α - Dimensionless mass ratio

r_c - Reaction rate

k - Rate constant

MW_I - Molecular weight of component I (I= A, B, C, D)

Symbols of Energy Balance

Subscript s – Shell side of heat exchanger

Subscript t - Tube side of heat exchanger

Subscript p - Product stream

Subscript w - Water

Subscript C - Cooling water

V_I - Volume of component I (I= s, t, w, p, R)

C_p - Specific heat capacity

U - Overall heat transfer co-efficient

m - Steam flow rate

P - Pressure

F - Cooling water flow rate

f - Heat transfer efficiency of steam heater

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