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Behavior of nickel in wastewater during the precipitation of layered double hydroxide

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Nickel is one of the most valuable heavy metals used in the electronics and metal plating industries. The demand has been increasing year by year due to the advances in technology. Some industrial wastewater contains a large amount of Ni. Generally, the removal of Ni from contaminated wastewater is accomplished by adding an antalkaline reagent to increase the pH to 10 or above, which would result in the generation of Ni-hydroxides and oxides after treatment. After that, it is necessary to adjust the pH below 8.6(effluent standard is pH5.8 to 8.6). However, this method has some disadvantages, such as the high cost of chemical reagents and problems in the disposal of alkali sludge. Therefore, a more efficient remediation method is required to achieve a more sustainable wastewater treatment technology. On the contrary, natural attenuation processes can reduce the mass, concentration, and mobility of contaminants, such via neutralization, adsorption, and mineral precipitation. They are safer, cost-effective and more environmentally friendly than traditional methods. Therefore, a sustainable remediation method may be developed by understanding and applying the mechanisms involved in the natural attenuation process. For example, mine drainage at Dougamaru abandoned mine at Shimane Prefecture, Japan contains concentration of Cu and Zn exceeding water standard, but Cu- and Zn-bearing mine drainage was naturally attenuated by the formation of green precipitates composed of Cu-bearing layered double hydroxide (LDH), hydrowoodwardite (Okamoto et al., 2010). Because a LDH has hydroxide structure, six-coordinate heavy metals such as not only Cu but also Ni and Co can be incorporated into the structure.

In this context, to check the applicability of LDH in Ni-bearing wastewater treatment, synthesis experiments were carried out by coprecipitation method to synthesize Ni-bearing LDHs with different concentration of dissolved Al. The results of ICP-AES measurements showed that the removal efficiencies of Ni from the synthetic wastewaters by the precipitation have increased with adding Al. Al addition method selected LDH as a precipitated phase can remove Ni at pH lower than previous methods which precipitated Ni-hydroxides. From the extraction experiments, the most of all Ni should be incorporated in to the structure of LDH. However, spectroscopic data is necessary to know about the bonding state and bond distance between Ni and Ni, or Ni and the other ions. XAFS analysis was conducted to evaluate those for the precipitate qualitatively. In this presentation, the results of XAFS analysis will be involved to show chemical behavior of Ni in the precipitation process.

Keywords: Remediation, Layered double hydroxide, Nickel