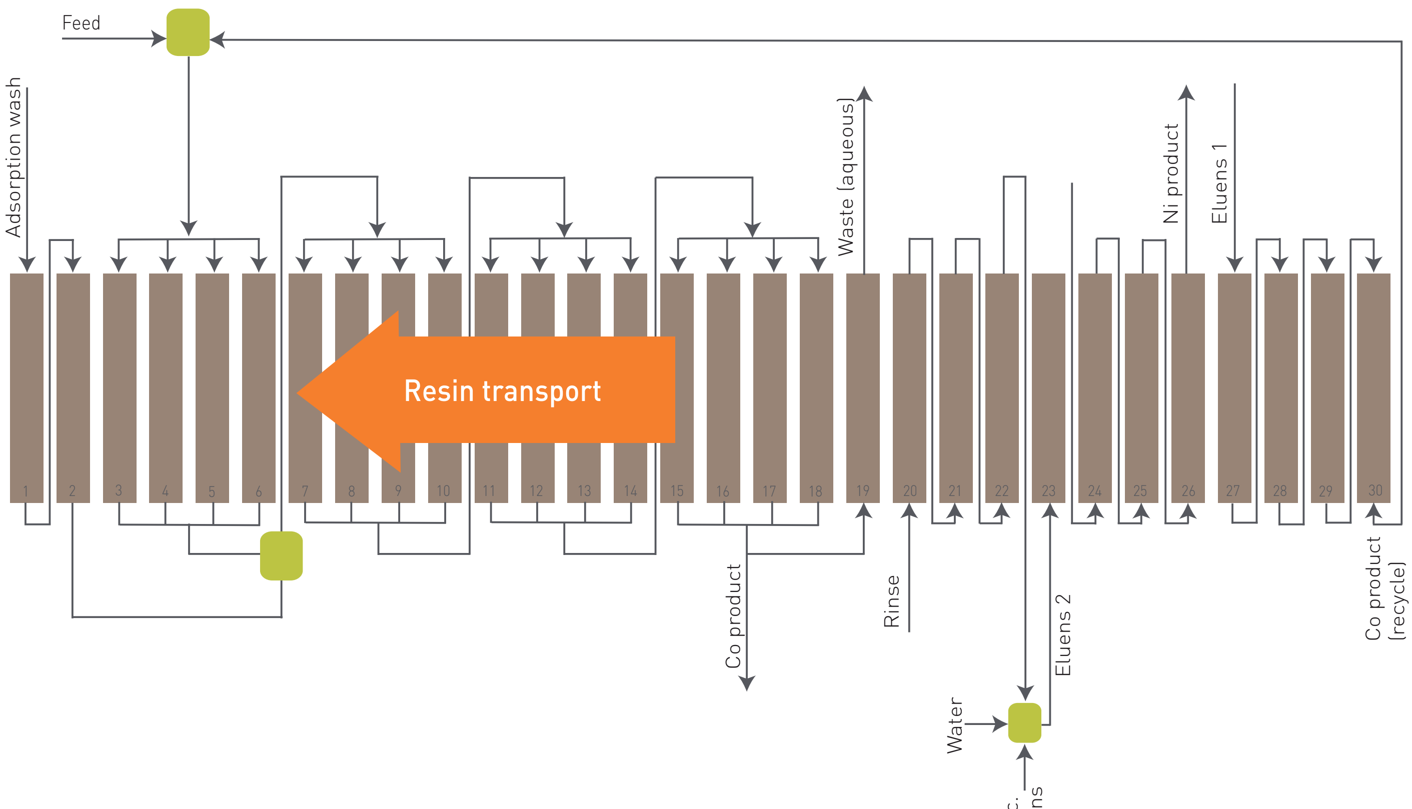

Process Flow Diagram for the separation of Nickel and Cobalt

Nickel/cobalt separation in hydrometallurgy

Introduction

Nickel is a hard, silver white metal that has industrial applications related to its strength, corrosion resistance, high ductility, good thermal and electrical conductivity and catalytic properties. Its primary use is in manufacture of stainless steel, steel alloys and superalloys. The world production of Nickel is estimated at 1,400 ktpa. The market price for Nickel has been fluctuating and is currently estimated in the range of $ 6 – 8 per pund (k$ 13 – 18 per ton)(1).

