CHAPTER I

INTRODUCTION

1.1 Scientific rationale

Superabsorbent polymers (SAPs) can be defined as materials that exhibit the ability to swell and retain large volumes of water within its structure. Their ability to absorb water is due to the presence of hydrophilic groups such as -OH, -CONH-, -CONH$_2$, -COOH, and –SO$_3$H and so on [1]. In nature, SAPs are either neutral or ionic depending on the ionization of their pendant groups [2].

Superabsorbent polymers are most commonly formed by free radical crosslinking polymerization of hydrophilic monomers with small quantities of crosslinking agent. The typical crosslinking agents include triallylamine, *N, N'*-methylenebisacrylamide, ethyleneglycoldiacrylate and so on [3]. Early SAPs were made from chemically modified starch, cellulose and other polymers like poly(vinyl alcohol), poly(ethylene oxide) which have a high affinity for water. These polymers become water swellable when lightly crosslinking agents are used. Now partially neutralised, lightly crosslinked poly(acrylic acid) is a choice in the SAPs industry. In water they swell to a rubbery gel which can be up to 99% wt of water [4].

Because of the ability to swell and hold a large amount of water, SAPs are used in many fields such as infant diapers, feminine napkins, agriculture, wastewater treatment, and so on [5]. Wastewaters from the textile dying and printing are often polluted by the azo dye. Since these azo dyes can decompose to give amine compounds which cause skin irritation, cancer and mutation of aquatic organisms and human, therefore, it is necessary to remove them before draining the wastewater into the natural water source [6]. The treatment of the azo dyes in industrial wastewater possesses several problems because dyes are generally difficult to biodegrade and photo-degrade. Thus, many different techniques including nano-filtration and coagulation have been developed for this treatment [7]. In wastewater treatment process, alum (aluminium sulphate) has been generally used as a coagulant because of its low cost. However, the treated water with aluminium sulphate induces Alzheimer's disease if free aluminium ions are present in this water and that they exhibit strong carcinogenic properties. Moreover, the tap waters may contain aluminium at high concentrations because aluminium has been added as a coagulant during the purification process. This implication may be serious since aluminium ions have been demonstrated to be toxic espectially in the renal function [8]. For solving this problem, polymeric flocculants have been particularly attractive in recent years. Many flocculation systems have been developed including single polymer systems [9], dual polymer systems [5] and microparticle/polymer flocculants [10]. All of them can be used for removing heavy metals and dye solutions in wastewater. However, the microparticle systems give better flocculation than conventional polymer systems.

1.2 Objectives of the research work

The objectives of this research are as follows:

1.2.1 To synthesize poly[acrylamide-*co*-(acrylic acid)] and aluminium hydroxide poly[acrylamide-*co*-(acrylic acid)] by radical chain solution polymerization. Effects of the reaction parameters such as acrylic acid, crosslinker, initiator and co-initiator concentrations were investigated.

1.2.2 To characterize functionality and morphology of poly[acrylamide-*co*-(acrylic acid)] and aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)].

1.2.3 To compare the water absorbency of poly[acrylamide-*co*-(acrylic acid)] and aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)] and determine the residual aluminium concentration of aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)] in the water.

1.2.4 To investigate the dye removal efficiency of the synthesized poly[acrylamide-*co*-(acrylic acid)] and aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)] and study the adsorption isotherm.

1.3 Expected benefit obtainable for development of this research

1.3.1 To explain the effect of reaction parameters on water absorbency and dye removal efficiency.

1.3.2 To achieve the aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)] with high efficiency of dye removal than poly[acrylamide-*co*-(acrylic acid)] and leaking of the aluminium ion for wastewater treatment application.

1.4 Scope and work plan

Polymeric flocculants of aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)] are synthesized using the synthetic aluminium hydroxide as a coagulant in the presence of acrylamide and acrylic acid as a comonomer pair. They are polymerized by a redox initiator with a crosslinking agent at 45 °C for 1 h. The influences of parameters on the performances of resulting product are investigated. The important procedure is as follow:

1.4.1 Literature of this research work

1.4.2 Synthesis of poly[acrylamide-*co*-(acrylic acid)] and aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)] via radical chain solution polymerization by changing the parameters:

  1.4.2.1 The effect of acrylic acid concentration at 0, 2×10^{-3}, 4×10^{-3}, 6×10^{-3}, 8×10^{-3}, and 10×10^{-3} mol

  1.4.2.2 The effect of *N, N'*-methylenebisacrylamide (N-MBA) concentration at 1.2×10^{-4}, 2.3×10^{-4}, 4.6×10^{-4}, and 9.2×10^{-4} mol

  1.4.2.3 The effect of ammonium persulphate (APS) concentration at 0.8×10^{-4}, 1.6×10^{-4}, 3.2×10^{-4}, and 6.4×10^{-4} mol

  1.4.2.4 The effect of *N, N, N', N'*-tetramethylethylenediamine (TEMED) concentration at 1.5×10^{-4}, 3.0×10^{-4}, 6×10^{-4}, and 12×10^{-4} mol

1.4.3 Characterization of the resulting products

  1.4.3.1 Identification of the functional groups of poly[acrylamide-*co*-(acrylic acid)] and aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)]

  1.4.3.2 Identification of aluminium form of aluminium hydroxide poly[acrylamide-*co*-(acrylic acid)] by ^{27}Al nuclear magnetic resonance

  1.4.3.3 Surface morphology of poly[acrylamide-*co*-(acrylic acid)] and aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)]

1.4.3.4 The water absorbency of poly[acrylamide-*co*-(acrylic acid)] and aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)] and the residual aluminium concentration of aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)] in treated water

1.4.3.5 The color reduction and adsorption isotherm of poly[acrylamide-*co*-(acrylic acid)] and aluminium hydroxide-poly[acrylamide- *co*-(acrylic acid)]

1.4.3.6 The turbidity measurement of poly[acrylamide-*co*-(acrylic acid)] and aluminium hydroxide-poly[acrylamide-*co*-(acrylic acid)]

1.4.4 Summarizing the results and preparing the report