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Separation and Recovery of Vanadium and Chromium from Liquor Solution by Fractional Precipitation

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Abstract

Vanadium and chromium was hard to separate due to their similar chemical and physical properties. Fractional precipitation technology with melamine and lead sulfate was conducted to separate and recover vanadium and chromium. Results showed that melamine played great adsorption efficiency of vanadium and lead sulfate could precipitate chromium successfully.

Keywords: Vanadium, Melamine, Chromium, Lead sulfate.

Vanadium and chromium are important metalsused for manufacturing iron, steel non-ferrous metals, andpetrochemicals because of their excellent physicochemical properties[1-3]. Many hydrometallurgical processes had been applied to leach out vanadium and chromium, including sub-molten salt technology[4,5], alkaline electrochemical advanced oxidation process[6-9], roasting-leaching technology [10-12], pressure leaching [13], .etc. However, the separation of vanadium and chromium in the leaching solution was still a challenge for most researchers. The most common technology for vanadium recovery was ammonium precipitation technology [14-16], ammonium sulfate or ammonium chloride was added into the leaching solution to generate ammonium vanadate or ammonium polymer vanadate (APV) with low solubility in acidic solution about pH 2.0-2.5. However, the acidic wastewater was hard to purify. Other way, the recovery of chromium was to generatechromic anhydride with chromium solution.

In this paper, we introduced a fractional precipitation technology to separate and recover chromium and vanadium. The technical route is displayed in Figure 1. The fractional precipitation technology was conducted with melamine and lead sulfate as precipitation agent. The solution firstly reacted with melamine and vanadium existed in VO_2^+ was adsorbed which stayed in the precipitation, while chromium was still in the filtrate solution. And then added some lead sulfates into the filtrate and reacted upon 60 min, the chromium was precipitated as $PbCrO_4$. Thus, vanadium and chromium were efficiently separated and recovered.

Melamine, which has three free amino groups and three aromatic nitrogen atoms in its molecule, can be potentially used as an adsorbent for metal ions[17-21]. Our recent research indicated that melamine had good potential for vanadium adsorption. The adsorption efficiency was over 99.97% under optimal conditions [22,23].

Factors associated with adsorption efficiency of vanadium by melamine were systematically investigated, including initial pH value of solution, molar ratio of melamine to vanadium, reaction temperature and reaction time. Results showed in Figure 2 indicated that melamine could be a great adsorption agent for vanadium recovery. And the initial pH of vanadium solution and dosage of melamine were the main factor affected the adsorption efficiency of vanadium.

Chemical precipitation was an efficient way to recover metal ions from solution based on the Ksp (solubility product constant). In this paper, lead sulfate was chosen to recover chromium from the solution based on the difference of the Ksp between lead sulfate and lead chromate, for which was $1.6x10^{-8}$ and $2.8x10^{-13}$ [24], respectively. The effects of parameters on the precipitation efficiency of chromium including initialpH of solution, reaction temperature, reaction time and dosage of lead sulfate were studied[25].

Figure 3 indicates that chromium was successfully precipitated by lead sulfate, and also the concentration of chromium could be reduced from 0.2mol/L to 0.15 mmol/L at optimal