Cobalt is a brittle, hard transition metal with magnetic properties similar to iron. It is mainly used as an alloy with iron, nickel or other metals to produce corrosion and wear resistant products for high temperature applications (such as jet engines, gas turbines, etc.). Cobalt is normally produced as a by-product of nickel or copper mining. The world production of cobalt is estimated between 45 and 50 ktpa. The value of Cobalt has been extremely high in the late seventies but is now estimated at $ 15 per pound (k$ 33 per ton)(1).

The purity requirements for Cobalt do not allow Nickel to exceed a concentration 0.1%. Earlier, the Nickel was removed by lime precipitations, but as the market specifications became more stringent, ion exchange technologies have been applied.

This application note illustrates the SEPARATION of Nickel and Cobalt in two separate streams by means of continuous ion exchange on a SepTor unit.

Design considerations

The resins used for metallurgy have different affinity towards different metallic ions. Nickel and Cobalt

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are both adsorbed onto the resin but Nickel is preferably retained. Therefore, Cobalt will be displaced in the presence of Nickel (to a limit). This difference in affinity is also exploit at elution. The more retained compounds (e.g Nickel) will require more concentrated eluens than the less retained ones (e.g. Cobalt). A process based on selective elution will separate adsorbed compounds in different streams based on affinity.

Other important aspect to take into account is the co-loading of ions. In this case the resin capacity will differ from that obtained when only one ion is fed.

Process design

Figure 1 shows a typical Process Flow Diagram for the production of Cobalt and the removal of 95% of the Nickel (feed basis).

Adsorption is done in two stages: undiluted adsorption and diluted adsorption step. This situation exploits the driving forces provided by the concentration gradient to maximize the adsorption efficiency. During adsorption about 95% of the Nickel is removed from the feed stream. The adsorption effluent is thus a high purity Cobalt stream (Cobalt product). In order to diminish product dilution the interstitial water from the columns coming from the elution rinse is removed using an entrainment rejection step prior to adsorption.

Elution is also done in two stages but with different aim. In this case the less retained compounds (Cobalt) are eluted with less concentrated eluens at the first stage. 20% of the adsorbed Nickel leaves with this first elution effluent (Cobalt effluent). This stream is recycled into the system at the loading section in order to diminish product losses. At the second stage the more retained compounds (Nickel) are eluted with higher eluens concentration. Less than 0.1% of the fed Cobalt will end up within this second elution effluent (Nickel product stream). The Nickel concentration in this stream is independent of the feed concentration when Cobalt is the desired product.

Washing steps are intercalated between adsorption and elution to diminish product losses and product contamination.

A continuous process with an approximate productivity of 1650 tpa Co, can be carried out on a SepTor 30-25 system with about 7 m3 of resin. The same operation carried out on fixed bed will require approximate twice the resin volume. The same operating mode can be followed if the process pursues the removal of Cobalt from a Nickel stream. In this case the product will be the second elution effluent (columns 23 – 26). The first elution (columns 27 – 30) will be design to remove the adsorbed Cobalt.

Process economy

In comparison with a fixed bed, the SepTor system offers the benefits of the continuous counter-current contact mode. This way the resin capacity is largely exploited leading to reduction in resin inventory and, at the same time, in chemicals and water consumption, and product dilution. Consumptions of water and chemicals (OPEX) are typically brought down around 40% or more. Due to the large prices of resins for hydrometallurgy (in the rang of $ 100 per liter) the reduced resin inventory has a large impact on CAPEX and compensate the difference in equipment costs.

Further, the SepTor system ensures a reduction in Cobalt losses through the Nickel product stream.

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