CHAPTER 1

INTRODUCTION

1.1 Introduction

In recent years there has been considerable interest in water-swellable "Superabsorbent Polymers (SAPs)" capabie of absorbing and holding large amounts of water. These polymers have found extensive commercial application as sorbents in personal care products such as infant diapers, feminine hygiene products, and incontinence products, and have received considerable attention for a variety of more specialized applications including matrices for enzyme immobilization, biosorbents in preparative chromatography, materials for agricultural mulches, and matrices for controlled release devices [1].

To function as an absorbent for aqueous fluids, a polymer must have certain following properties:

1) It must be hydrophilic, for example, many if not most of the superabsorbents contain polymerized acrylamide, acrylic acid, or acrylic acid salts.

2) The polymer must swell in aqueous fluids but must not dissolve. In most instances, this requirement dictates that some crosslinking takes place either during polymerization or after the polymer is prepared. With totally synthetic polymers, a crosslinking agent may be conveniently included in the polymerization recipe. However, in the preparation of polysaccharide graft copolymers, crosslinker can in many cases be excluded because:

a) Some crosslinking often occurs naturally during the graft copolymerization process.

b) Hydrogen bonding between polysaccharide chains (particularly cellulose) prevents the graft copolymer from dissolving.

Crosslink density is a critical factor in determining properties of the absorbent. Too little crosslinking will produce a soft, loose gel and excessive water solubility, whereas too much crosslinking reduces polymer swelling to the point where little fluid is absorbed.

3) Although not a strict requirement, absorbents should have some ionic character, since charge repulsion is an important factor in promoting polymer swelling in aqueous fluids.

There are many kinds of SAPs available in the market place. Considering the shelf life of the materials, there are two types of products existing as natural or biodegradable SAPs which are biodegradable and last only about one year, and petroleum-based SAPs which are non-biodegradable and have an absorption efficiency of four years or even longer.

As for the biodegradable one, the naturally occurring resources for this type of polymer are of starch- and cellulose-base. Starch or cellulose grafts in a form of carboxylated product are abundantly available in the market. According to a wide variety of research work carried out elsewhere, starch is proven as a better substrate for graft copolymerization with vinyl monomer to produce SAPs. Because of the more amorphous characteristic, access of incoming monomers to the substrate is greater to copolymerize and thus a higher degree of water absorption is attainable. Although starch occurs naturally throughout the plant world, only a limited number of plants of the commercial starches, cassava starch is produced in tropical countries such as Thailand and others. Thailand ranks ninth in the world's producer of cassava roots and is the world's largest exporter of cassava products. Quite often, the production of cassava starch exceeds the export and consumption scale that make the country too much surplus and unused cassava products. This situation forces the cassava starch to go into vain and it is usually destroyed in order to keep the suitable pricing of the product. It is therefore appropriate to develop a cheap and reliable process to use the surplus cassava starch to increase its commercial value by modifying its chemical structure with petroleum based monomers through the initiation of gamma rays to produce a SAP for various applications.

1.2 Objectives

The objectives of this research are the following:

1. To determine the optimum condition for the synthesis of starch-*g*-poly(acrylamide-*co*-acrylic acid) by a simultaneous irradiation method.

2. To determine the optimum condition for saponification of starch-*g*-poly(acrylamide-*co*-acrylic acid) to produce the saponified starch-*g*-poly(acrylamide-*co*-acrylic acid).

3. To study the water absorption capacity of saponified starch-*g*-poly (acrylamide-*co*-acrylic acid) in various absorbing environments.

1.3 Expected Benefits Obtainable for Future Development of the Research

The benefits for the development can be:

1. To obtain the technique for synthesis of starch-*g*-poly(acrylamide-*co*-acrylic acid), which can be modified for production of cassava starch-based SAP.

2. To use the surplus cassava starch to save the pricing of the crop and to add more values to this crop.

1.4 Scope of the Investigation

In this research, the necessary procedures of graft copolymerization of acrylamide and acrylic acid onto cassava starch via gamma radiation to achieve the best product are as follows:

1. Surveying of literature and in-depth studying of this research work.

2. Preparing graft copolymer of acrylamide and acrylic acid onto cassava starch via gamma radiation by simultaneous irradiation method and studying the following parameters so as to select the suitable technique and to attain the appropriate reaction conditions:

   a) The optimum ratio of monomer (g) to cassava starch (g).

   b) The optimum quantity of total dose (kGy).

   c) The optimum quantity of dose rate (kGy hr^{-1}).

   d) The optimum ratio of acrylamide (g) to acrylic acid (g).

   e) The addition of nitric acid and maleic acid as the additives.

3. Extracting the homopolymer (polyacrylamide, poly(acrylic acid)) and free copolymer [poly(acrylamide-*co*-acrylic acid)] of the crude product.

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4. Bringing the graft copolymer obtained from Section 3 for further characterization steps:

a) Determination of percentage conversion of the monomer.

b) Determination of the homopolymer formation.

c) Determination of percentage add-on of the graft copolymer.

d) Determination of grafting ratio of the graft copolymer.

e) Determination of grafting efficiency of the grafted polymer.

5. Saponifying of starch graft copolymer. In order to keep the ratios of acrylamide and acrylic acid moiety at the specific quantity, the optimum reaction time (minute) will be investigated.

6. Studying the absorption capacity of the saponified starch-*g*-poly(acrylamide-*co*-acrylic acid) in distilled water, sodium chloride, magnesium chloride, calcium chloride, and pH buffer solutions.

7. Summarizing the result and preparing the report.