Preparation and characterization of zero-valent iron grafted bentonites and their applications for orange II decolourization

Yunfei Xi[1,2*], Megharaj Mallavarapu[1,2] and Ravendra Naidu[1,2]

[1]Centre for Environmental Risk Assessment and Remediation (CERAR), University of South Australia, Mawson Lakes, SA 5095. yunfei.xi@unisa.edu.au
[2]Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE), University of South Australia, Mawson Lakes, SA 5095.

In this study, zero-valent iron (ZVI) was successfully grafted on the surfaces of two Australian bentonites by a reduction method. The natural bentonites used in this study were supplied by Pacific Enviromin Ltd, Queensland, Australia (denoted as QB) and Watheroo Minerals Pty. Ltd, Western Australia (denoted as WB) respectively. The cation exchange capacities (CEC) of QB and WB are 66.7 and 53.5 meq/100 g respectively and the clay samples were passed through a 200 mesh sieve before use. ZVI grafted clay samples were characterized using X-ray diffraction which has revealed the phase of zero valent iron, and scanning electron microscopy was applied to study the morphology and morphological changes on samples, where ZVI showed chain-like structure with floc aggregates (see Fig. 1) but after grafting, spherical individual ZVI particles were observed on the surface of clay minerals (as shown in Fig. 2). Good dispersion of iron particles on the surface of clay minerals was recorded using SEM Energy dispersive X-ray (EDX) spectrum mapping technique.

ZVI grafted bentonites, unmodified clay minerals and pure ZVI were used for orange II decolourization from aqueous phase. It was observed that ZVI grafted clay minerals can work in a wide range of pH from 4 to 10. Compared with ZVI, these ZVI grafted clay materials had similar high decolourization capacities (> 90 %, at 4 g/L dosage), the OII concentration can be reduced from initial 96.5 mg/L to usually lower than 3 mg/L (see Fig. 3). And ZVI grafted showed higher reactivity when taking into consideration the lower content of iron on these new materials. These clay-ZVI hybrids have great application potential by overcoming the disadvantage of ultra fine ZVI powder and it also overcomes the fire hazardous of ZVI powder as clay minerals' surface is fire retardant in nature. This study is significant for providing novel modified clay catalyst materials for the decolourization of azo dye contaminants from waste water.

