Oriental Journal of Chemistry Vol. **26**(2), 721-723 (2010)

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

R.P. PRAJAPATI[1]*, ANAND SHARMA[2] and D.R. TIWARI[3]

[1]Department of Chemistry (DESM) Regional Institute of Education Bhopal - 462 013 (India).
[2]Department of Chemistry and Geology, Government M.V.M., Bhopal - 462 001 (India).

(Received: April 04, 2010; Accepted: May 21, 2010)

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 minimzie 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 colleted from NFL Vijaipur Industry district Guna(M.P.). Nickel electro-recovery from spent catalyst, lechate solution was used to determine the best operating conditions from recovery process and resutls 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 becomes 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 prouction of large amount of solid waste containing nickel which is the spent or deactiviated catalyts. The catalyst 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 pilled up. The accumating mass of spent catalyst is posing a great pollution probelm for the concerned nitrogenous fertilizer indutry in particular and the country in general. Many researchers have studied pyrometallurgy and chelating agent process for recovery of Nickel from spent catalsyts. Some other researchers studied the extraction of nickel from spent catalysts based on sulphate and chloride electrolytes. Rambla et. al performed nickel electro-planting 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) Vijaipur, 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 stainles 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

$$Ni^{2+} + 2e^- \rightarrow Ni$$

$$2H_3O^+ + 2e^- \rightarrow H_2 + 2H_2O$$

Anode reactions

$$6H_2O \rightarrow O_2 \rightarrow 4H_3O^+ + 4e^-$$

RESULTS AND DISSCUSION

Based on experiment for recovery of nickel from spent catalysts by electro-extraction, it was found that incresing 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 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.

Table 1: Physico Chemical properties of Nickel spent catalyst

S. No.	Physical Properties Properties	Chemical Properties Component	% Dry weight
1.	Bulk density (Kg/Lt) = 1.21	NiO	19.5
2.	Surface area (m2/g)=10.1	SiO_2	0.25
3.	Pore volume	Al_2O_3	Balance
	(C.C/g)= 0.11	CaO	8.1
4.	Crushing strength	K_2O	0.15
	(Kg/cm2) =41.5	Na_2O	0.23
		Cl	0.0023
		Sulphor	0.021

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.

REFERENCES

1. Ambad, M., Bhatty,M.J., Masood K. Recovery of Ni from spent catalyst, PCSIR (Karachi) **7**(4): 227-232 (1970).
2. Tiwari R.N., Arora B.R., Ganguli, N.C., Factors affecting the recovery of Ni from spent Ni-Alumina and NiO-silica type catalyst *technology* **9**(2-3): 134 (1972).
3. Material safety data sheet (G. 53H), United Catalyst Inc. (1996).
4. Chaudhary A.J. , Donalldon J.D., Boddingon S.C., Grimes S.M., Heavy metal in environment Part II A hydrochloric acid leading process for recovery of nickel value from a spent catalyst. *Hydrometallurgy* **34**: 137-150 (1993).
5. Ullmann's encyclopedia of industrial chemistry. Fifth ed. A17,m VCH Weinheim p-189 (1994).
6. Rambla J., Brillas E., casado J., Nickel electro winning using a Pt catalyzed hydrogen diffusion anode part-II Batch Tank with a sulphate bath. *Journal of Applied Electrochemistry* **29**(10): 1211-1216 (1999).
7. Khanna R.K., Singh R.P., Vasistha A.K., Reclamation of nickel catalyst from spent catalyst by dry -reduction method *JOTAI* **32**(4): 166-173 (2000).
8. Alfantazi A.M., Shakshouki A., The effect of chloride Ions on the electro-winning of Nickel from sulphate electrolysis. *Journal of the Electrochemical Society* **149**: C506 (2002).
9. Lupi C., pasquali M., electrolytic Nickel recovery from Lithium Ion Batteries, *Mineral engg.* **16**: 537-542 (2003).
10. Dipak J. Garole and A.D. Sawant, Simultaneous recovery of Nickel and Aluminium from spent reformer catalyst 23rd annual conference of the Indian council of Chemist, at K.C. College, University of Mumbai (2005).
11. Ghanem R., Farag H., Eltaweel Y., and Ossman M.E., 'Recovery of Nickel from spent catalyst by single and multi -stage leaching process', Int. *J. Environmental and waste Management,* **2**(6): 540-548(2008).