Candidate's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This topic has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

In the event that my thesis be found to violate the conditions mentioned above, I voluntarily waive the right of conferment of my degree and agree be subjected to the disciplinary rules and regulations of Universiti Teknologi MARA.

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ABSTRACT

Chemical desulphurisation of Thailand coals namely Mae Moh 1 (MM1), Mae Moh (MM II) and Ban Pu (BP) with mixture of hydrogen peroxide and formic acid, a mild oxidising treatment was successfully investigated. The effect of some process parameters, such as reagent mixed ratio, peroxide concentration, leaching temperature and leaching time, was investigated. The removal of total sulphur, pyrite, sulphate and organic sulphur forms were done via chemical leaching using mixture of hydrogen peroxide and formic acid at leaching temperatures of 30, 50 and 70°C at ambient pressure with various leaching times. The optimum conditions for MMI were achieved using reagents volume mixed ratio of 30ml 6% (O_2) hydrogen peroxide: 70ml formic acid with leaching temperature and time of 50°C and 24 hours, respectively. The results obtained indicated that pyrite, sulphate and organic sulphur removal increased with increasing leaching temperature at various leaching times. The reagent mixture was able to remove approximately 49% of the total sulphur and 40% of ash. Almost all of the sulphate and 25% of the organic sulphur have been removed with 72% of coal yield achieved at ambient pressure. There was a slight decreased in calorific value performance of the leached coal, which is within a tolerable limit. Further, the pyrite-free coal of MM1 was treated at optimum conditions and proved that the reagent mixture was efficient to remove inorganic and organic sulphur. A kinetic analysis on pyrite removal reaction of MMI was found to correlate well with a second-order rate equation that gave activation energy of 45.0×10^6 J $kmol^{-1}$. Desulphurisation of various coals involving MMII and BP mixed with the mild oxidising agent and single-reagent treatment were done under optimal conditions. Preliminary study on MMII and BP coals at different pressures (ambient and elevated pressure) was also carried out under optimal conditions. These coals were selected according to the sulphur distributions that have high organic sulphur in comparison to MMI and suitable to be applied at elevated pressure. The mild oxidising treatment used in this study was found to slightly affect the coal microstructure as revealed by the Scanning Electron Microscope – Energy Dispersive X-ray.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Coal is by far the largest fossil energy resource in the world. It is one of our important sources of energy besides oil, natural gas, hydropower and solar energy. Unfortunately, the full utilisation of this resource is limited by the presence of high levels of sulphur in many of the major deposits [1]. Historically, the usage of coal started in China, and the Chinese were the first people to develop the coal industry to heat buildings and smelt metals three thousand years ago [2]. In the beginning of the 20^{th} century, the coal industries were mainly developed in the western European countries. Coal was burned for different purposes including heating, cooking, harnessing mechanical power, powering steam trains and ships (transportation) and generating heat for manufacturing processes [3]. Malaysia's coal mining history dates back to 1851.To date, Malaysia has about 1,050 million tones of various qualities of coal resources ranging from lignite to anthracite. Most of them are found in the states of Sarawak, Sabah and Selangor. [4]. Malaysia also depends on imported coal from Australia, Indonesia, China, South Africa and Thailand to generate electricity. For example,in Phase 3, the Kapar Klang station in Selangor utilises 2.5 million tonnes of imported coal per year to produce an additional capacity of 1,000 MW of electricity [5].

Recently, the Malaysian government approved a policy on energy utilisation and consumption, which allowed the increase of coal base generation of electricity from 8.8% in 2000 to about 40% by the year 2010 [6]. The demand for electricity had increased from 8,000 MW to 13,000 MW in the year 2000 and will surge to