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METHODS IN INDUSTRIAL BIOTECHNOLOGY FOR CHEMICAL ENGINEERS

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CONTENTS

PREFACE

Industrial Biotechnology is an interdisciplinary topic to which tools of modern biotechnology are applied for finding proper proportion of raw mix of chemicals, determination of set points, finding the flow rates etc., This study is significant as it results in better economy, quality product and control of pollution. The authors in this book have given only methods of industrial biotechnology mainly to help researchers, students and chemical engineers. Since biotechnology concerns practical and diverse applications including production of new drugs, clearing up pollution etc. we have in this book given methods to control pollution in chemical industries as it has become a great health threat in India. In some cases, the damage due to environmental pollution outweighs the benefits of the product.

This book has six chapters. First chapter gives a brief description of biotechnology. Second chapter deals will proper proportion of mix of raw materials in cement industries to minimize pollution using fuzzy control theory. Chapter three gives the method of determination of temperature set point for crude oil in oil refineries. Chapter four studies the flow rates in chemical industries using fuzzy neutral networks. Chapter five gives the method of minimization of waste gas flow in chemical industries using fuzzy linear programming. The final chapter suggests when in these studies indeterminancy is an attribute or concept involved, the notion of neutrosophic methods can be adopted. The authors feel that the reader should be well versed with fuzzy models like neural networks, fuzzy relational equations, fuzzy control theory, fuzzy linear programming and neutrosophic fuzzy models like NRE together with a knowledge of the technical functioning of chemical industries.

The authors are deeply indebted to Dr. Kandasamy, Kama and Meena for their sustained cooperation.

W.B.VASANTHA KANDASAMY
FLORENTIN SMARANDACHE

Chapter One

INTRODUCTION

In keeping with the definition that "biotechnology is really no more than a name given to a set of techniques and processes", the authors apply some set of fuzzy techniques to chemical industry problems such as finding the proper proportion of raw mix to control pollution, to study flow rates, to find out the better quality of products. We use fuzzy control theory, fuzzy neural networks, fuzzy relational equations, genetic algorithms to these problems for solutions.

When the solution to the problem can have certain concepts or attributes as indeterminate, the only model that can tackle such a situation is the neutrosophic model. The authors have also used these models in this book to study the use of biotechnology in chemical industries.

The new biotechnology revolution began in the 1970s and early 1980s when scientists learned to precisely alter the genetic constitution of living organisms by processes out with traditional breeding practices. This "genetic engineering" has had a profound impact on almost all areas of traditional biotechnology and further permitted breakthroughs in medicine and agriculture, in particular those that would be impossible by traditional breeding approaches.

There are evidences to show that historically biotechnology was an art rather than a science, exemplified in the manufacture of wines, beers, cheeses etc. It is well comprehended by one and all that biotechnology is highly multi disciplinary, it has its foundations in many fields including biology, microbiology, biochemistry, molecular biology, genetics, chemistry and chemical and process engineering. It is further asserted that biotechnology will be the major technology of the twenty first century.

The newly acquired biological knowledge has already made very important contributions to health and welfare of human kind.

Biotechnology is not by itself a product or range of products; it should be regarded as a range of enabling technologies that will find significant application in many industrial sectors.

Traditional biotechnology has established a huge and expanding world market and in monetary terms, represents a major part of all biotechnology financial profits. ‘New’ aspects of biotechnology founded in recent advances in molecular biology genetic engineering and fermentation process technology are now increasingly finding wide industrial application.

In many ways, biotechnology is a series of embryonic technologies and will require much skilful control of its development but the potentials are vast and diverse and undoubtedly will play an increasingly important part in many future industrial processes.

