

The SOTEX Process

Recovery of Vanadium and Nickel from Soot and Flue Ash

In ash and soot residues from Orimulsion-fired power stations, the dominating metal constituents are vanadium, nickel and iron, together with high amounts of magnesium. A process for the recovery of vanadium and nickel from these residues (main content is carbon) starts with a primary water wash to eliminate the high amount of magnesium. The reason for this pre-wash is to recover and recycle magnesium back to combustion and to decrease the consumption of acid in the following sulfuric acid leaching step. The solubility of vanadium is very low and the dissolution of nickel can be neglected.



The SOTEX Plant in Stenungsund, Sweden

The residue after the water wash is leached at an elevated temperature by a sulfuric acid solution, part of which is the recycled raffinate from the vanadium extraction. The

leaching yield of vanadium (mainly IV-valent) is about 55 % and of nickel about 95 %. A final (post) leach with sodium hydroxide dissolves the remaining vanadium (mainly V-valent). The resulting leach solution, containing practically all the vanadium (~ 25 g/l) and nickel (~12 g/l) is fed to the solvent extraction circuit.

It may be mentioned that starting with ash and soot from crude oil fired stations the resulting metals are the same but the main leaching residue is carbon. This residue is initially burnt and the ash is leached again to increase the total yield of vanadium. In the same operation, the concentration of iron is reduced by precipitation of jarosite. During leaching, the RedOx potential is controlled by SO₂ addition to keep vanadium in its IV-valent state.



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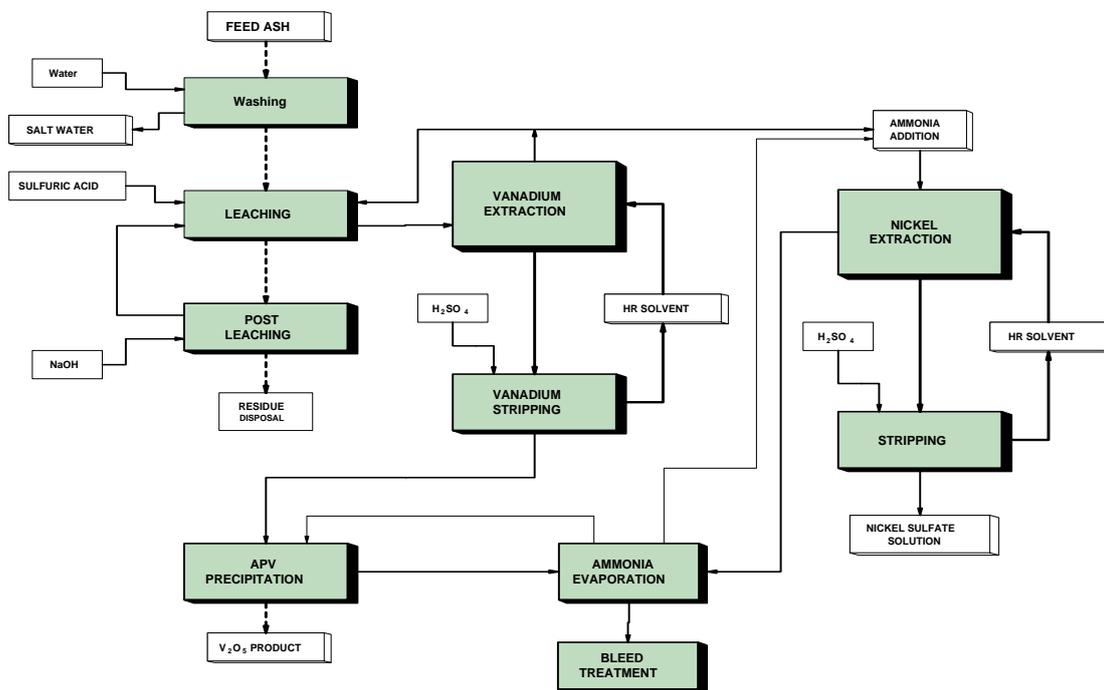
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The extraction of vanadium is performed with a mixture of DEHPA and TBP in kerosene. Half of the raffinate, with a somewhat increased acidity, is returned to leaching. The other half is further treated to extract nickel and to control the build-up of impurities. Owing to the high vanadium concentration in the feed, a large extraction capacity can be obtained and, consequently, the process flows will be less for a given vanadium throughput. The economical importance of this effect is decisive.

