Introduction of recovering nickel from the spent catalyst

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ABSTRACT

This introduction of study investigates the possibility of recovering nickel from the spent catalyst (NiO/Al2O3) resulting from the steam reforming process to produce water gas (H2/H2O) in many industries. In the extraction process, nickel is recovered as sulfate using sulfuric acid as a solvent. The considered parameters affecting nickel recovery were acid concentration, temperature and time of digestion solid:liquid ratio, particle size and stirring rate. Nickel was to be directly recovered as a sulfate salt by direct crystallization method. The conversion was 99% at 50% sulfuric acid concentration, solid: liquid ratio (1:12) by weight, particle size less than 500 micron for more than 5 h and 800 rpm at 100_C [1]

INTRODUCTION

This technology includes four basic steps: feed preparation, reduction, smelting and casting. For the past 16 years, the INMET CO process has been the only thermal recovery technology for metals [2]. The acceptance of a waste to be processed depends on both the total chemical analysis carrier out by INMET CO's laboratory and on the information supplied by the generator. The extraction of rare metals from the hydrodesulfurization catalyst by leaching with sulfuric acid yields an acidic solution rich in rare metals such as molybdenum, vanadium, cobalt and nickel in addition to aluminum [3]. Mixtures of LIX63 (5,8-diethyl-7 hydroxy-6-dodecanone oxime) and CYANEX272 (containing bis (2,4,4-tri-methylpentyl) phosphinic acid as the active components or PIA-8 (containing the active component bis(2-ethylhexyl)phosphinic acid) were considered to be the most suitable for separating and recovering cobalt and nickel from sulfuric acid solutions in the presence of an appreciable amount of aluminum at a low pH value [4]. Although different acids have been previously used for leaching nickel from spent catalyst, sulfuric acid has been selected as the cheapest and the most effective. Also, applying sulfuric acid in the extraction process allows aluminum to be readily recovered as a sulfate salt by direct crystallization from the raffinate. The aim of this work is to recover nickel from the spent nickel catalyst based alumina (NiO/Al2O3) used in the steam reforming industry. accumulation of nickel which is considered a major source of contamination. The introduct of study is mainly based on leaching nickel oxide from the spent catalyst to produce nickel sulfates and alumina, which is considered as an inert. Different experiments were done to show the effect of various factors affecting the optimum conditions. The parameters considered were: acid concentration, time and temperature of

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digestion, solid:liquid ratio, crushed spent catalyst, particle size and stirring velocity [5]..

METHODS

Spent catalyst was crushed and screened to attain the required particle size. In each experiment methods, 1 g of spent catalyst was added to a certain amount of sulfuric acid having a specified concentration. Temperature, reaction time, solid:liquid ratio, particle size, and stirring velocity were adjusted. The reaction took place in a sealed container and the resulting slurry was filtered on sintered glass. Atomic Absorption Spectroscopy was used to determine the nickel content in the filtrate after a suitable dilution. Table 1 shows the different factors affecting nickel recovery [6].

Acid concentration	(10–98%) by weight
Digestion temperature	(20–120)°C
Digestion time	(15–60) min
Solid:liquid	(1/12–3/4) by weight
Particle size	(as received–less than 500 micron)
Stirring velocity	(50–1400) rpm

Table 1. Factors affecting nickel recovery

RESULTS AND DISCUSSION

5.1. Effect of particle size.

The influence of spent catalyst particle size was introduced using the particle size range (as received, >2000, 850<2000, <500 micron). Fig. 1 represents the effect of the particle size of the spent catalyst on the percentage conversion at different sulfuric acid concentrations (10,20, 35, and 50% by weight), at room temperature without mixing. The data show that as the particle size decreases to <500 micron, a maximum conversion was obtained at 50% acid concentration [7].

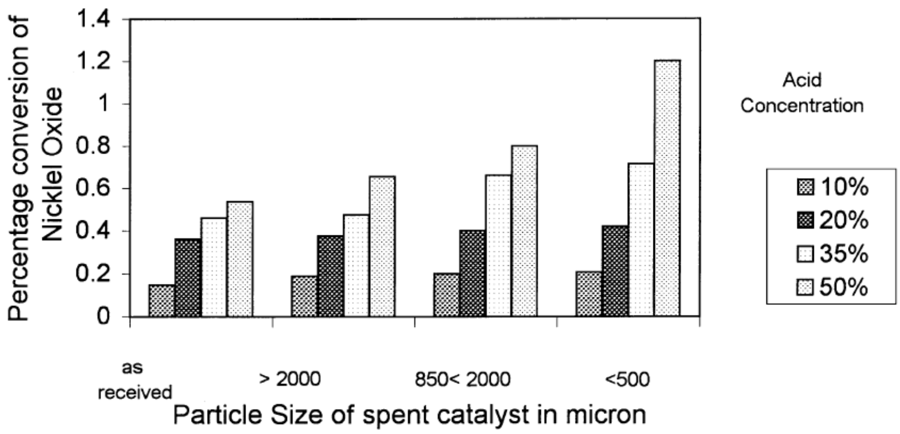

Fig. 1. Effect of particle size on percentage conversion

5.2. Effect of sulfuric acid concentration

Fig. 2 illustrates the effect of varying sulfuric acid concentration from 10 to 90% by weight. The percentage recovery of nickel increased with increasing sulfuric acid concentration up to a certain range and then decreased with further increase in concentration. A maximum of 99% conversion took place at 50% acid concentration. This indicates that the rate of dissolution of low acid concentration was small, then increased, reaching a maximum value at 50% acid concentration; the rate of dissolution then started to decline by increasing the acid concentration [8].