It is no doubt an interaction between biology and engineering. The developments of biotechnology are proceeding at a speed similar to that of micro-electronics in the mid 1970s. Although the analogy is tempting any expectations that biotechnology will develop commercially at the same spectacular rate should be tempered with considerable caution. While the potential of new biotechnology cannot be doubted a meaningful commercial realization is now slowly occurring and will accelerate as we approach the end of the century. New biotechnology will have a considerable impact across all industrial uses of the life sciences. In each case the relative merits of competing means of production will influence the economics of a biotechnological route. There is no doubt that biotechnology will undoubtedly have great benefits in the long term in all sectors. The growth in awareness of modern biotechnology parallels the serious worldwide changes in the economic climate arising from the escalation of oil prices since 1973.

Biotechnology has been considered as one important means of restimulating the economy whether on a local, regional national or even global basis using new biotechnological methods and new raw materials. Much of modern biotechnology has been developed and utilized by large companies and corporations.

However many small and medium sized companies are realizing that biotechnology is not a science of the future but provides real benefits to their industry today. In many industries traditional technology can produce compounds causing environmental damage whereas biotechnology methods can offer a green alternative promoting a positive public image and also avoiding new environmental penalties.

Biotechnology is high technology par excellence. Science has defined the world in which we live and biotechnology in particular will become an essential and accepted activity of our culture. Biotechnology offers a great deal of hope for solving many of the problems our world faces!. As stated in the Advisory Committee on Science and Technology Report Developments in Biotechnology, public perception of biotechnology will have a major influence on the rate and direction of developments and there is growing concern about genetically modified products. Associated with genetic manipulation are diverse question of safety, ethics and welfare.

Public debate is essential for new biotechnology to grow up and undoubtedly for the foreseeable future, biotechnology will be under scrutiny. We have only given a description of the biotechnology and the new biotechnology. We have highly restricted ourselves from the technical or scientific analysis of the biotechnologies as even in the countries like USA only less than 10% of the population are scientifically literate, so the authors have only described it non-abstractly and in fact we are not in anyway concerned to debate or comment upon it as we acknowledge the deep and dramatic change the world is facing due to biotechnology and new biotechnology.

For more of these particulars please refer [1, 2, 13, 15, 17].

Chapter Two

BIOTECHNOLOGY IN CHEMICAL INDUSTRIES

The chemical industries have become a great threat in India. For the problems they cause on environmental pollution is much more than the benefit derived by their product. Some of them damage other living organisms like fishes, plants and animals; some cause health hazards to people living around the industries like respiratory ailments, skin problems and damage to nervous systems. So we have chosen to illustrate the minimization of pollution by CKD in cement Industries. Most of these problems can be controlled provided one takes the proper proportion of the mix of raw materials, which would minimize the pollution.

Cement kiln dust (CKD) emits nitrogen, carbon etc., that are pollutants of the atmosphere and the waste dust affects the smooth kiln operation of the cement industry system and it reduces the production of clinker quality. Hence the minimization of waste CKD in kiln is an important one in the cement industry. The control of the waste CKD in a kiln is an uncertainty. Researchers approach this problem by mathematical methods and try to account the waste CKD in a cement kiln. But, most of their methods do not properly yield results about the waste CKD in kiln. Further, the control of the waste CKD in kiln is a major problem for this alone can lead to the minimization of atmospheric pollution by the cement industry. So in this chapter we minimize the waste CKD in kiln and account for the waste CKD in kiln using fuzzy control theory and fuzzy neural networks.

In this chapter fuzzy control theory (FCT) is used to study the cement kiln dust (CKD) problem in cement industries. Using fuzzy control method this chapter tries to minimize the cement kiln dust in cement industries. Cement industries of our country happens to be one of the major contributors of dust. The dust arising in various processing units of a cement plant varies in composition. In 1990 the national average was 9 tons of CKD generated for every 100 tons of clinker production. The control of cement kiln dust is a very important issue, because of the following reasons : 1. CKD emits nitrogen, carbon etc., which are pollutants of the atmosphere, 2. The waste dust affects the smooth kiln operation of the cement industry system and it reduces the production of clinker quality. The following creates mainly this waste dust in three ways in cement industries : (a) Cement kiln dust when not collected in time and returned into the kiln, cause air pollution, (b) Process instability and unscheduled kiln shutdowns and (c) Mixing of raw materials.

