

UNIVERSITI TEKNOLOGI MARA

**LIQUEFACTION OF MUKAH
BALINGIAN COAL USING
TETRALIN-GLYCEROL MIXED
SOLVENT SYSTEM**

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ABSTRACT

Direct liquefaction of Mukah Balingian coal was successfully carried out using tetralin, glycerol and tetralin-glycerol mixed solvent system in a batchwise reactor system. This study aimed to determine the effect of tetralin-glycerol mixed ratio, liquefaction temperature and reaction time on coal conversion and percent of products yield. Tetralin, being an excellent hydrogen donor solvent, showed high conversion of 85 wt.% with 75.13 wt.% of oil+gas. However, it was revealed that usage of glycerol alone at a high temperature of 420 °C is not possible due to the production of high molecular weight of polymerised residue. Usage of the tetralin-glycerol mixed solvent ratio at 70:30 (% vol/vol) gave the highest conversion of 78.05 wt.% with oil+gas yield of 44.26 wt.%. As liquefaction temperature was increased, thermal treatment allows more bond breaking occurred, resulting in the highest conversion obtained at 420 °C. Yet, the highest yield of oil+gas was obtained at 400 °C, indicating that this mixed solvent system prone to polymerization at a temperature higher than 400 °C, thus obtaining more asphaltene and pre-asphaltene content. The most suitable reaction time for this mixed solvent system to produce the highest conversion was found to be at 30 minutes. Beyond this time, a very slight increment of conversion with reduced oil+gas yield was observed. It was postulated that the similar phenomenon was responsible for the effect of temperature and reaction time. Response Surface Methodology (RSM) software was used to optimize the conditions (temperature and reaction time) to obtain the highest conversion possible using this mixed solvent system. It was found that the optimum conditions are at a temperature of 417.27 °C and reaction time of 18 minutes to produce 76.72 wt.% of conversion. Interestingly, GCMS analyses of coal liquids (hexane soluble compounds) revealed that usage of the mixed solvent system allows elucidation of both non-polar and polar compounds which is not obtainable by using the single solvent system. Higher temperature, however, caused category of the compound obtained to become increasingly aromatic. It was observed that lower-ring number PAHs (two and three fused rings) are more abundant and the higher-ring-number PAHs are the products of growth reactions of smaller hydrocarbon units.

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CHAPTER ONE

INTRODUCTION

In this chapter, an overview of energy demand with oil as main energy source and coal as an alternative energy source were discussed. Additionally, coal utilization involving combustion, gasification and liquefaction of coal were further elaborated.

1.1 BACKGROUND OF STUDY

1.1.1 Oil as Main Energy Source

Energy is crucial to all aspects of development from powering manufacturing and transformation of agricultural sectors to providing electricity for running schools and health facilities (Mohamed and Lee, 2004). Oil has been an essential element in economic growth and its increasing production since 1845 had allowed for living standards to be increased (Fantazzini, Höök, and Angelantini, 2011). Figure 1.1 depicted how oil dominates fuel shares of the world total energy supply throughout the years despite the gradual transition in fuel was observed (BP Energy Outlook, 2017).

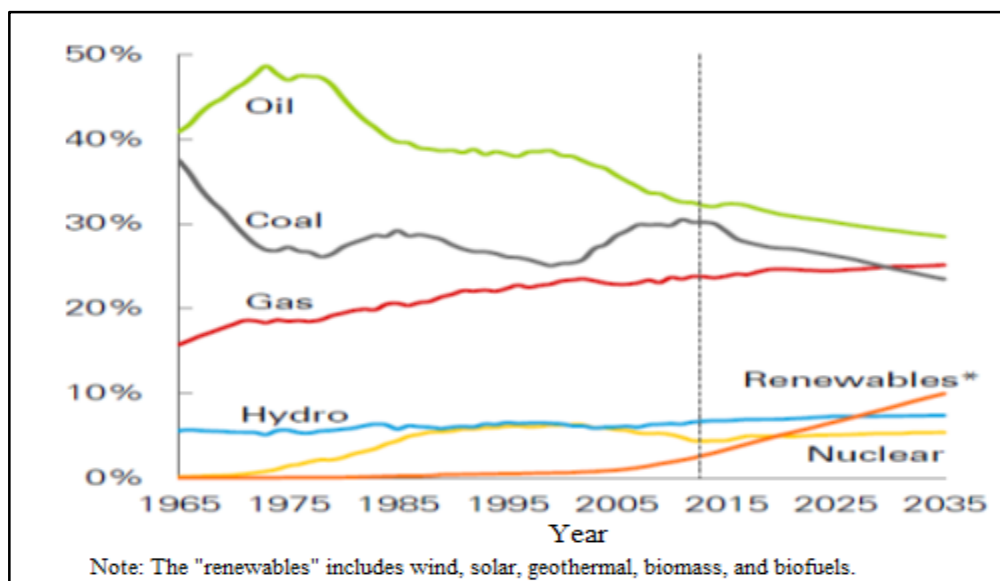


Figure 1.1: Shares of primary energy (BP Energy Outlook, 2017)