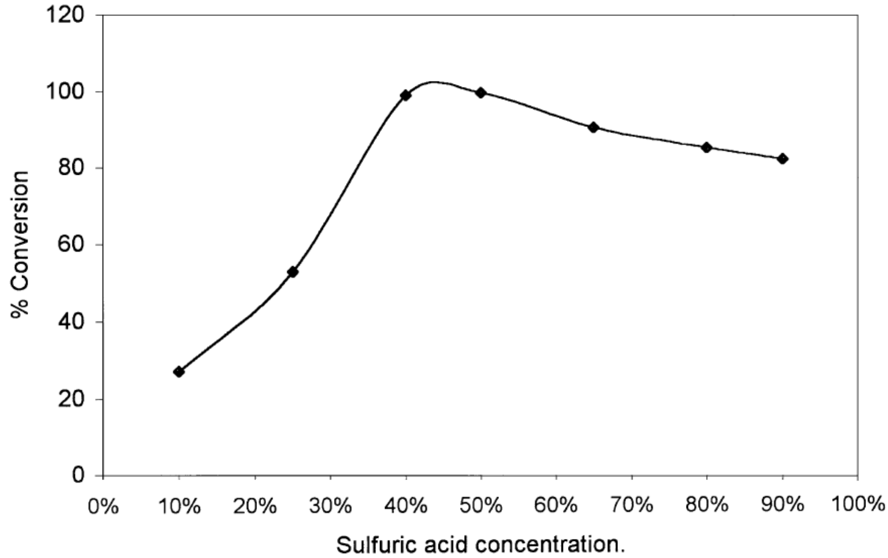

Fig. 2. Effect of sulfuric acid concentration on percentage conversion.

5.3. Effect of solid:liquid ratio

Experiment methods were carried out using different waste solid:sulfuric acid ratios with 50% acid concentration and particle size < 500 micron. It was found that using the stoichiometric amounts of solid:liquid gives a low conversion (26.3%) while increasing the acid amount improves the conversion reaching 98% at a solid:liquid ratio (1:12) as shown in Fig. 3. As the amount of acid increases, the conversion increases, but the further separation of sulfates from the excess acid is difficult and is achieved by many ways [9].

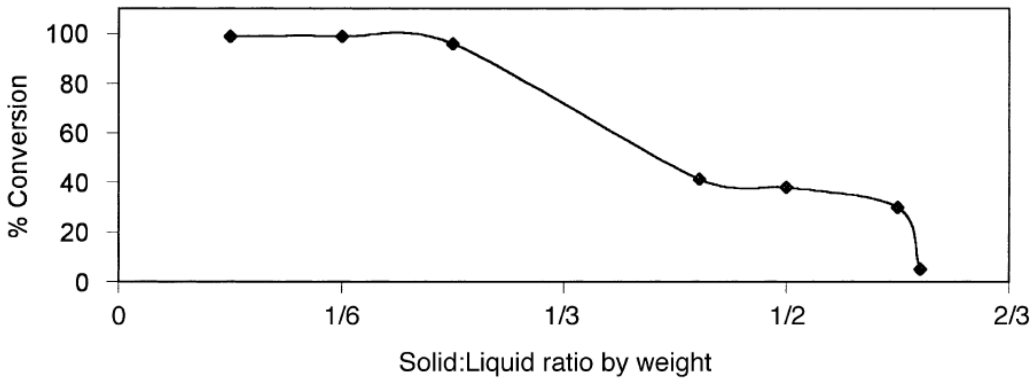

Fig. 3. Effect of solid: liquid ratio.

CONCLUSION

It is possible to utilize spent catalyst (NiO/Al2O3) obtained from the steam reforming plants to produce nickel sulfates by using sulfuric acid. According to environmental considerations it is very useful to reuse the solid waste to produce a salable product such as nickel sulfates which can be used in electroplating. Moreover, the efficient separation of nickel from spent catalyst create a possibility for reusing the alumina support in the catalyst and thus the solid waste spent catalyst is completely utilized. The operating conditions required to reach 99% conversion were 50% acid concentration, solid: liquid ratio (1:12), less than 500 micron particle size for a contact time higher than 5 h and 800 rpm stirring rate a temperature of 100_C [10].

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