The data obtained from Graft R. Kessler [12] is used in this chapter to test the result. After using the data from Kessler [12] this chapter tries to minimize the CKD in cement factory. The minimization of CKD plays a vital role in the control of pollution in the atmosphere.

W.Kreft [21] used the interruption of material cycles method for taking account and further utilization of the waste dust in the cement factory. But this method does not properly account the waste CKD. Kesslar [12] has used volatile analysis to reduce CKD. In the volatile analysis method the alkali ratio is used to indicate the waste amount of CKD in clinker.

Kesslar [12] classifies the raw data under investigation in four ways :

I. Monitor and control of the system
II. Burning zone and fuel combustion improvements
III. CKD reprocessing
IV. Find the mix of raw materials in proper proportion.

The ratio of alkali should be lying between 0.5 to 1.5 in Kiln load material. But in this method the CKD was approximately estimated up to 40%. He has not exactly mentioned the percentage of CKD according to the alkali ratio in an online process. So this method has affected largely the kiln system.

In this chapter, in order to account for the waste CKD, the variables are expressed in terms of membership grades. This chapter considers all the four ways of waste CKD mentioned by Kesslar [12] and converts it into a fuzzy control model. This chapter consists of five sections. In section 1 we describe the cement kiln system and the nature of chemical waste dust which pollutes the atmosphere. In section 2 we adopt the fuzzy control theory to monitor and control the system and give suggestion for the improvement of burning and combustion zone. Section 3 deals with the determination of gas volume set point and temperature set point for CKD reprocessing which is vital for the determination of percentage of net CKD. The amount of waste dust depends largely on the mix of raw materials in proper proportion of raw material mix is shown in section 4. The final section deals with results and conclusion obtained from our study.

2.1 Description of waste CKD in cement kiln

The data available from any cement industry is used as the information and also as the knowledge about the problem. This serves as the past experience for our study for adapting the fuzzy control theory in this section. This chapter analysis the data via membership functions of fuzzy control method and minimizes the waste CKD in cement industries. Since the cement industry, emits the cement kiln dusts into the atmosphere, this waste dust pollutes the atmosphere.

This analysis not only estimates the cement kiln dust in cement industries but also gives condition to minimize the waste CKD so that the industry will get maximum profit by minimizing the waste CKD in cement industry.

CKD is particulate matter that is collected from kiln exhaust gases and consist of entrained particles of clinker, raw materials and partially calcined raw materials. The present pollution in environment is generated by CKD along with potential future liabilities of stored dust and this should make CKD reduction a high priority. Here we calculate and minimize the net CKD in kiln system. This chapter tackles the problem of minimizing waste CKD in kiln system in four stages. At the first stage we monitor and control the system. In the second stage we adopt time-to- time improved techniques in burning zone and combustion. At the third stage CKD reprocessing is carried out and in the fourth stage we optimize the mix of raw materials in proper proportion using fuzzy neutral network. The above stage-by-stage process is shown in the following figure 2.1.1. Fuzzy control theory and fuzzy neutral network (FNN) is used in this chapter for the above – described method to minimize the CKD in kiln system.

