SYNTHESES AND APPLICATION OF ANIONIC POLYELECTROLYTES IN WATER AND WASTE WATER TREATMENT

G. UDAYA BHASKAR
Central Power Research Institute, Post Box No. 1242, Bangalore 560 012, India
and
S. K. GUPTA*
Centre for Environmental Science and Engineering, Indian Institute of Technology, Powai, Bombay 400 076, India

(Received October 30, 1986; revised February 19, 1987)

Abstract. Five anionic polyelectrolytes were prepared with different molar ratios of acrylamide and acrylic acid monomers. The optimum flocculation conditions were found to depend on the polyelectrolyte and characteristics of the sample. The optimum time for flash mixing for alum and for polyelectrolytes was 1 to 2 min. The optimum flocculation time was 10 to 25 min and optimum flocculation intensity varied between 20 to 30 rpm. The pH was found to be inversely proportional to flocculation efficiency. The COD removal and coliform bacteria removal were 65 and 98%, respectively.

1. Introduction

The application of synthetic polyelectrolytes in water and wastewater treatment has been known since the late 50’s. The polyelectrolytes are normally applied in conjunction with a metallic coagulant such as ferric chloride or alum. A large number of synthetic polyelectrolytes are available commercially under different trade names. The exact formulations of these products are an industrial secret and little is known about their composition.

Synthetic anionic polyelectrolytes such as polyacrylamide and its co-polymers with acrylic acid have received much attention in their use in Western countries for water clarification, although their use in India has been limited. The acrylamide family of monomers was chosen for this study because it can result in polymers and co-polymers which have highly polar functional groups attached to the backbone. At the same time they are relatively more soluble in water than other types of polymers.

The present investigation was carried out to synthesize some new acrylamide based anionic polyelectrolytes and to investigate their application in water and wastewater treatment as coagulant aid. The specific objectives were:

(i) to synthesize anionic polyelectrolytes using acrylamide and acrylic acid as monomers in different molar ratios;
(ii) to assess the performance of these polyelectrolytes as a coagulant aid in synthetic

* Author for all correspondence.

water samples by varying parameters, viz., pH, time of flocculation, and intensity of flocculation;
(iii) to identify the effect of different molar ratios in the polymer on flocculation efficiency; and
(iv) to assess the COD and bacteria removal from sewage samples using these polyelectrolytes as a coagulant aid with alum as a coagulant.

2. Materials and Methods

2.1. SYNTHESIS OF POLYELECTROLYTES

Five acrylamide-acrylic acid co-polymers were synthesized using a radical polymerization method by taking monomers in different molar ratios. The syntheses were carried out using benzoyl peroxide as initiator. The monomers used were acrylamide and acrylic acid in different proportions. Tertiary butanol was used as a solvent because this gave the maximum yield of polyelectrolytes as compared to methanol, ethanol, and propanol.

The above chemicals were mixed in a round bottom flask and the reaction was carried out in an oxygen free atmosphere. After the completion of the reaction a white powder was obtained. The impurities were removed and the compound was dried in a vacuum-oven. All the polymers were obtained by adopting the same procedure. The acrylamide to acrylic acid molar ratios for the various polymers obtained were 9 : 1, 8 : 2, 6 : 4, 5 : 5, and 3 : 7; these have been designated as P₁, P₂, P₃, P₄, and P₅, respectively.

2.2. PREPARATION OF SYNTHETIC WATER AND SEWAGE SAMPLES

Synthetic samples of water having turbidity of 600 NTU and alkalinity of 60 mg L⁻¹ as CaCO₃ were prepared by taking appropriate quantities of Fuller’s earth and sodium bi-carbonate in tap water to obtain a combination of high turbidity and low alkalinity denoted by S₁.

The sewage samples were prepared by collecting raw sewage from sump well No. 8 of the Indian Institute of Technology, Bombay. This was kept for 1 hr under quiescent conditions to remove the settleable particles. The supernatant was used for the flocculation studies. These samples represent the combination of low turbidity and low alkalinity denoted by S₂.

2.3. PREPARATION OF ALUM AND POLYELECTROLYTE SOLUTIONS

Commercial grade alum was dissolved in tap water gradually to obtain a final concentration of 10 mg mL⁻¹. The solution of the polymers was prepared by dissolving them in cold or hot water to obtain a final concentration of the solution of 1 mg mL⁻¹.

2.4. JAR TEST STUDIES

Jar tests were conducted using jar test apparatus (Phipps and Bird, Inc., Richmond, U.S.A.). Polyelectrolytes were used as coagulant aid in conjunction with alum