CHAPTER I

INTRODUCTION

To reduce the local cost of chemicals, several schemes of probable solution have been contemplated, one of which, based on the idea of reducing imported chemicals or raw materials from other countries, is produced from locally available waste-products.

Many kinds of waste-product can be found easily in our country namely corn-cobs, cashew-nut shells, coconut shells, etc. which contain several organic compounds. Furfural is one of the compounds that can be extracted from various plant materials.(1) The % weight of the furfural was given in Table 1.1

Table 1.1

The % weight of furfural from various plant materials (1)

Raw material	% weight furfural
Corncobs	99.6
Coniferous wood	99.2
Oakwood	96.0
Cottonseed husk	93.9
Birchwood	92.4
Peat	58.7

It undergoes condensation polymerization with phenol yielding phenolic resins which are very useful in polymer industry.

Phenolic resins are synthetic resins obtained by condensation polymerization of phenol or substituted phenols, with aldehydes or aldehyde-producing substances. The first report of the general reaction was made in 1872 by Baeyer[2], who found that phenol and acetaldehyde combined in the presence of an acid catalyst to give an unmanageable resinous mass. The needs of the infant science of organic chemistry for specific, unique analysis also influenced the efforts of many later investigators who deferred a study of these masses in favour of crystallizable reaction products. Among these later investigators were Michael[3], who reported that alkalies would also catalyze the reaction resulting in a resin and Kleeberg[4] who in 1891 was the first to work with formaldehyde.

Eight years later, Smith was granted the first patent[5],[6] for a phenolic resin product when, in 1899, he described a method for a cast cured resin substitute for hard rubber. This was followed by other attempts at commerciallization. Until 1907 Baekeland had defined the differences between the action of acid and of alkali and between reaction of more than and of less than one mole of aldehyde per mole of phenol well enough to be able to manufacture reproducibly a thermosetting resin. Most importantly, he conceived the use of counterpressure during hot cure to prevent the bubbles and foaming from heat that had plagued all previous attempts to make a stable, solid, strong, cured resinous object.

He made applications for patents in 1907, these were granted in December 1909[7], and made the first public disclosure in a paper before the American Chemical Society on February 5, 1909[8]. In this and a closely following paper[8] he described the alkaline-catalyzed Bakelite resin and the acid-catalyzed thermoplastic product with less formaldehyde and phenol, the latter prepared by his co-worker Thurlow and for which he coined the term Novolak. This is now a generic word and spelled "novolac".

The early products from the General Bakelite Company, which was organized in 1910, found immediate acceptance in molded parts, insulating varnishes, and laminated sheets for the rapidly growing automobile and electrical industries, and as decorative varnishes and cast products for the consumer market.

Baekeland licensed the technology widely in Germany, Japan, Canada, and England-and spoke and wrote often for technical societies, so that knowledge of the new resins spread quickly. Since then the number of manufacturers has continued to grow to over fifty in the United States alone in 1968. The markets have grown more diverse and larger, many users being big enough to manufacture phenolic resins for their own use.

Phenol-furfural resin is a type of phenolic resins which was widely studied not less than fifty years ago. It was found that the resin was being used largely in several industries. It was used as molding materials, binders for paper, bonding agent for asbestos and graphite, hardening catalyst, condensing agent, protective coating for cellulose esters, compartments in brake

linings, cellulose acetal lacquers, coating for candles and thermal insulations.

Most papers and patents about the phenol-furfural resin were reported commercially and preferably to its applications. However, some researches about effect of catalyst, temperature, and mole ratio of the phenol and furfural on the condensation reaction were published with little information[9],[10],[11]. It was reported that when catalyst, temperature, and mole ratio were varied, it gave several types of phenol-furfural resin product.

Because of this lack of information, the present research on kinetic study of the phenol-furfural reaction was initiated. It is known that the acid-catalyzed phenol-furfural reaction yields resins which are soluble in ethyl alcohol, and therefore hydrochloric acid will be used as catalyst in this work. In order to study the kinetics of the reaction, reaction rates at various temperatures and quantities of catalyst will be measured by spectrophotometric method. From these reaction rates, calculation of the order and specific rate constant of the reaction can be made. Furthermore, the activation energy and frequency factor (A) can be obtained. By interpretation of these data, a mechanism of the reaction may be suggested.