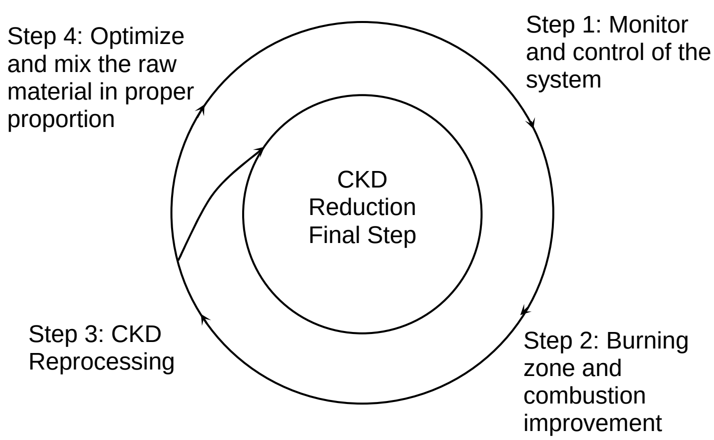

FIGURE 1: CKD Reduction using fuzzy control

The fuzzy controller is composed of linguistic control rule, which are conditional linguistic statements of the relationship between inputs and outputs. One of the attractive properties of fuzzy controller is its ability to emulate the behaviour of a human operator. Another important characteristic of a fuzzy controller is its applicability to systems with model uncertainty or even to unknown model systems. The use of fuzzy control applications has expanded at an increasing rate in recent years. In this chapter we use fuzzy control to monitor waste dust in cement kiln system and CKD reprocessing. The fuzzy control in kiln system is described in the figure 2.1.2. We use fuzzy neural network method and tries to find a proper proportion of material mix in cement industries.

The authors aim to achieve a desired level of lime saturation factor (LSF), silica modulus (SM) and alumina modulus (AM) of the raw mix, to produce a particular quality of the cement by controlling the mix proportions of the raw materials. To achieve an appropriate raw mix proportion is very difficult, due to the inconsistency in the chemical composition ratio given for the raw materials.

Fuzzy neural network model is used to obtain a desired quality of clinker. The raw mix as per the norms of cement industries should maintain the ranges like LSF 1.02 to 1.08, SM 2.35 to 2.55 and AM 0.95 to 1.25, which are the key factors for the burnability of clinker to obtain a good quality of cement. Fuzzy control theory method is used to minimize waste cement kiln dust. Fuzzy control theory allows varying degrees of set membership based on a membership function defined over a range of values. The membership function usually varies from 0 to 1.

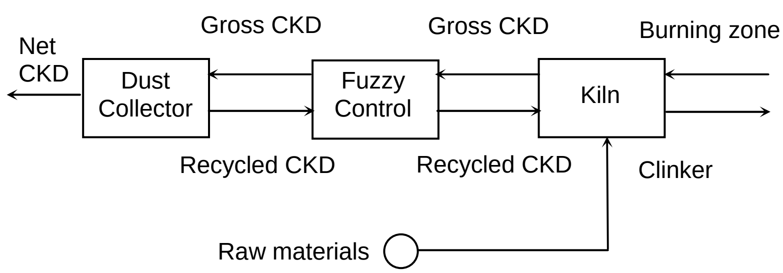

FIGURE 2: Fuzzy control in kiln system

2.2 Monitoring and control of the system using FCT and improvement of burning zone and combustion

Monitoring and control of the system is the most effective method towards CKD reduction in environment. CKD consists mainly of raw materials, which contain volatile compounds, therefore, tracking and control of the volatile compounds throughout the system often allows for the minimal CKD. The initial step in our plan towards CKD reduction is to identify the amount of the CKD. Here the indirect weighing method is applied to identify the amount of the CKD. Calculating sulphur/alkali ratio is a good indication of a possible imbalance. This ratio is calculated as the molar ratio of SO_3/(K_2O)+Na_2O) in kiln load material.

CKD VOLATILE ANALYSIS

Volatile	Molecular Weight
Na_2O	62
K_2O	94.2
SO_3	80

Ratio of alkali = SO_3 /K_2O + Na_2O = 80/156.2 = 0.512

This ratio should be between the values 0.5 to 1.5 in Kiln load material. The industry knows upto 40% of CKD exits, when the alkali ratio is between the values 0.5 to 1.5. But they cannot say exactly how much percentage of CKD waste comes from kiln by using the ratio of alkali in the online process. If industry knows this correct percentage of CKD in the online process, they can change some condition in the kiln and thus reduce the CKD in the online process. We adopt fuzzy control to estimate the percentage of CKD by using the ratio of alkali. The alkali ratio, kiln load material in tons and percentage of CKD are measured from the past happening process in kiln on a scale from 0.5 to 1.5, 5 to 25 tons and 0 to 40% respectively.