

بسم الله الرحمن الرحيم



HOSSAM MAGHRABY



شبكة المعلومات الجامعية التوثيق الالكتروني والميكرو فيلم



HOSSAM MAGHRABY

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

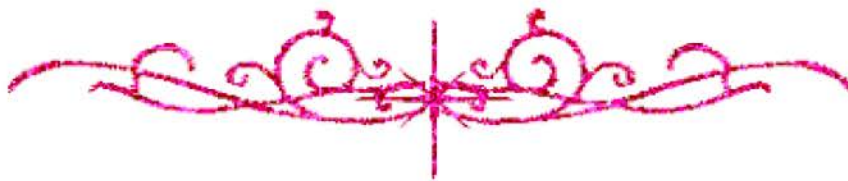
قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
على هذه الأقراص المدمجة قد أعدت دون أية تغيرات



يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار



HOSSAM MAGHRABY



بعض الوثائق الأصلية تالفة



HOSSAM MAGHRABY



بالرسالة صفحات

لم ترد بالأصل



HOSSAM MAGHRABY

Menoufia University
Faculty of Electronic Engineering
Menouf

B1822

ADVANCED CONTROL METHOD APPLIED TO CEMENT INDUSTRY

A THESIS

Submitted for M. Sc. Degree in
Automatic Control Engineering

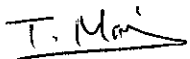
By

MOHAMED HAMDY MOHAMED EL-SAYED

B. Sc. Automatic Control Engineering and Measurements
Faculty of Electronic Engineering, Menoufia University

Approved by:

PROF. DR. TALAAT MOHAMED ABDEL-MONIEM

[]

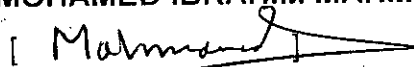
Faculty of Engineering
Alexandria University

PROF. DR. ESAM IBRAHIM EL-MADBOULY

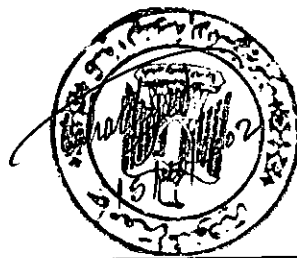
[]

Faculty of Electronic Engineering
Menoufia University

PROF. DR. MOHAMED IBRAHIM MAHMOUD

[]

Faculty of Electronic Engineering
Menoufia University



2002

Menoufia University
Faculty of Electronic Engineering
Menouf

ADVANCED CONTROL METHOD APPLIED TO CEMENT INDUSTRY

A THESIS

Submitted for M. Sc. Degree in
Automatic Control Engineering

By

MOHAMED HAMDY MOHAMED EL-SAYED

B. Sc. Automatic Control Engineering and Measurements
Faculty of Electronic Engineering, Menoufia University

Supervised by:

PROF. DR. ESAM I. EL-MADBOULY

[]

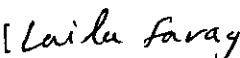
Faculty of Electronic Engineering
Menoufia University

PROF. DR. MOHAMED NAGUIB HASSAN ALY

[]

Faculty of Engineering
Alexandria University

PROF. DR. LAILA MOHI EL-DIN FARAG

[]

National Research Center
Cairo University

2002

ACKNOWLEDGEMENT

First of all, I would like to express my deepest gratitude and indebtedness to

GOD, the Most Merciful

Second, I am greatly honored that this research was under supervision of:

1. Prof. Dr. Esam I. Elmadbouly

I would like to express my greatest appreciation to Prof. Dr. Esam for his generous support and heartfelt encouragement. He associated so much to this research that every single page in this dissertation has benefited a lot from his insight and constructive criticism. Therefore, I value his expertise, clear thinking, and supportiveness through this research.

2. Prof. Dr. Mohamed Naguib Hassan Aly

I want to express my gratitude to Prof. Dr. Naguib who introduced me to innovative research and critical approach. His valuable advice, his professional and comprehensive guidance and his extensive knowledge enlightened my way in this research.

3. Prof. Dr. Laila Mohi El-din Farag

I would like to thank Prof. Dr. Laila for helping me in collecting the background of the research particularly in the technology of cement industry and her very good review.

I would like to thank my dear friends Eng. **Ahmed M. Shehata** and Eng. **Saied Abd El-Atty** for helping me.

Finally, I would like to introduce a **special thank** to the people of the cement industry in Egypt for their introducing all possible helps for success of this research.

MENOUFIA UNIVERSITY
FACULTY OF ELECTRONIC ENGINEERING
MENOUF

Abstract

A Master Thesis of

**Advanced Control Method Applied to
Cement Industry**

By

Mohamed Hamdy Mohamed El-Sayed

(B.Sc.)

