Activated carbon-doped with iron oxide nanoparticles (Fe$_2$O$_3$ NPs) preparation: Controlling size, shapes and purity

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Inspired by the intensively studies of activated carbon used as high performance adsorbent materials, we prepared iron oxide nanoparticles (Fe$_2$O$_3$ NPs) and produced activated carbon doped with iron oxide nanoparticle (GAC-Fe$_2$O$_3$ NPs). The synthesis method was a facile chemical precipitation using sodium hydroxide (NaOH) as precipitant agent. The impact of varying the molar ratio of reactant and precipitant (1:1, 1:1.5, 1:2) and of varying precipitating temperature (50, 70, 90 °C) were explored. Production yield of synthesized Fe$_2$O$_3$ NPs and GAC-Fe$_2$O$_3$ NPs were also reported. The physical and chemical characteristic of the synthesized samples were examined by transmission electron microscope (TEM), Brunauer–Emmett–Teller analysis (BET), thermogravimetry analysis (TGA), Fourier transform infra-red (FT-IR) and ultraviolet-visible spectrophotometer. The smallest synthesized Fe$_2$O$_3$ NPs of ~10 nm (approximate size) with specific surface area of ~110 m$^2$/g were obtained for preparing with the FeCl$_3$ : NaOH molar ratio of 1:1 at 70 °C and with the FeCl$_3$ : NaOH molar ratio of 1:1.5 at 90 °C. With higher FeCl$_3$ : NaOH molar ratio and higher precipitating temperature, the synthesized Fe$_2$O$_3$ NPs formed more rugby shape with finer surface. By the chemical characteristic, we observed the impurity about 5-10 wt.% devoted for sodium salt due to insufficient purification. Minimal Fe$_2$O$_3$ NPs coated on activated carbon were about 75 wt.% for the synthesis at molar ratio of the FeCl$_3$:NaOH 1:1.5 and 70 °C. The Fe$_2$O$_3$ NPs production yield was about 45-60% and 75-80% for the synthesized Fe$_2$O$_3$ NPs and Fe$_2$O$_3$ NPs doped activated carbon, respectively.

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