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THE REACTION MECHANISM OF DECOMPOSING CHLOROFORM BY Bi-METAL NANO-METALIC PARTICLES OF Fe/Ni

Su-Hwei Hsieh and Jao-Jia Horng
Graduate School of Engineering Science and Technology,
National Yulin University of Science and Technology,
Touliou, Taiwan, ROC

By adding Ni into the production of Fe/Ni nano-metalic particles, the acceleration of reduction ability of particles to decompose Chloroform is observed. The addition also could inhibit the shielding effect of pure iron compounds. This research studied the production and properties of the nano-particle metallic compounds of Fe and Ni, the decomposition of Chloroform by the particles and the mechanism of the decomposition processes.

The experimental results indicated effective and rapid decomposition of chloroform by the Fe/Ni nano-particles on aluminum oxides, comparing to nano particles of iron in other researches. The reaction mechanism of Fe/Ni particles was pseudo first order with the half life about 0.7 hour, which was much shorter than the nano-Fe particles.

Keywords: Nano-particles, compound metals Fe/Ni, Chloroform

The studies of using iron to reduce or decompose Chloroform or other chlorine-containing solvents (as dense non-aqueous petroleum liquids, DNAPLs) were popular in groundwater remediation in recent years. Many forms of iron were used, including the underground fences of ferrous iron, oxides, zero-valence iron and particles of nano-particles of above. The applications were to use the reduction reaction of iron to decompose the chlorine-containing solvents in the groundwater. Many researchers concluded the treatment processes were quite effective and the mechanisms were somewhat complex. However, the extended use of iron could degrade the groundwater quality. In addition, the efficiencies of reduction reactions require further improvement.

Therefore, many researchers propose the use of nano-metalic-particles for treatment, including iron particles, Pd-Fe particles, etc.[1-11]

For increasing the treatment efficiency, the uses of bi-metals, such as Fe/Pd and Fe/Ni, were popular recently. However, no research could adequately coat the nickel and iron as nano-particles. Our initial proposal was to coat iron/nickel on polymer-type of nano-particles in order to enable their transport in groundwater. However, we found the production was somewhat difficult due to the cost of polymer particles. We therefore used aluminum oxides as the base particles and coated Nickel and iron on them (as shown in Figure 1 and 2).

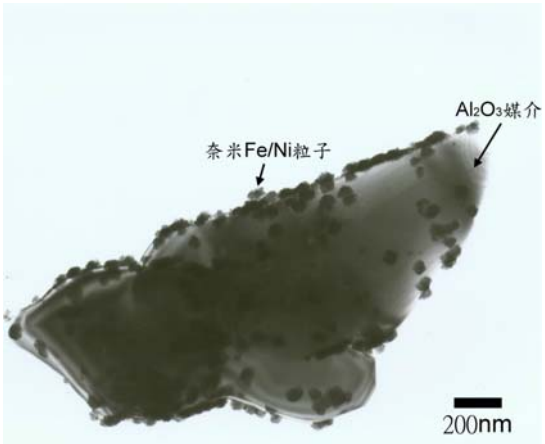

Figure 1. Nano-Fe/Ni on Aluminum oxides (TEM 50,000X)

Figure 2. Nano-Fe/Ni on Aluminum oxides (TEM 200,000X)

By adding Ni into the production of Fe/Ni nano-metalic particles, the acceleration of reduction ability of particles to decompose Chloroform is observed. The addition also could inhibit the shielding effect of pure iron compounds. This research studied the production and properties of the nano-particle metallic compounds of Fe and Ni, the decomposition of Chloroform by the particles and the mechanism of the decomposition processes.

The experimental results indicated effective and rapid decomposition of chloroform by the Fe/Ni nano-particles on aluminum oxides (Figure 3 and 4), comparing to nano particles of iron in other researches (Table 1). The reaction mechanism of Fe/Ni particles was pseudo first order with the half life about 0.7 hour, which was much shorter than the nano-Fe particles did (Figure 3 and 4, Table 1).

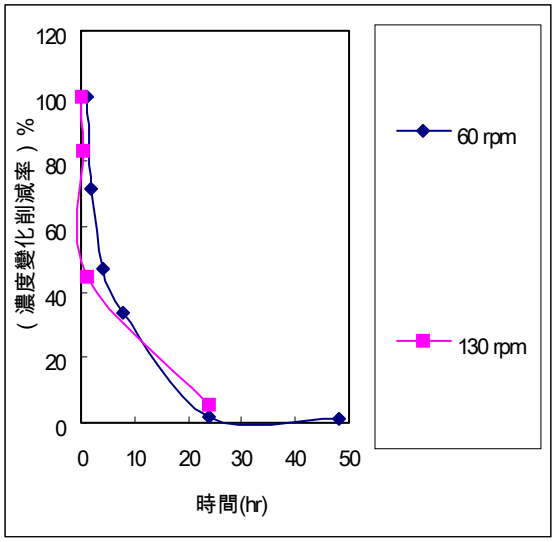

Figure 3. The decomposition of Chloroform by 2.5 g of the nano-Fe/Ni particles in different

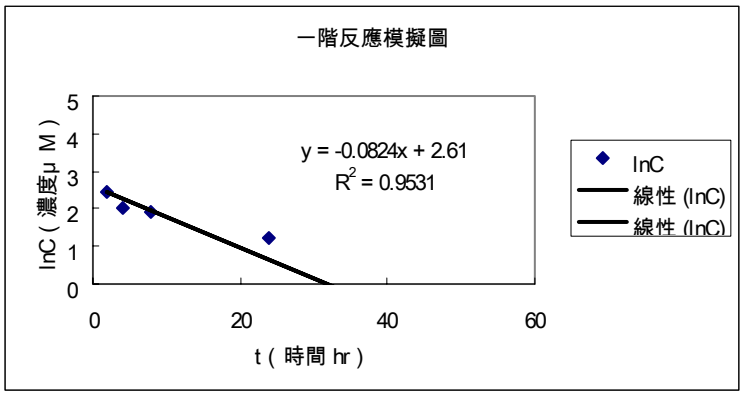

Figure 4. The regression to determine the Pseudo first-order reaction

Table 1. The comparison of reduction mechanisms and test conditions

Reference	$t^{1/2}$	Initial conc	Iron addition	Conditions
Gillham and O'Hannesin (1994)	33 hr	> 0.13 ppm	250 g of 100 mesh Fisher electrolytic iron/L	-
Matheson and Tratnyek (1994)	36 hr	-	16.7 g of 100 mesh Fisher electrolytic iron/L	150℃, 15 rpm
Lien and Zhang (1999)	100 hr no detected	-	500 g (Aldrich iron (99%, < 10 μm))/L	>22℃, 30 rpm
Lien and Zhang (1999)	100 hr no detected	CCl_4:15.86 mg/L	Nano-iron particles	-
Shen (2000)	100 hr K=0.17day^{-1}	20 μm	46.1 g Ridel-deHan madby reduction iron/L	20℃，500rpm
E.J.O`LOughlin (2003)	$t^{1/2}$=144 hr $t^{1/2}$=1 hr	20 μm	5 g AuGR/L 5 g AgGR/L	-
Lian (2002)	Kshr^{-1}=0.93 (0.5 hr)	1,1,1-$C_2H_3Cl_3$ 20~30 ppm	5 g Pd-Fe/L	20℃，30 rpm (rotary shaker)
This Study	$t^{1/2}$=0.7~0.8 hr	20 μM (2~3 ppm)	2.5 g Fe-Ni-Al_2O_3/L	30℃, 130 rpm

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