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ORIGINAL PAPER

Fe_3O_4 nanoparticles coated by new functionalized tetraaza-2,3 dialdehyde micro-crystalline cellulose: synthesis, characterization, and catalytic application for degradation of Acid Yellow 17

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Abstract In this study, we developed an original approach for preparing cellulose-coated magnetite nanoparticles (NPs). Two novel Schiff bases (PDA-*g*-DAC) and [Bz-(PDA-*g*-DAC)] were synthesized via condensation reactions of periodate oxidized micro-crystalline cellulose (DAC) with *o*-phenylene diamine (PDA) to obtain its azomethine derivative with 85% yield. Subsequently, the functionalization of (PDA-*g*-DAC) with benzil (Bz) yields the tetraaza macrocycle [Bz-(PDA-*g*-DAC)]. The physicochemical characterization of the condensation products was performed using ^{13}CNMR, FTIR, ATG, DSC, and X-ray diffraction techniques. Magnetic nanomaterial-based Schiff base cellulose was successfully prepared using in situ chemical co-precipitation of coordinated ferric and ferrous ions in cellulose Schiff base matrix under optimized conditions, and then, its magnetic properties were characterized. The results demonstrated that the Fe_3O_4 NPs coated with [Bz-(PDA-*g*-DAC)] were homogeneously coated in the matrix under ultrasonic irradiation with the saturation magnetization of 69.50 emu g^{-1}. In addition, XRD line broadening analysis showed that the average particle size of the NPs was 37.3 nm. Furthermore, FTIR spectra demonstrated that [Bz-(PDA-*g*-DAC)] concavity was anchored to magnetite Fe_3O_4 NPs through azomethine groups. Vibrating sample magnetometry (VSM) of [Bz-(PDA-*g*-DAC)@Fe_3O_4] magnetic nanocomposite samples showed the typical behavior of ferromagnetism. This study provided a green and facile method to inhibit magnetic nanoparticle aggregation. Activity results revealed that the prepared [Bz-(PDA-*g*-DAC)@Fe_3O_4] catalyst shows the maximum activity for degradation of Acid Yellow 17 (AY17) compared to other prepared catalysts. After degradation reaction, the [Bz-(PDA-*g*-DAC)@Fe_3O_4] catalyst was recovered from the reaction mixture via an external magnet and used for further five consecutive cycles with excellent catalytic activity, successively, which was comparable to the fresh catalyst. The catalyst degradation efficiency and its easy separation exhibited that [Bz-(PDA-*g*-DAC)@Fe_3O_4] catalyst is a promising material for the removal of AY17 from aqueous solutions in green chemistry perspectives.

Keywords Schiff base · Biopolymers · Coatings · Fe_3O_4 nanoparticles · Tetraaza macrocycles · Catalytic properties

Introduction

The synthesis and characterization of magnetic nanocomposites from polymeric matrixes have recently attracted the attention of researchers [1] as they are widely applied in different applications due to their considerable performance, such as high-density data magnetic recording media [2], catalysis [3], magnetic fluids [4], image-intensifying agents for nuclear magnetic resonance imaging [5], medical diagnosis, and magnetic-induced cancer therapy [6, 7].

Among iron oxides and ferrites, magnetite (Fe_3O_4) has attracted increased attention owing to its significant magnetism and particular crystallographic properties [8]. Iron oxide magnetic nanoparticles are synthesized via a classic

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