CHAPTER I

INTRODUCTION

Recently, due to the depletion of high-grade ore reserves, environmental legislation, in addition to political and economical factors; it is necessary that increasingly effective productions of metals be obtained through hydrometallurgy. Researches for new processes and novel extractants along with developments of conventional ones are crucial for effective production of metal. Since the overall cost of metal depends mainly on the metal purity, separation processes are absolutely important in the production.

A problem encountered in the production of metals is the separation of some pairs or groups of metal, for instance, niobium (columbium) and tantalum, chromium and vanadium, cobalt and nickel, and the platinum-group metals like platinum, palladium, rhodium, iridium, ruthenium, and osmium. These pairs or groups of metal usually occur together in ores. Cobalt and nickel, for example, are transition elements which have such a lot of similar properties as summarized in Table 1-1. These

propertries make them difficult to be separated physically by using conventional separation processes such as ion-exchange processes, and extraction without reaction.

Table 1-1 Properties of cobalt and nickel [Strauss, and Kaufman, n.d.; Weast, 1968]

Properties	Cobalt	Nickel
atomic number	27	28
atomic weight	58.9332	58.71
covalent radii, (Å)	1.16	1.15
ionic forms	2+ (cobaltous) 3+ (cobaltic)	2+ (nickelous) 3+ (nickelic)
normal melting point, (°C)	1,495	1,453
normal boiling point, (°C)	2,900	2,732
specific heat capacity at 0 °C	0.1028	0.1032

Extraction processes have played an important role in production of rare ions or metals, especially from a dilute solution, and separation or removal of dilute heavy metals in wastewater treatments. However, the commercial process for removal of concentrated heavy metals from wastewater is chemical precipitation – the most common separation method – since this process usually involves a large amount of the chemical used. Typically, for the precipitation process of metal production from ores,

one metal species is precipitated with chemical reagent. The precipitate which usually is not a useful form of metal is then separated from the feed solution, for example by filtration or centrifuge, so as to convert this metal to the other form of metal which is widely used. Whereas the raffinate contains another metal species may pass to the other process on condition that these species are not in useful forms.

For example, Ohtsuka, N. (1990) invented a method for separating cobalt from nickel by using solvent extraction process in which the cobalt ions that were extracted by the organic solution were precipitated with oxalic acid employed as a strip solution. Then the strip solution had to be settled in order to recover the crystalline cobalt oxalate which is a useful form of cobalt salt. Even though this process was effective, the amount of expensive organic solvent and extractant used was very large, namely the volume ratio of organic solution to feed solution is 1:1. Furthermore, in the solvent extraction process, the mass-transfer area is quite low. As a result, large equipments and multistage operations become necessary for a large-scale process resulting in higher capital cost.

Another methods for separation and recovery of metals are conventional solvent extraction process, emulsion liquid membrane process, and supported liquid membrane process. These methods always deal with low-concentration process streams.