Vanadium is stripped from the organic solution with 1.5 M sulfuric acid to a concentration of about 50 g/l V. After an iron removal step with strong sulfuric acid, the organic solution is washed with water and recycled. From the vanadium strip liquor, ammonium polyvanadate (APV) is precipitated by oxidation and addition of ammonia.

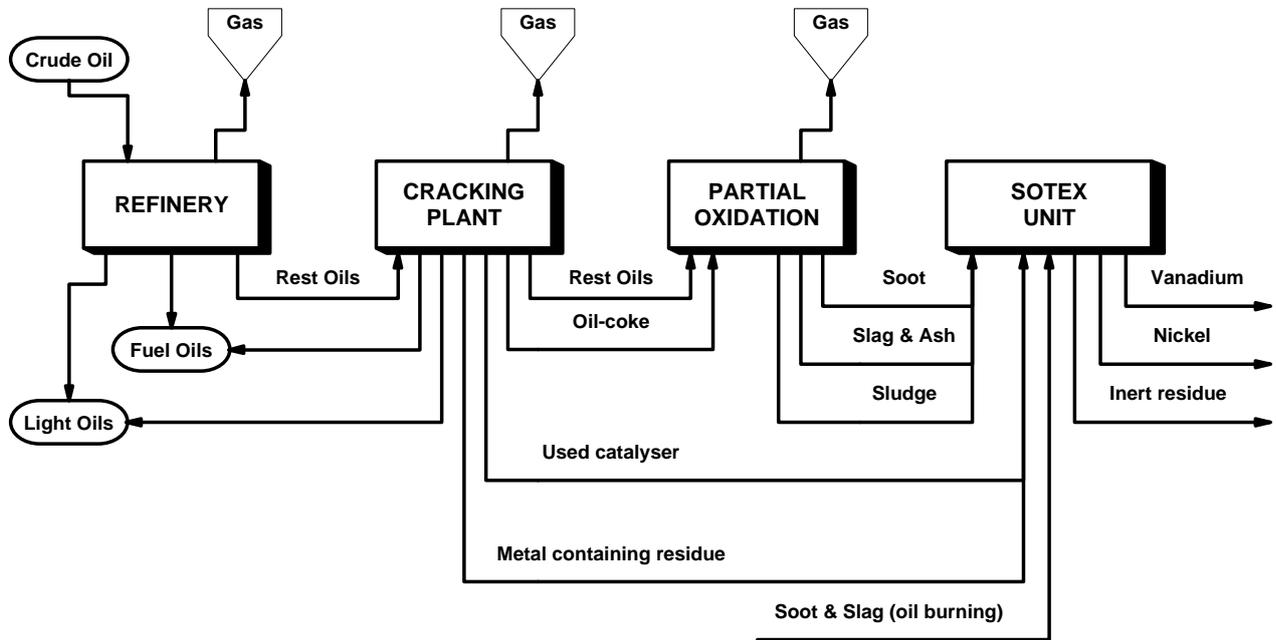
The APV slurry is thickened and pumped to a vacuum belt filter, where the APV cake is carefully washed with fresh water. The APV filter cake is dried and then calcined to vanadium pentoxide (V_2O_5).

To the second half of the raffinate, ammonia is added to form a nickel ammonium complex, which is extracted with LIX 84. Due to simultaneous formation of metal hydroxides, the solution is carefully filtered. After extraction of nickel, the resulting raffinate is further treated in a bleed treatment section. The organic solvent is scrubbed with weak sulfuric acid and then, nickel is stripped by 1.5 M sulfuric acid. Flow rates of solutions and solvents are adjusted to give very concentrated nickel sulfate strip liquor.



Block diagram: Extraction of Vanadium and Nickel from Soot and Flue Ash

Material Flow to a SOTEX Unit



Reference.

Recovery of vanadium from flue ash (soot) emanating from oil burned power stations, Some Hydrometallurgical Processes for the Reclamation of Metal Values, Proc Int Waste Treatment and Utilization Conf, Waterloo, Canada 1978.

The SOTEX Process for Recovery of Vanadium from Heavy Crude Oil Residues, 2nd Int Conf on Heavy Crude and Tar Sands, Caracas, Venezuela 1982.