

CURRENT RESEARCH AND DEVELOPMENT IN BIOTECHNOLOGY ENGINEERING AT IIUM

VOLUME II

Editors:

Ibrahim Ali Noorbatcha
Hamzah Mohd. Salleh
Mohamed Elwathig Saeed Mirghani
Raha Ahmad Raus



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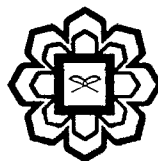
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CHAPTER 20

ENZYMATIC DEVULCANIZATION OF WASTE RUBBER

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ABSTRACT

Enzymatic devulcanization, a technique of preparing waste rubber products for recycling, uses enzyme secreted from bacteria to break the sulfur bonds in the vulcanized rubber structure. This study aims at optimizing the process conditions for bacterial (*Thiobacillus ferrooxidans*) growth which leads to the best devulcanization process. Factorial experimental designs have been applied in two stages. Results show that the optimized conditions to promote the growth of bacteria and the secretion of protein related to tetrathionate hydrolase are by incubating at 25°C, with an initial pH buffer of 4, at an agitation speed of 125 rpm and with salt concentration as follows; in (g/L) of $\text{KH}_2\text{PO}_4 = 4\text{g}$, $(\text{NH}_4)_2\text{SO}_4 = 4\text{g}$, and $\text{MgSO}_4 \cdot 7\text{H}_2\text{O} = 0.1\text{g}$. Physical changes on the rubber surface after devulcanization have been observed via FESEM. This work is important because it is an environmental-friendly and safe method of devulcanization and with thorough study it is hoped that the objective to recycle higher percentage of waste rubber can be achieved.

Keywords: *Thiobacillus ferrooxidans*, tetrathionate hydrolase, enzymatic devulcanization, optimization, recycling rubber product,

INTRODUCTION

Malaysia is one of the largest producers of rubber and as a result produces million tonnes of vulcanized rubber waste from the rubber-based industries each year. These rubber wastes originate from used tires, used rubber-based products and also factory- reject products such as gloves, rubber threads and medical products and they are tremendously polluting. It is also a very well known fact that rubber waste cycling is costly and very inefficient.

In the tire sector, many recycling method has been adopted to reduce the abundance of waste tires stockpiling such as converting them into other useful rubber-based products, burnt as fuel or retreaded (Ahmed et al., 1996). Retreading is carried out via devulcanization process. Among the method of devulcanization adopted were chemical, mechanical, ultrasonic, microwave and microbial or enzymatic (CalRecovery Inc., 2004). However, none of the devulcanization techniques previously developed have proven to be commercially successful.