TABLE OF CONTENTS

CHAPTER NO. TITLE PAGE NO.

CHAPTER NO. **TITLE** **PAGE NO.**

CHAPTER NO. **TITLE** **PAGE NO.**

CHAPTER NO. **TITLE** **PAGE NO.**

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

SYMBOLS

$T(t)$	-	Reactor temperature
T_{amb}	-	Ambient Temperature
T^{set}	-	Reactor temperature set point
$m_M(t)$	-	Monomer mass
$\dot{m}_M^{in}(t)$	-	Monomer Feed Rate
Q_{rea}	-	Reaction heat
ΔH	-	Reaction enthalpy
$m_P(t)$	-	Polymer mass
m_c	-	Mass of coolant
m_w	-	Mass of water
MW_M	-	Molecular weight of monomer
$C_{p,M}$	-	Specific heat of Monomer at constant pressure
$C_{p,C}$	-	Specific heat of Coolant at constant pressure
$C_{p,P}$	-	Specific heat of Polymer at constant pressure
$C_{p,W}$	-	Specific heat of Water at constant pressure
U	-	Overall heat transfer coefficient
A	-	Jacket heat transfer area
$G(\theta^*)$	-	Actual Plant model
$(UA)_{loss}$	-	Heat loss coefficient
T_j^{out}	-	Coolant outlet temperature

$\dot{m}_c$	-	Coolant rate
T_j^{in}	-	Coolant inlet temperature
θ_1	-	Transport delay in jacket
θ_2	-	Transport delay recirculation loop
τ_p	-	Heating/cooling time constant
$K_p(c)$	-	Heating/cooling function
$\dot{m}_M^{in,\max}$	-	Maximum monomer feed rate
$\left[t_{M,0}^{in}, t_{M,1}^{in}\right]$	-	Time interval of feed period for polymer A and polymer B
$\left[t_{M,2}^{in}, t_{M,3}^{in}\right]$	-	Time interval of feed period for polymer B
T_{inlet}	-	Inlet Temperature
T_{steam}	-	Steam temperature
$c(t)$	-	Control valve position
R_P	-	Polymerization rate
$1/h_f$	-	Fouling factor
σ	-	Standard Deviation
i	-	Impurity factor
k	-	First-order kinetic constant
$k_0, k_1, k_2, E,$	-	Constants
$c_0, c_1, c_2 c_3,$		
a_0		
R	-	Natural gas constant
μ	-	Batch viscosity
ρ_M	-	Density of Monomer
ρ_P	-	Density of Monomer

ρ_C	-	Density of Coolant
B_1	-	Reactor bottom area
P	-	Jacket perimeter
B_2	-	Jacket bottom area
h	-	Film heat transfer co-efficient
d_0, d_1	-	Constants
μ_{wall}	-	Wall viscosity
T_j	-	Average cooling jacket temperature
T_{wall}	-	Wall temperature
t^{heat}	-	Time instant when the monomer feed starts
X_i	-	Inputs to the ANN
W_i	-	Weights to the Inputs
b	-	Bias
y	-	Plant output
f(Y)	-	Output of the sigmoid activation function
V	-	Error matrix
e_q	-	Difference in process and network output
t_q	-	Process output
a_q	-	Network output
X(k)	-	Weight matrix at i^{th} instant
$J(X_k)$	-	Partial derivative of error with respect to weights
$C_1(s)$	-	Outer loop controller
$C_2(s)$	-	Inner loop controller
$G_1(s)$	-	Outer loop process
G(s)	-	Overall process
$G_2(s)$	-	Inner loop process

$T^{*}(t)$	-	Desired reactor temperature
d_1 ,d_2	-	Disturbances
T_j^{*}	-	Desired cooling jacket temperature
T_j^{set}	-	Coolant temperature set point
u	-	Plant input
$\theta(t)$	-	Parameter estimate
$C(\theta_c(t))$	-	Control law
f	-	Auxiliary variable
$\hat{x}_{k/k-1}$	-	Mean of predicted state
θ^*	-	Unknown parameter vector
n	-	Number of states
$W_m^{(i)}$	-	Weights to the Sigma Points
$x^{(i)}$	-	Sigma points
α,β	-	Parameters to calculate the sigma points
κ	-	Secondary scaling factor
$\hat{P}_k$	-	Covariance of the predicted state
Q	-	Covariance of process noise
P_{xz}	-	Covariance of residue
$\hat{z}_{k/k-1}$	-	Mean of measured output
$G(\theta(t))$	-	Estimated plant model
P_{zz}	-	Covariance of innovation
K_k	-	Kalman Gain
$\hat{P}_k$	-	Updated covariance
$\hat{x}_k$	-	Updated state
R	-	Covariance of measurement noise
θ_c	-	Gain vector

ABBREVIATIONS

ANN	-	Artificial Neural Network
CC	-	Cascade Controller
EKF	-	Extended Kalman Filter
ERN	-	Externally Recurrent Networks
GMC	-	Generic Model control
IAE	-	Integral Absolute Error
ISE	-	Integral Square Error
LTI	-	Linear time-invariant
MSE	-	Mean square error
MLP	-	Multi Layer Perceptron
MNN	-	Multiple Neural Network
PVC	-	Poly Vinyl Chloride
PID	-	Proportional-Integral-Derivative
RNN	-	Recurrent Neural Networks
SISO	-	Single-input Single-output
UKF	-	Unscented Kalman Filter