Supplemental Information of "Treatment of dye wastewater nanofiltration concentrates containing high level anions by pH sensitive nano-size Fe(III)@silica microgel" for New Journal of Chemistry

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1. FT-IR Characterization

The FT-IR spectra of $mSiO_2$, Fe(III)@$mSiO_2$, Cys-Fe(III)@$mSiO_2$ and used Cys-Fe(III)@$mSiO_2$ after coagulation and Fenton-like degradation are shown in Fig. S1. The broad peak in the range of 3300-3600 cm^{-1} could be associated with the stretching vibration of –OH. And the peaks at 1637-1641 cm^{-1} correspond to the bending vibration of water adsorbed, polymerized and crystallized in the coagulant. Furthermore, the peaks at 2361~2365 cm^{-1} are due to carbon dioxide in air. The peaks at 1016-1018 cm^{-1} and around 958 cm^{-1} in Fe(III)@$mSiO_2$ and Cys-Fe(III)@$mSiO_2$ correspond to symmetrical stretching vibrations of Si-O-Fe respectively. In addition, the strong absorption peaks at 1098-1100 cm^{-1} correspond to the stretching vibrations of Fe-OH-Fe, which indicates the polymer are formed in the Fe(III)@$mSiO_2$. But these peaks weakened at Cys-Fe(III)@$mSiO_2$. Fe-O-Fe and Fe-O are probably formed with the transformation of Fe-OH-Fe and Fe-OH bonds. The peaks at 603-605 and 459-460 cm^{-1} correspond to the winding vibration of Si-O and Fe-O. Bending vibration of Fe-OH corresponds to the peaks at 667-668 cm^{-1}. The reason could be interpreted as the Fe-O-Fe and Fe-O bonds connect with Si in Cys-Fe(III)@$mSiO_2$, which forms the Si-O-Fe bonds after the addition of silicon to the solution. Overall, FT-IR analysis probably shows that Cys-Fe(III)@$mSiO_2$ is not a simple mixture of raw materials. New chemical compounds containing iron and silicon are formed during the synthesis of the samples.

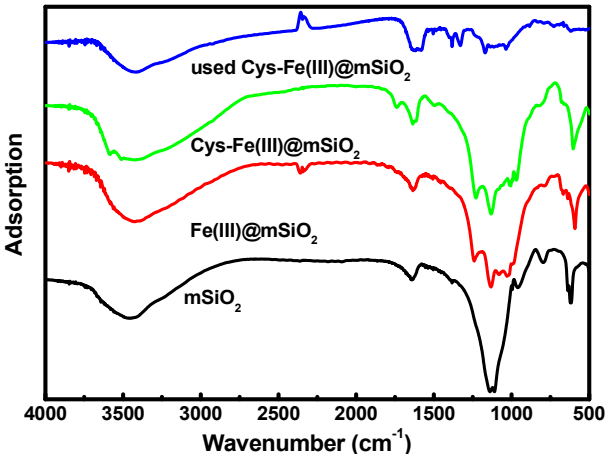

Fig. S1. FT-IR spectra of $mSiO_2$, Fe(III)@$mSiO_2$, Cys-Fe(III)@$mSiO_2$ and used Cys-Fe(III)@$mSiO_2$ after the Fenton-like degradation and silica coagulation processes for nanofiltration concentrates

2. Effect of H_2O_2 concentration for the degradation of nanofiltration concentrates

The H_2O_2 consumption was related to color and COD removal in the nanofiltration concentrates. Fig. S2 shows the removal of color and COD at different H_2O_2 concentrations of Cys-Fe(III)@$mSiO_2$. When the mole ratio of Fe(III) ions to H_2O_2 increased from 1:10 to 1:20, the color and COD removal increased from 73.1 % and 52.6 % to 98.4 % and 83.3 %. However, the mole ratio of Fe(III) ions to H_2O_2 varied from 1:30 to 1:40, the color and COD removal decreased from 90.6 % and 69.8 % to 58.6 % and 27.4 %. The reduced efficiency of the color and COD might lie to the hydroperoxyl radical (HO_2•) was generated since the excess amount of H_2O_2 could attack the active hydroxyl radical (•OH). And HO_2• has little acceleration effect in the degradation processes. As well known in the references, the generation rates of Fe(III) with H_2O_2 to hydroxyl radicals is much lower than that of Fe(II) with H_2O_2. With the use of iron and cysteine in Cys-Fe(III)@$mSiO_2$, sulfur compounds could stimulate the

circulation valences of iron ions, thereby improve the Fenton-like catalytic activity of Fe(III) ions. And the similar enhancement of Fe(III) degradation was observed with the adding assistance of Cys in Fe(III)/mSiO$_2$ for the degradation of nanofiltration concentrates.

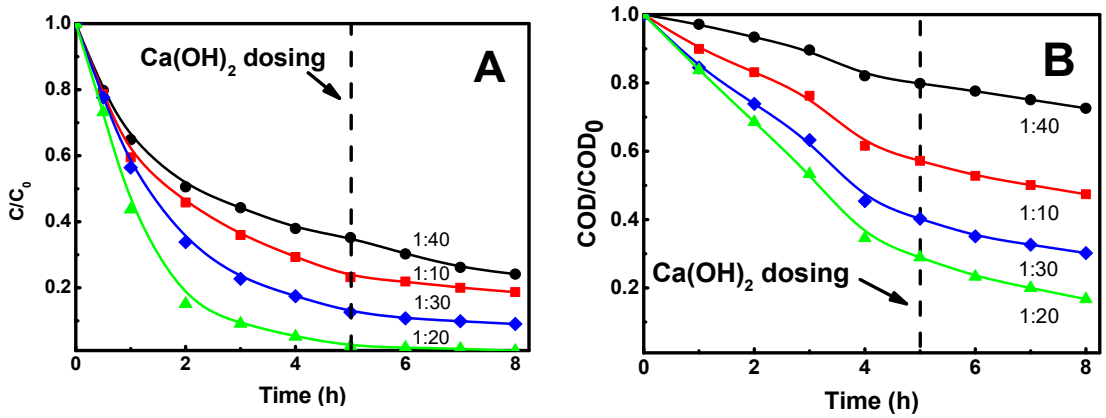

Fig. S2 Effect of H_2O_2 concentration for Cys-Fe(III)@mSiO$_2$ on color removal (A) and COD (B) during the degradation of nanofiltration concentrates (200 mg/L Fe(III), pH_0=4, pH_1=8.5 at 8 h).