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Green Manufacturing Process of Vanadium Pentoxide Via Ammonium Leaching of Vanadium Slag

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Abstract

As the major resources for vanadium extraction, vanadium slag is typically obtained from the oxygen blowing of the molten pig iron during steelmaking process using titanomagnetite ores. At present, sodium salt roasting is the most commonly used process for extracting vanadium from vanadium slag. Unfortunately, serious environmental problems are created through discharging sodium sulfate waste residue, ammonium-nitrogen waste water, and caustic gases from the roasting process. Besides, the overall vanadium recovery is no higher than 85%.

A green process has been developed at the laboratory scale for the extraction of vanadium and the manufacturing of vanadium pentoxide from vanadium slag. The process involves the following steps: (1) the selective oxidization of vanadium by roasting the vanadium slag in oxidative atmosphere; (2) the extraction of vanadium from the roasted slag by ammonium leaching; (3) the separation of the leach liquor from the extracted vanadium residue; (4) the cooling crystallization of ammonium metavanadate from the liquor; (5) the manufacturing of vanadium pentoxide by calcination of the ammonium metavanadate; and (6) the recovery of ammonium salt solution.

In comparison with the sodium salt roasting technology, the new process is environmentally friendly and cost efficient. The ammonia gas was absorbed and recycled as ammonium salt solution by carbonation. The crystallization mother solution and the washing water could be recycled in the leaching step. Therefore, the low value-added sodium sulfate waste residue and ammonium-nitrogen waste water can be eliminated. Besides, as chromium in the roasted slag was remained trivalent attributed to the selective oxidization, only vanadium could be extracted out in the ammonium leaching step. Consequently, the puzzling problem for separating chromium and vanadium was settled, and the reduced vanadium-chromium precipitate in the sodium salt roasting process was eliminated. Moreover, the extracted vanadium residue obtained in this process, with a relatively low sodium content, was mainly comprised of chromic oxide and iron oxide and can be utilized economically via recycling in the blast furnace or manufacturing chromium-iron alloy. The overall vanadium recovery could reach 95% or higher. The purity of the vanadium pentoxide product was even higher than 99.5%.

Keywords: vanadium slag, leaching, ammonium, ammonium metavanadate, vanadium pentoxide