This new approach incorporates multiple leaching steps in Outotec OKTOP reactors and uses hydrochloric acid and oxygen. The heart of the process is the regeneration of ammonia and hydrochloric acid, which decreases the operational expenses while maintaining excellent metal recovery. As a closed process, it also minimizes waste and by-products, and therefore has minimal environmental impact.

Iron is precipitated using slaked lime or limestone at around pH2 while oxygen is fed to the reactors. Under these conditions iron precipitates as goethite. Controlled sulfur removal at this stage significantly decreases scaling in the downstream process.
About five hours of residence time is sufficient for good removal of iron and sulfur. Both iron and sulfur can be precipitated to a very low concentration without significant loss of valuable metals.

**Solvent extraction and electrowinning**

Copper is purified from the process solution by solvent extraction, using conventional hydroxyoxime-based copper extractants, with ammonia being used to control pH in order to improve extraction. Impurities are removed from the organic phase in scrubbing stages before the copper is stripped to a copper sulfate electrolyte, while electrowinning is done by conventional means. Cobalt is also extracted by solvent extraction. Impurities are scrubbed with diluted hydrochloric acid before stripping and the cobalt is then precipitated from the rich stripping solution.

Nickel is recovered from the process solution by solvent extraction, using the reagent Versatic 10, with ammonia again being used to maintain a pH of 5 to 5.3. Unlike sulfate-based extraction processes, there is no significant gypsum precipitation since most of the sulfates have already been precipitated as part of the iron removal stage and the process solution has been diluted slightly due to the pH control. The loaded organic is scrubbed with the diluted anolyte from nickel electrowinning to reduce calcium loading and, in turn, gypsum precipitation. Nickel is recovered by electrowinning.

**Ammonia and hydrochloric acid regeneration**

After nickel solvent extraction the raffinate is a concentrated calcium chloride solution containing a significant amount of ammonium chloride. Ammonium is regenerated into ammonia by adding calcium hydroxide. Because sulfates are not present in the Outotec process, there is no significant gypsum precipitation during ammonia regeneration. The solution and stream are fed to a stripping column, where ammonia is recovered in the gas phase. The ammonia gas is condensed back to an ammonia solution, which is recycled for use as a neutralization chemical in solvent extractions. This helps to produce a more concentrated ammonia solution and enables better overall water-balance control.

The final process step is hydrochloric acid regeneration, where calcium chloride solution is reacted with sulfuric acid to produce pure gypsum precipitate. Hydrochloric acid stays in the solution and is returned to the leaching stage. The typical hydrochloric acid concentration in the solution is between 120 and 150 g/L. Acid regeneration takes place in multiple reactors, with a total residence time of four to five hours.

**Comprehensive solution**

The atmospheric operating environment helps to minimize initial capital investment, and Outotec can supply the majority of the key equipment. The Outotec PROSCon automation solution enables fast plant ramp-up, smooth operation, and high-quality end products. The comprehensive offering of proprietary equipment and ongoing services and support maximizes the operational availability of the solution, increases profitable operations, and provides customers with a faster return on investment.
In summary

In summary, the Outotec nickel matte leaching process is an extremely flexible method that can be used for treating a wide variety of raw material feeds. In addition to nickel matte, the process can easily be modified for treating different concentrates and intermediates. Other key benefits include:

- Tailored and optimized technology solutions for the entire production chain, from raw materials to end products
- Production of high-quality nickel end products, saleable by-products, and stable residues
- Fast, smooth plant ramp-up and operation
- Advanced automation minimizes operating costs
- Testing, engineering, process design, and equipment and automation solutions from a single provider
- Closed process circuit minimizes waste production and optimizes water usage

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HCl regeneration