A mathematical model of heat transfer around the preheater tower in dry process in cement industry has been developed. A description of automatic control system of the preheater-kiln process by using fuzzy control is given. The model describes the energy balance of each preheater stage. Relevant temperatures of the preheater tower (gas and dust) as well as those inside the cyclone (unmeasured) can be attained via this model. In addition, cyclone clogging diagnosis has been undertaken using two types of the advanced control. The first is the fuzzy controller which can reach the normal temperature values inside the cyclones with a minimum material feed. The second is the clog removal expert system which avoids the occurrence of clogging faults early. A dedicated expert diagnosis system presents to enhance the performance of the preheater tower by detecting the position of the prime clog early and select the proper solution to remove it by means of direct air cannons at the place of the prime clog only (not all cannons), and adjust the bypass ratio of the kiln gas automatically

NOTE ON PUBLICATION

A paper extracted from the research work of the M. Sc. thesis:

Paper title: Modeling and Fuzzy Control of the Preheater-Kiln Tower in Dry Process of Cement Industry

Authors: E. El-Madbouly, M. Naguib, L. M. Farag and M. Hamdy

**Accepted for publication in Menoufia Journal of
Electronic Engineering Research (MJEER), Vol. 12,
No.1, Jan. 2002**

ABBREVIATIONS

SP	Suspension preheater process
SF	(Suspension preheater (SP) with Flash Furnace (FF)) process
SISO	Single input-Single output system
FLC	Fuzzy logic controller
CRES	Clog Removal Expert System

LIST OF SYMBOLS

ε	Volatility of raw mix alkalis
V	Alkali valve =Bypass volume
K	Circulation factor
R_c	Residual content in the clinker
ΔQ_1	Heat carried in by fluid flow
ΔQ_2	Heat carried over to the next section
ΔQ_3	Heat transferred from the wall
ΔQ_4	Heat stored in the fluid
C	Heat capacitance of fluid per unit length
θ	Fluid temperature, assumed uniform in all transverse sections
v	Velocity of flow, assumed constant and uniform in a transverse section
R	Surface resistance per unit length
ϕ	Wall temperature
τ	Dimensionless time
η	Dimensionless distance
ℓ	Total length of heat transfer line
L	Dead time
a	Dimensionless constant
C_h	Heat capacitance of a hot gas per unit length
C_c	Heat capacitance of a cold raw meal per unit length
U_h	Velocity of hot gas phase inside gas duct and cyclone

U_c	Velocity of cold raw meal phase inside gas duct and cyclone
θ_h	Temperature of the hot gas phase
θ_c	Temperature of the cold raw meal phase
L_h	Delay of the hot phase (gas)
L_c	Delay of the cold phase (raw meal)
a_h, a_c	Dimensionless constants
D	Time derivative in the nondimensional time domain $\partial / \partial t$
r	Delay ratio between two flows
θ_{h1}	Gas temperature inlet
θ_{c1}	Raw meal temperature inlet
θ_{h2}	Gas temperature outlet
θ_{c2}	Raw meal temperature outlet
m_{feed}	Rate of raw meal feed
T_{gi}	Gas temperature outlet from cyclone (i)
T_{di}	Raw meal temperature outlet from cyclone (i)
K_g	Gain of the first order system
T_g	Time constant
E_{in}	Input energy
E_{out}	Input energy
m	Mass flow rate of the material
C_p	Specific heat of the material
K_i	Fraction value for each cyclone stage
$(m_x)_i$	Mass of the mixture inside cyclone i
$(C_{px})_i$	Specific heat of the mixture inside cyclone i
$(T_x)_i$	Temperature of the mixture inside cyclone i
$(m_g)_i$	Mass of the gas exit from cyclone i
$(C_{pg})_i$	Specific heat of the gas exit from cyclone i
$(m_d)_i$	Mass of the raw feed exit from cyclone i
$(C_{pd})_i$	Specific heat of the raw feed exit from cyclone i

i	Integer number = 1, 2, ..., 7
T_{ref}	Reference temperature
E	Error between the desired and process O/P
CE	Change of error between two samples
U_f	Fuzzy value of rate of feed
U_o	Crisp value of rate of feed
T_{out}	Output temperature
$\mu_c(u)$	Membership function
$V1$	Preheater valve
$V2$	By-pass valve

LIST OF FIGURES

Fig.2.1	The section of quarry
Fig.2.2	Titan hammer crusher
Fig.2.3	Double rotor mill
Fig.2.4	Two double-deck silos
Fig.2.5	Preheater-Kiln system
Fig.2.6	Clinker Cooler
Fig.2.7	Various preheater kilns with their fuel energy requirements
Fig. 2.8	Suspension preheater and rotary kiln
Fig.2.9	Gas and material temperature of the individual stages of cyclone preheater
Fig.2.9	Gas and material temperature of the individual stages of cyclone preheater
Fig. 2.10	Diagram of clinker burning process
Fig. 2.11	Krupp Polysius-Precalciner
Fig. 2.12	By-Pass installation in the kiln-preheater system
Fig. 2.13	Bypass reduction of the alkalis in clinker
Fig. 2.14	The definitions of concept
Fig. 2.15	The circulating factor
Fig.3.1	Cyclone preheater tower
Fig.3.2	Cyclone view
Fig.3.3	Heat percolation process
Fig.3.4	Parallel heat flow exchanger
Fig.3.5	Parallel heat flow exchanger solution
Fig.3.6	Block diagram of any cyclone (i) in the Preheater system
Fig.3.7	Block diagram of whole Preheater system