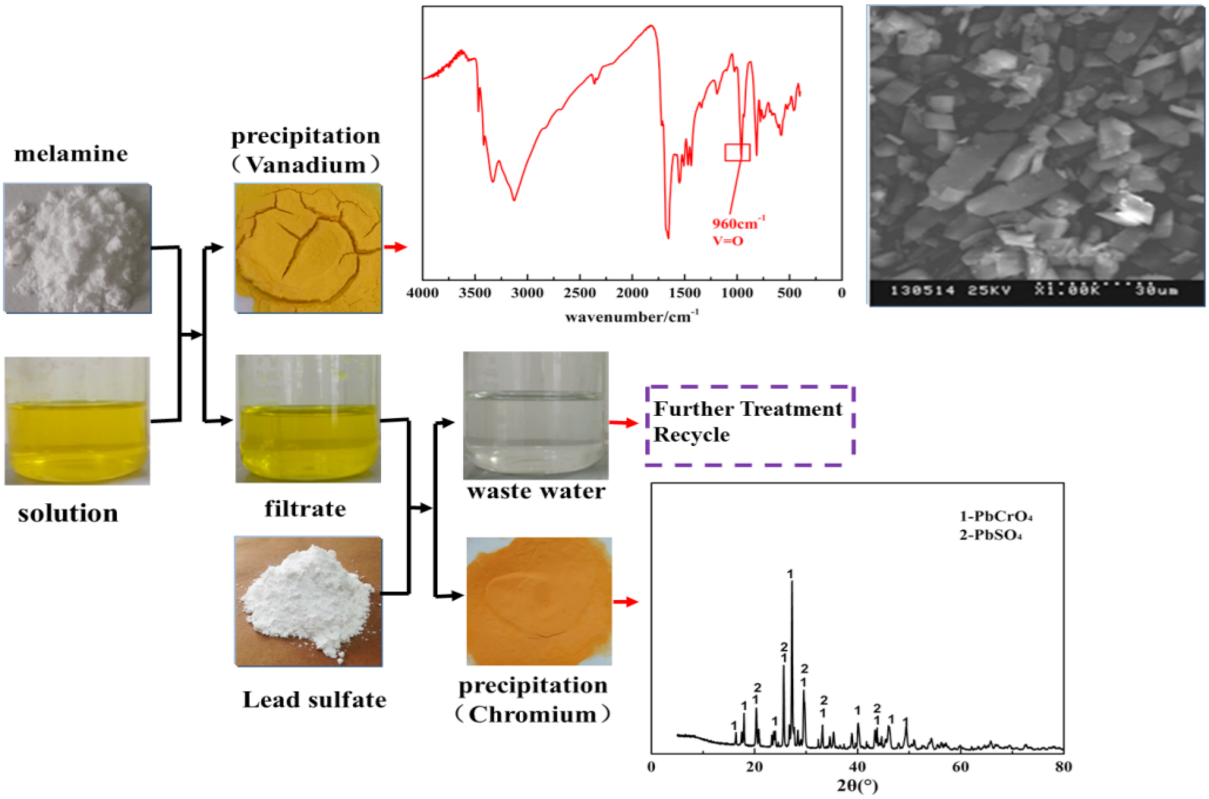

Figure 1: The technical route of the experiment

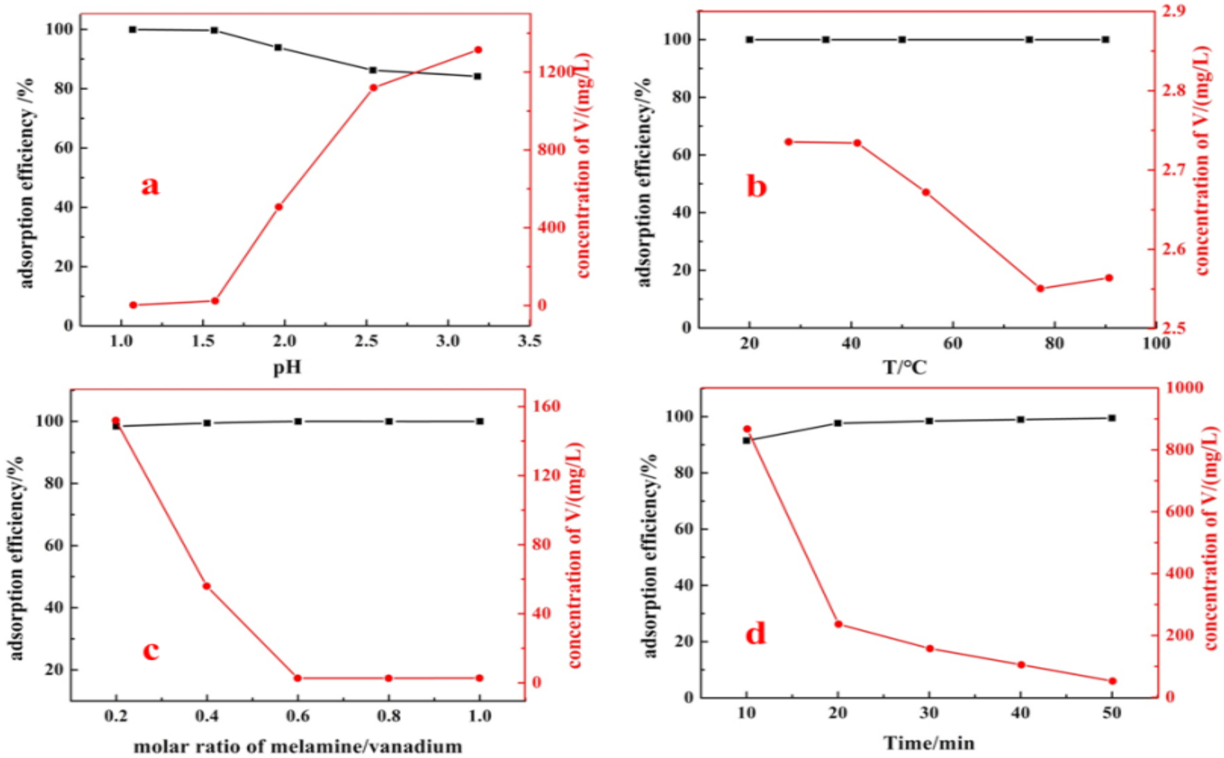

Figure 2: Effect of parameters on adsorption of vanadium with melamine: a) initial pH of vanadium solution; b) reaction temperature (T); c) molar ratio of melamine to vanadium; d) reaction time

