Postpolymerization of Acrylamide in Aqueous Solution

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***Abstract*—The electrochemical polymerization of acrylamide in aqueous medium was carried out using NH_4NO_3 as a supporting electrolyte. The anolyte became viscous and post polymerization was observed. The effects of impressed current, time of electrolysis and the concentration of monomer on the postpolymerization were investigated.**

***Index Terms*—Postpolymerization, Electrochemical polymerization, Acrylamide.**

I. INTRODUCTION

For synthesizing the complex macromolecules, post polymerization offers the most prominent method[1]. Post polymerization allows for the introduction of diverse functionalities which might be challenging or impossible to achieve through direct polymerization of modified monomers[2-4]. Thus, post polymerization may help to increase the versatility and enhance polymer properties in biomedical engineering, gene delivery, water treatment and oil recovery. This paper deals with the electrochemical post-polymerization of acrylamide in its aqueous solution.

II. EXPERIMENTAL SECTION

Materials

Acrylamide (AA) and NH_4NO_3 were of analytical grade and used without further purification.

Polymerization Method

The electrochemical polymerization of AA in water with NH_4NO_3, as a supporting electrolyte was carried out in an H-type sintered cell. The polymer formation did not occur when a solution of AA in water containing NH_4NO_3 was left for 24 h at 25°C. However, when the solution was subjected to electrolysis at 20mA for 2h, polymerization was observed. The locus of polymerization was the anodic compartment and the anolyte became viscous and impressed current decreased with the time of electrolysis, as shown in the figure 1. This might be responsible for the increase of resistance in the polymerizing solution. The remarkable post-polymerization was observed in this electrochemical polymerization of AA i.e., polymer formation continued after the termination of passage of the electric current through the reaction mixture. The post-polymerization of AA mode at different conditions are summarized in Table 1, Table 2 and Table 3.

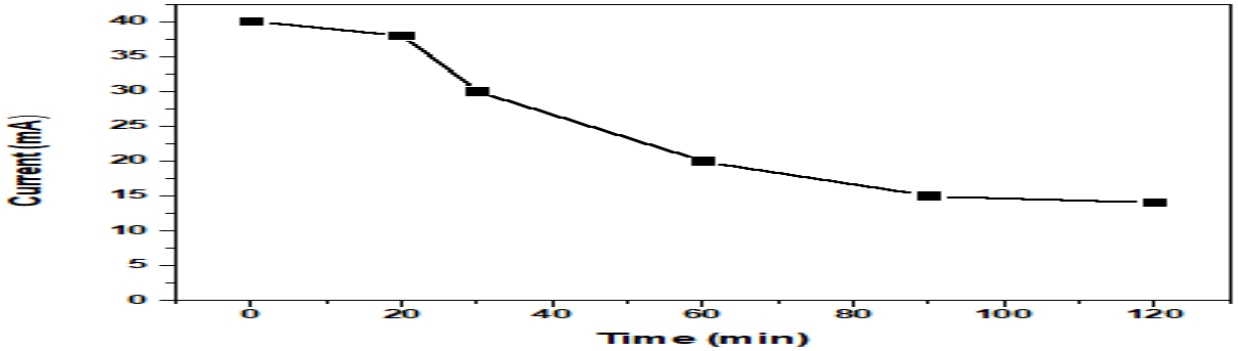

Figure 1. Variation of impressed current with time during the polymerization of AA (6.34 mol L^{-1}) in water at 25 °C. Electrode – Pt , Concentration of NH_4NO_3 : 0.30 mol L^{-1} .

Table 1. Effect of current in post-polymerization of Acrylamide (AA) (2.82 mol L^{-1}) in anolyte containing NH_4NO_3 (0.30 mol L^{-1}) in water at 25 ℃. Time of electrolysis = 2h ; Anolyte volume = 12.5 mL.

Current (mA)	Time of post-polymerization (h)	Polymer yield after post-polymerization (%)
10	24	25.0
20	24	34.5
20	36	42.6
40	24	46.3
40	36	Solid gel
50	24	Solid gel
60	24	Solid gel

Table 2. Effect of the time of electrolysis on post-polymerization of Acrylamide (AA) (2.82 mol L^{-1}) in anolyte containing NH_4NO_3 (0.30 mol L^{-1}) in water at 25 ℃. Time of current = 20mA; Anolyte volume = 12.5 mL.

Time of Electrolysis (h)	Time of post-polymerization (h)	Polymer yield after post-polymerization (%)
1	24	22.8
2	24	34.5
2	36	42.6
3	24	44.0
4	36	48.2
4	24	Solid gel
5	24	Solid gel

Table 3**.** Effect of Acrylamide (AA) concentrations on post-polymerization of Acrylamide (AA) (2.82 mol L^{-1}) in anolyte containing NH_4NO_3 (0.30 mol L^{-1}) in water at 25 ℃. Time of electrolysis = 2h ; Current = 20mA, Anolyte volume = 12.5 mL.

Monomer Concentration (mol L^{-1})	Time of post-polymerization (h)	Polymer yield after post-polymerization (%)
2.82	24	34.5
2.82	36	42.6
4.93	36	Solid gel
6.34	24	Solid gel
7.75	24	Solid gel

III. DISCUSSIONS

The post polymerization i.e., continuation even after the termination of the passage of electric current to the reaction mixture is perhaps due to the low termination rate. Such effect has also been reported for the other several systems [5,6]. It is also attributed to the initiating species which got accumulated in the anolyte and continued to cause the polymerization even after the termination of electrolysis.

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