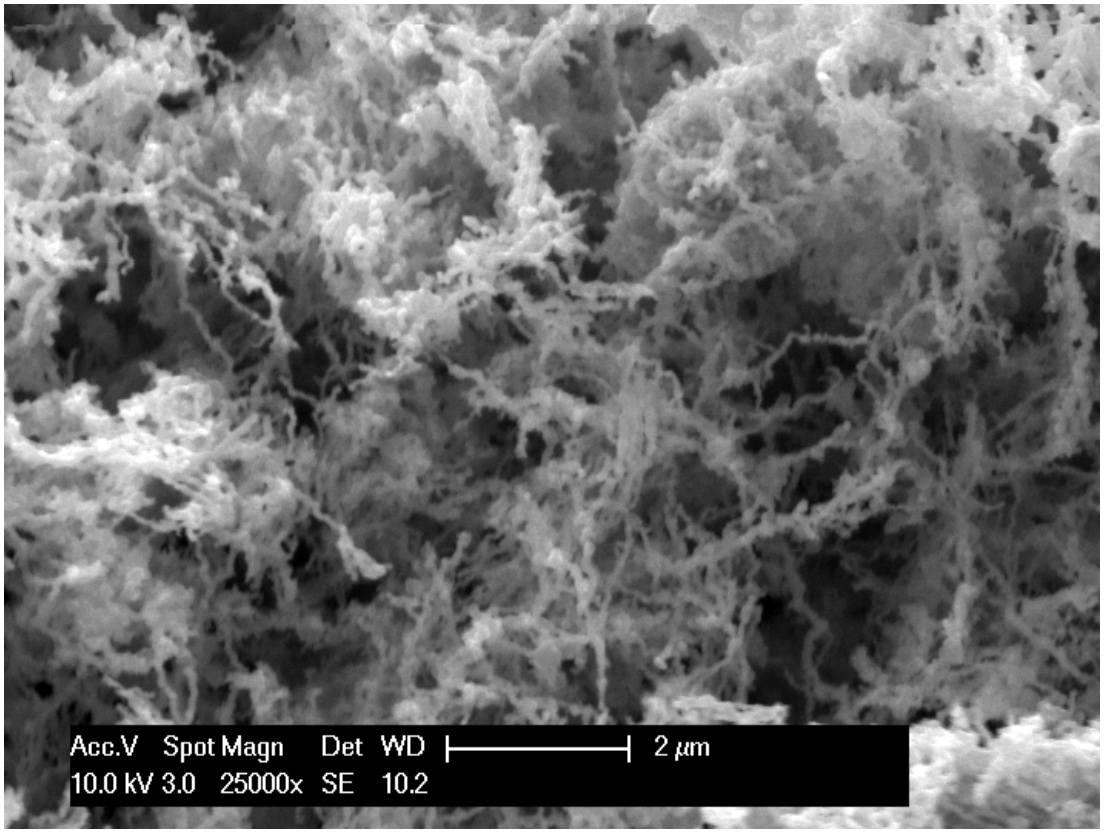

Fig. 1. SEM image of ZVI

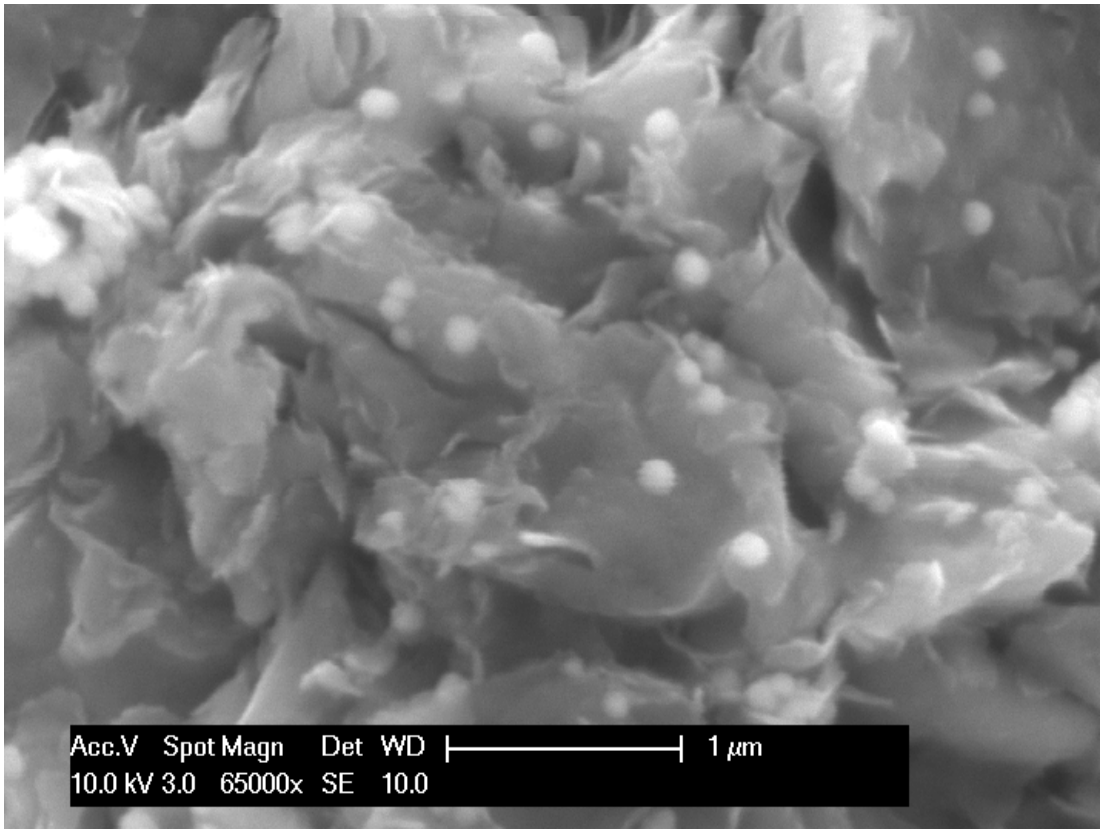

Fig. 2. SEM image of QB-ZVI (spherical iron particles can be observed on clay's surface)

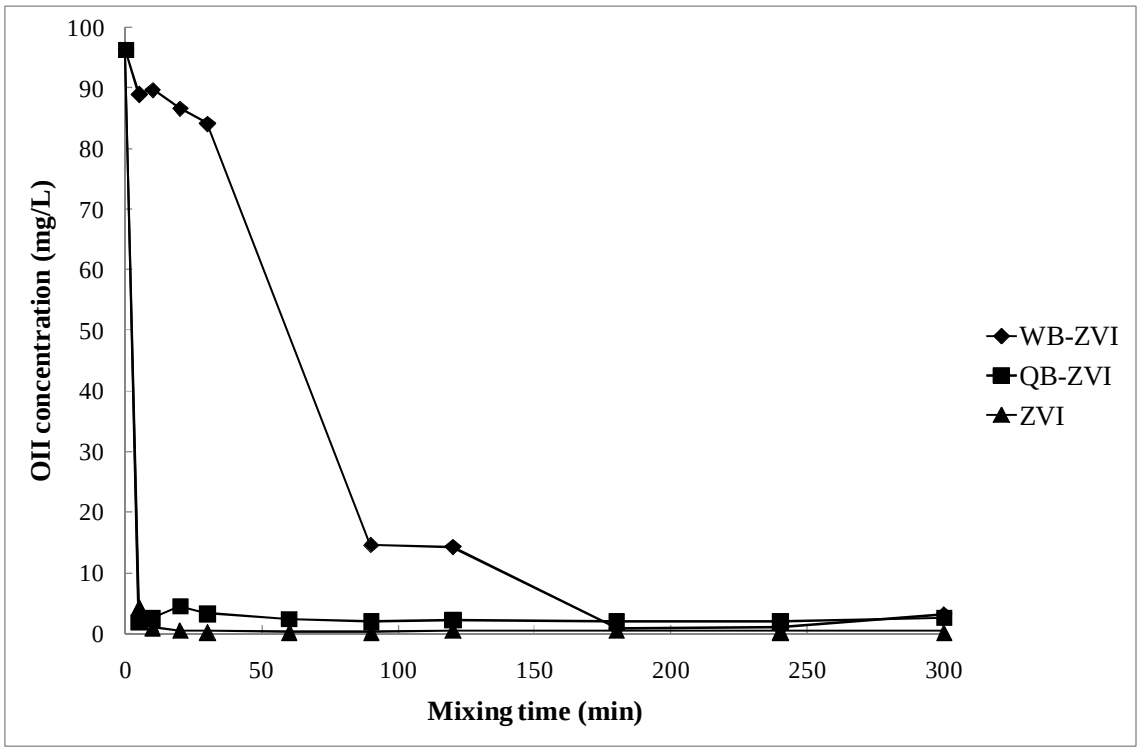

Fig. 3. Effect of mixing time on OII removal