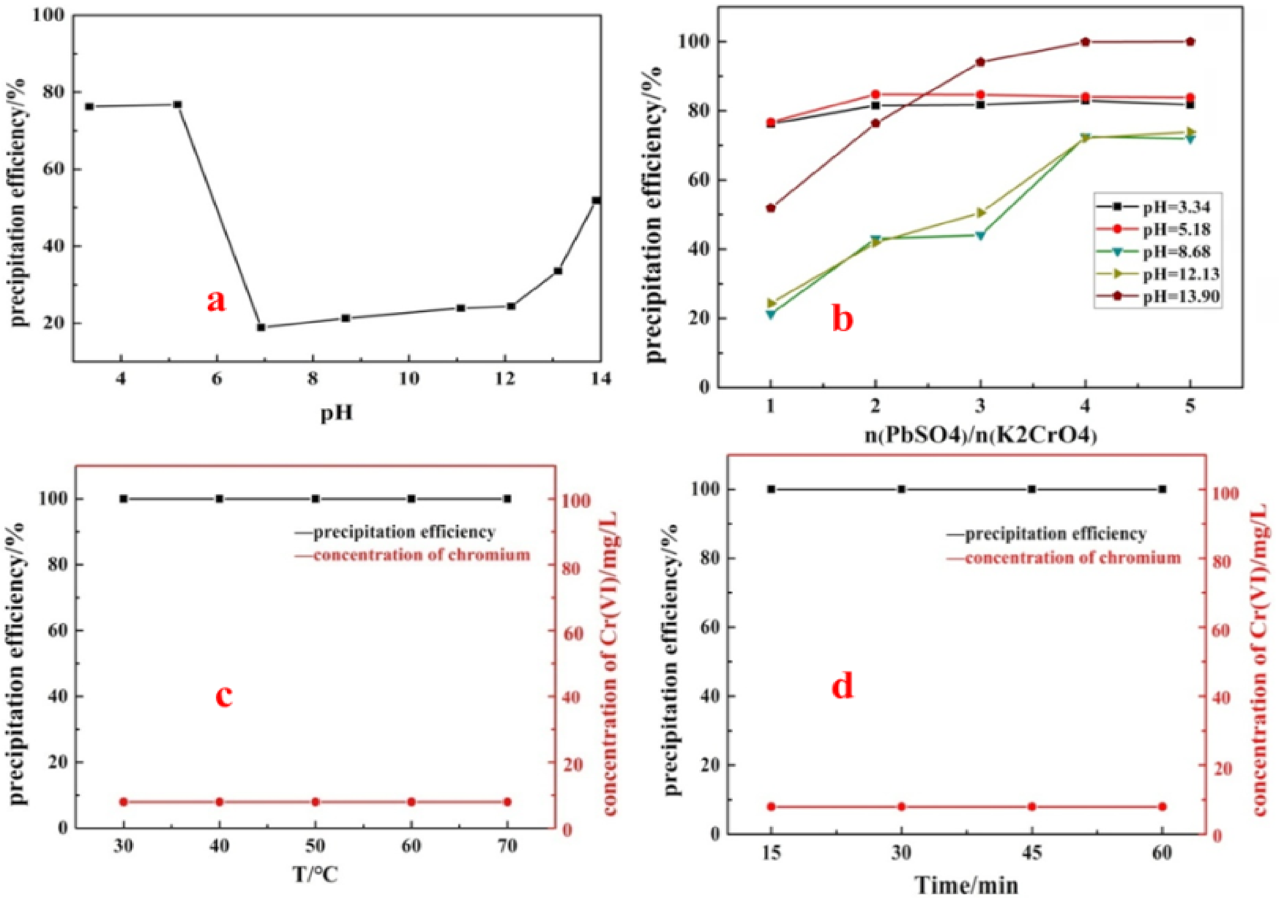

Figure 3: Effect of parameters on precipitation efficiency of chromium: a) pH; b) molar ratio of lead sulfate to potassium chromate; c)reaction temperature (T); d) reaction time

conditions. During the reaction process, the initial pH value of solution and dosage of lead sulfate had big influence on the precipitation efficiency of chromium (VI), while the effect of reaction temperature and reaction time could be ignored. The precipitation was composed of $PbCrO_4$, $PbSO_4$ and other oxides contained lead. Other way, the lead sulfate was all gone into the precipitation, not dissolved in the filtrate and would not cause secondary pollution during the precipitation process.

In summary, melamine could efficiently adsorb vanadium and lead sulfate could precipitate chromium effectively. A new technology combined these two technologies could be an efficient way to separate and recover vanadium and chromium from liquor solution.

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