

**UNIVERSITI TEKNOLOGI MARA**

**CHEMICAL DESULPHURISATION OF LOW  
RANK MAE MOH COAL VIA MIXTURES OF  
HYDROGEN PEROXIDE AND  
HYDROCHLORIC ACID SOLUTION,  
A MILD OXIDISING TREATMENT**

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## TABLE OF CONTENTS

	<b>Page</b>
<b>Acknowledgments.</b>	iii
<b>List of Tables.</b>	vii
<b>List of Figures.</b>	ix
<b>List of Appendices.</b>	xvi
<b>Glossary.</b>	xvii
<b>Abstract.</b>	xviii
<b>1.0 Introduction.</b>	1
1.1 Coal as an Alternative Energy.	1
1.2 Importance of Pre-Combustion Technique.	5
1.3 Scopes and Objectives of Research.	6
<b>2.0 Literature Review.</b>	9
2.1 Coal Formation and Classification.	9
2.2 Origin of Sulphur Forms in Coal.	16
2.3 Chemical Reactions of Sulphur-Containing Functional Groups in Coal.	19
2.4 Chemical Desulphurisation Techniques.	23
2.4.1 Chemical Desulphurisation using Mild Oxidising Agents.	24
2.4.2 Chemical Desulphurisation using Mild Reducing Agents.	27
2.4.3 Chemical Desulphurisation using Strong Bases.	28
2.4.4 Chemical Desulphurisation using Strong Organic Bases.	30
2.5 Kinetic Analysis on Coal Desulphurisation Process.	31
<b>3.0 Materials and Methods.</b>	32
3.1 Chemicals and Materials.	32
3.1.1 Acidic Chromous Chloride Solution.	32
3.1.2 Hydrogen Peroxide, H <sub>2</sub> O <sub>2</sub> .	32
3.1.3 Hydrochloric Acid, HCl.	33
3.1.4 Nitric Acid, HNO <sub>3</sub> .	33
3.1.5 Sulphuric Acid, H <sub>2</sub> SO <sub>4</sub> .	34
3.1.6 Potassium Permanganate, KMnO <sub>4</sub> .	34
3.1.7 Barium Chloride 2-hydrate, BaCl <sub>2</sub> .2H <sub>2</sub> O.	34
3.1.8 Ethanol.	35
3.2 Coal Preparation and Coal Assays.	35
3.3 Sulphur Assays, The American Society of Testing & Materials (ASTM D2492)	35
3.3.1 Sulphate Sulphur Determination.	37
3.3.2 Pyritic Sulphur Determination.	37
3.4 Chemical Desulphurisation.	40
3.4.1 Chromous Chloride, CrCl <sub>2</sub> Method.	40
3.4.1.1 Preparation of Acidic Chromous Chloride Reagent.	40

## ABSTRACT

Combustion of coals to produce energy has created environmental problems such as sulphur, which is converted to  $\text{SO}_2$  and  $\text{SO}_3$  gases and the ash product. In order to produce a "clean coal", the pre-treatment processes of sulphur removal from coal have to be effective to remove sulphur and ash without severe effects on the coal microstructure and calorific value. In this study, a mild oxidising treatment of  $\text{H}_2\text{O}_2$  and HCl mixtures has been identified to remove sulphur and ash from low rank Mae Moh III coal (MM3). The optimum conditions achieved were 30ml 6% ( $\text{O}_2$  content) peroxide : 70ml 0.1N HCl (reagent volume mixed ratio) with leaching temperature and time of  $50^\circ\text{C}$  and 8 hours, respectively. Under these conditions, *c.a.* 53%, 88%, 100%, 37% and 72% of sulphur<sub>total</sub>, sulphur<sub>pyrite</sub>, sulphur<sub>sulphate</sub>, sulphur<sub>organic</sub> and ash were removed with 31% of coal dissolution were achieved, respectively. Preliminary study of desulphurisation at elevated pressure was also carried out under the optimal conditions. The results indicated that, sulphur<sub>organic</sub> removal of fresh and pyrite-free coals were further increased to 30 and 40%, respectively. Different protic acids mixed with peroxide ( $\text{H}_2\text{SO}_4$  and  $\text{HNO}_3$ ), coal and single-reagent treatment (unmixed reagent) were also applied under the optimal conditions. The results showed that, mixtures of  $\text{H}_2\text{O}_2$  : HCl gave higher sulphur<sub>total</sub> removal. Furthermore, it was found that no synergistic effect was contributed by single-reagent treatment on the desulphurisation of MM3. The mild oxidising treatments slightly affected the coal microstructure as revealed by Scanning Electron Microscope – Energy Dispersive X-ray. Likewise, the calorific value of the treated coal samples was not affected as analyzed by bomb calorimeter. A kinetic analysis on pyritic removal reaction of MM3 was found to correlate well with a second-order rate equation that gave activation energy of  $61.4 \times 10^6 \text{ J kmol}^{-1}$ .

# CHAPTER 1

## INTRODUCTION

### 1.1 Coal as an Alternative Energy.

Coal plays a key role as a primary source of organic chemical feedstocks in the world till the 1950's and maintained its large share as a primary source of energy in the 20<sup>th</sup> century. Further, Krevelen [1] reported that the history of production and consumption of coal prove that this energy has been widely used especially in industrial area. Based on the 1998 world's consumption level, the demonstrated coal reserves are enough for consumption for over 215 years, whereby oil and natural gas reserves are only enough for at least 39 and 63 years, respectively [2]. Thus, coal may become more important as an energy source in the 21<sup>st</sup> century.

Figure 1.1 shows the production of fossil fuels since the industrial revolution. This figure clearly illustrates the tremendous evolution in the coal mining industry especially during the previous century. After 1910, the growth in coal production decreased considerably. The apparent relative decrease in the coal consumption after 1910 can be attributed to the increasing demand for petroleum and natural gas. After 1945, the production capacity of coal has stepped up from 20 million tons in 1900 to about 3250 million tons in 1990. The main factor responsible for this increase was the improved efficiency of the coal-consuming technical processes. Today, about 3-5 times as much useful energy is obtained from 1 ton of coal than was the case 50 years ago [1]. Figure 1.1 also proves that the development of coal production matched by that of natural gas and mineral oil in the future.