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Preparation of poly (DMAEM)-cross linked pregelled starch graft copolymer and its application in waste water treatments

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ABSTRACT

Pregelled starch (PS) was first cross linked with epichlorohydrin (ECH) to obtain insoluble cross-linked pregelled starch (CPS). The latter was graft co-polymerized with different amounts of dimethylaminoethyl methacrylate (DMAEM) using potassium permanganate/sulphuric acid redox system. This was done to obtain six levels of poly (DMAEM)-cross linked pregelled starch graft copolymers (PDMAEM-CPS) having different graft yields (expressed as N%) with increasing order and designated as (PDMAEMCPS 1 to PDMAEMCPS 6). The latter copolymers were dispersed in aqueous solution of heavy metal ions Cu (II) ions and filtered to form polymer–metal ions complex. Different factors affecting the heavy metal ions removal such as pH, extent of grafting, treatment time and starch dose were studied in detail. It was found from the obtained results that; the residual metal ions removal from their aqueous solutions increased with (a) increasing the extent of grafting of PDMAEMCPS i.e. from PDMAEMCPS 1 to PDMAEMCPS 6; (b) increasing the pH of the metal ions solution complex from 1 to 8; (c) increasing the starch dosage from 0.25 to 2.0% (w/v), then leveled off thereafter and (d) increasing the time of the reaction up to 20 min then leveled off after that. On the other hand, Pb, Cd and Hg ions were also removed from their solutions with different extent. Furthermore, the prepared copolymer could be recovered by washing the metal ions from the complex with weak acid 1 N HNO_3 (pH 2) and the metal-binding activity of the starch was slightly reduced by this process. Finally, the ability of PDMAEMCPS to remove three types of acid dyes from their solutions was also reported.

1. Introduction

It is well known that, heavy metal ions and organic compounds as well as dyes remain a serious environmental problem facing the world for water pollution, as a result of their numerous industrial applications. In addition many of them are known to be toxic or carcinogenic even at low concentration, not biodegradable and tend to accumulate in living organisms causing a serious diseases and disorders (Crini, 2005). Therefore, their presence in water should be controlled. Different methods such as precipitation, ion-exchange, reverse osmosis, solvent extraction, electro dialysis techniques (Barcicki, Pawlowski, & Cichocki, 1980; Boto and Pawlowski, 1987), biological treatments (Fu and Viraraghhavan, 2001; Pearce, Lloyd, & Guthrie, 2003), membrane process (Bruggen and Vandecasteele, 2003; Ning, 2002), advanced oxidation process (Al-Momani, Touraud, Degorce-Dumas, Roussy, & Tomas, 2002), chemical and electrochemical techniques (Von Gunten, 2003) and adsorption procedure (Calace, Nardi, & Pietroletti, 2002; Gupta, Jain, Ali, Sharma, & Sanin, 2003; Li-Ming and Dan-qing, 2002; Xu, Shun, Gui, Ji-De, & Alayiding, 2005a) have been developed for the removal and recovery of metal ions and organic compounds from sewage and industrial wastewater. Amongst all the techniques proposed, adsorption-using sorbents is one of the most fascinating and popular methods for high quality treated effluents. Recently, a great attention and faster publications rate on developing cheaper and effective adsorbents containing natural polymers to overcome the non-biodegradability and high cost of the adsorbent resins were reported. Amongst these, natural polysaccharides, such as chitin and Chitosan (Kumar, 2000), cyclodextrin (Crini and Morcellet, 2002), cellulose (Guclu, Gurdag, & Ozgumus, 2003), amino functionalized silica (Heidari, Younesi, & Mehraban, 2009), as well as starch derivatives (Keles and Guclu, 2002; Mostafa and Samerkandy, 2004; Niu, Wu, Wang, Li, & wang, 2007; Sanford and Baird, 1983; Wurzburg, 1986) deserve particular attention with respect to their ability to remove heavy metal ions and dyes from aqueous solutions (Arami, Yousefi Limaee, & Mohammad Mahmoodi, 2008; Muthukumar, Sargunamani, Selvakumar, & Venkata Rao, 2004). In this respect, starch is abundant, biodegradable and renewable resources and has the capacity to associate by

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