

Electro-recovery of nickel from spent catalyst (solid waste) coming out from nitrogenous fertilizer industry

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ABSTRACT

Spent catalysts are principally solid waste which that coming out from nitrogenous fertilizer industry, during the production of ammonia, resulting in the production of large amount of solid waste containing nickel, which is the spent or deactivated catalysts. These catalysts contain from 12-14% nickel based on the production process in fertilizer industry disposal of spent catalyst is a problem as falls under the category of hazardous industrial waste. The recovery of Nickel from spent catalyst is an important economic aspect and secondary sources, such as spent catalyst could minimize land fill disposal and the waste of natural resources. These spent catalysts are generally supported on porous materials like alumina and silica through precipitation or impregnation processes. For extraction of nickel from spent nickel catalysts, the waste catalyst was collected from NFL Vijapur Industry district Guna(M.P.). Nickel electro-recovery from spent catalyst, leachate solution was used to determine the best operating conditions from recovery process and results were obtained.

Key words: Electro-recovery, spent catalyst, leaching, pyrometallurgy, nickel.

INTRODUCTION

Nickel containing catalysts or nickel catalysts are well known in process industries. The increase in the industrial demand for this metal has brought forth a steady growth in the need for refining of the metal. Initially Nickel catalysts perform at high activity but by time they become less active and reach at a point where they are not more effective to be used in a commercial process. Large amount of nickel catalysts are used as primary reforming and secondary reforming in nitrogenous fertilizer industries, resulting in the production of large amount of solid waste containing nickel which is the spent or deactivated catalysts. The catalysts have an active life from 5 to 7 years, on the most of which it is deactivated and must be replaced. Therefore, over the last few years, tonnes and tonnes of spent reforming catalysts are being piled up. The accumulating mass of spent catalyst is posing a great pollution problem for the concerned nitrogenous

fertilizer industry in particular and the country in general. Many researchers have studied pyrometallurgy and chelating agent process for recovery of Nickel from spent catalysts. Some other researchers studied the extraction of nickel from spent catalysts based on sulphate and chloride electrolytes. Rambla et. al performed nickel electroplating using platinum catalyzed by hydrogen diffusion anode and the effect of chloride and sulphate ions. Lupi et.al. Studied the electrolytic nickel recovery from Lithium ion batteries. Present investigation gives detail about the selective extraction of nickel from spent catalyst using leachate agent by electro-recovery process.

MATERIAL AND METHODS

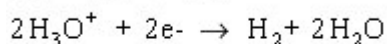
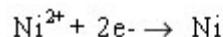
The sample spent nickel catalyst was collected from nitrogenous fertilizer industry (NFL) Vijapur, district Guna (M.P.). The physico-chemical properties of the nickel reformer catalyst was

analyzed as per standard method, all chemical used in this study was analytical grade from various suppliers. The physico-chemical properties of spent catalyst are given in table-1.

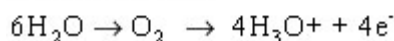
The solid spent catalyst was crushed and grounded till size range 0.3-0.4 mm the powder obtained in then dried at 100-110°C. 50 gm of dried catalyst powder placed into a flask and 250ml, of 80% sulphuric acid were added slowly to the content of the flask with boric acid and nickel chloride for 50 minute and 70°C. The solution obtained from the leaching spent catalyst was collected which mainly contains nickel sulphate, boric acid nickel chloride with pH equal 4 was placed in the cell. The stainless steel cathode was cleaned, washed and then weighed. The anode and cathode was connected in the cell and current was passed in the cell, at the end o the experiment the cathode were removed, washed, dried and weighed. The amount of nickel deposited was determined. The efficiency of deposition was calculated as the mass of nickel deposited to the mass of nickel in the leathate liquor

and is referred as % recovery. In Nickel electro-recovery from sulphate acidic baths the main reaction are :

Cathode reaction



Anode reactions



RESULTS AND DISSCUSION

Based on experiment for recovery of nickel from spent catalysts by electro-extraction, it was found that increasing the initial nickel concentration leads to increasing the current efficiency that is true since more Ni^{2+} will reach the cathode leading to a higher amount of nickel deposited and as a result higher current efficiency, during electro-extraction of nickel from sulphate solution. The effect of higher

Table 1: Physico Chemical properties of Nickel spent catalyst

S. No.	Physical Properties	Chemical Properties	
		Component	% Dry weight
1.	Bulk density (Kg/Lt) = 1.21	NiO	19.5
2.	Surface area (m ² /g)=10.1	SiO ₂	0.25
3.	Pore volume (C.C/g)= 0.11	Al ₂ O ₃	Balance
4.	Crushing strength (Kg/cm ²) =41.5	CaO	8.1
		K ₂ O	0.15
		Na ₂ O	0.23
		Cl	0.0023
		Sulphor	0.021

temperature was also lead to higher yields of nickel and better current efficiency. At higher temperature, the mobility of ions increased and the viscosity of solution decreased leading to higher transfer of nickel ions from bulk of solution to the cathode surface. Therefore the current efficiency increased. The ninety nine percent of the nickel was recovered as nickel sulphate when the catalysts, having small particle size was dissolve in an 80% solution for 50 minute in at 70°C.

CONCLUSION

Nickel has been recovered from spent nickel catalyst leachate solution by electro- deposition on cathode. The amount of Nickel recovered increase by increasing the initial nickel concentration, temperature and time to deposition. Therefore it can be concluded that proposed work is economically favorable, as well as it avoids environmental contamination with untreated spent catalyst waste.

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