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Photocatalytic Reduction of Nickel using Synthesized nano Titanium Oxide - Acidified neem saw dust Composite from Battery waste

B. Surendra[a],S.Sai Santosh[b], Palli Nikhil [b], M.Sree Venkat[b], Punugoti Thanusha[b], Anudeep Donepudi[c], Dr. Meena Vangalapati[d*]

a Research Scholar Department of Chemical Engineering, Andhra University, Visakhapatnam, AP, India
b B.tech Student, Department of Chemical Engineering, Andhra University, Visakhapatnam,AP, Indi
c Post Graduate in information systems, CQ University , Melbourne,Australia
d Professor, Department of Chemical Engineering, Andhra University, Visakhapatnam, AP, India*

Abstract The heavy metals, present in the battery waste water released from industries are extremely toxic and pose a serious threat to public health. The physical adsorption methods are effective, but require an additional adsorbent regeneration step. The degradation of heavy metals in industrial effluents through chemical remediation has also gained tremendous attention due to its enormous applications. Photo catalytic degradation using renewable UV / sun light is one of the most promising techniques due to its simplicity and economy. Till date, various metallic/bimetallic oxides such as TiO2, ZnO, Fe2O3 have been tested for degradation of photo catalytic components due to their superior activity, low price. Attempts have been made to study the photo catalytic degradation of heavy metals using nano Titanium Oxide and Acidified neem saw dust (nTO/ANSD) composite as a photo catalyst.

In this present research, nTO/ANSD composite was synthesized and assessed for photo-chemical degradation of nickel in presence of UV light. It was observed that 96.4% Nickel was reduced using photo catalytic process. The X-Ray Diffraction(XRD) and Scanning Electron Microscopy (SEM) for nTO/ANSD studies were also performed. The recovery process of the nTO/ANSD composite photo catalyst is easier and reusability studies shows that the catalyst can be reused to remove the traces of heavy metals with slight reduction in efficiency.

Keywords: Heavy metal, Photo catalytic degradation, photo catalyst, nTO/ANSD, X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM).

1. Introduction

Industrial development leads to increasing pollution of hazardous metals .Biological interest in nickel arises from its prominent role in industrial pollution and its toxicity to plants, and animals . Large amounts of nickel are introduced into the environment through various industries like dyeing and chemical manufacture, leather tannery, metal plating . Nickel discharged into the sewage system causes serious environmental impact. Higher levels of nickel metals have been found to be toxic mainly to the kidney and livers, lung cancer and gastric damage. The nickel removal treatment includes precipitation, ion exchange, photo catalysis, reverse osmosis, and adsorption process.

Photo catalysis remains one of the best methods for wastewater remediation techniques .This process has the ability to destroy or reduce the pollutant, rather than just mitigate, trap, or isolate them. The application of various types of semiconductor materials, including titanium dioxide (TiO2) and zinc oxide (ZnO) as a light responsive material to treat wastewater.

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2. Materials and Methods

2.1 Preparation of Nanoparticles of TiO2 and Acidified Neem Saw Dust (nTO/ANSD) composite

Prepare 30% $Ticl_4$ solution. Take 15ml of this solution and add 250ml of milli Q water. To this add 2gms of ANSD and mix the solution to neutral pH by adding hydrazine hydrate. Allow the mixture to settle. The solution is centrifuged and the solid cake is taken out. The pellet (solid) is then dried in an hot air oven at 120°C. The dried cake is finely powdered using a mortar. The fine powder is stored in an air tight container.

2.2 Photocatalytic process for the reduction of Nickel by (nTO/ANSD) composite from battery waste

The photoctalytic reduction of Nickel by (nTO/ANSD) composite from battery waste under various conditions. i.e., pH (2-12), photo catalyst dosage (0.5-4 % W/V), contact time (20-140 min), initial metal concentration (10-100 ppm) and temperature (30-60°C) were carried out in the presence of UV light. Then the sample is estimated by Atomic absorption Spectroscopy (AAS) at a wavelength of 375 nm.

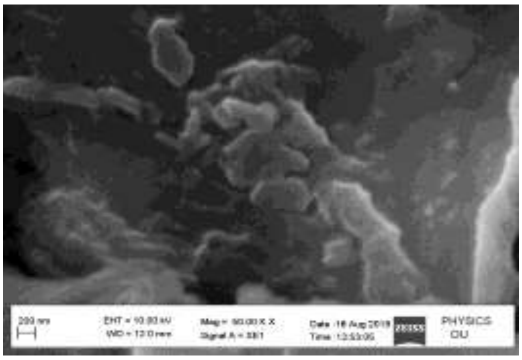
Fig 1. Neem saw dust

Fig 2. Acidified neem saw dust

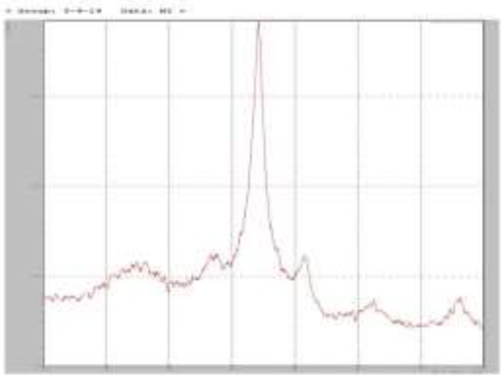
3. Results and discussion

3.1 Characterization of (nTO/ANSD) composite

The extracted Nickel from battery waste is characterized by SEM and XRD.



(a)



(b)

Fig. 3 (a) SEM image of synthesized nTO/ANSD composite
(b) XRD pattern for nTO/ANSD composite

The SEM image in fig. 3 (a) shows the detailed structure and size of the synthesized nTO/ANSD composite. The size was in the range of 200 nm at 15000 range magnification.

The XRD pattern showed in fig 3 (b) shows the presence of synthesized nTO/ANSD composite. The Highest peaks represent the different functional groups present in the powder of synthesized nTO/ANSD composite.

3.2 Optimization of various parameters of photocatalytic reduction of nickel by synthesized nTO/ANSD composite:

The photoctalytic reduction of Nickel by (nTO/ANSD) composite from battery waste under various optimized conditions. i.e., pH (6), photo catalyst dosage (2.5 % W/V), contact time (80 min), initial metal concentration (10

ppm) and temperature (40°C) were carried out in the presence of UV light. Then the sample is estimated by Atomic absorption Spectroscopy (AAS) at a wavelength of 375 nm.
The results obtained from these optimized conditions by photocatalytic reduction by synthesized nano composite were shown in the fig. 4 (A, B, C, D and E).
The percentage reduction of Nickel from battery waste by nano composite is 96.4%.

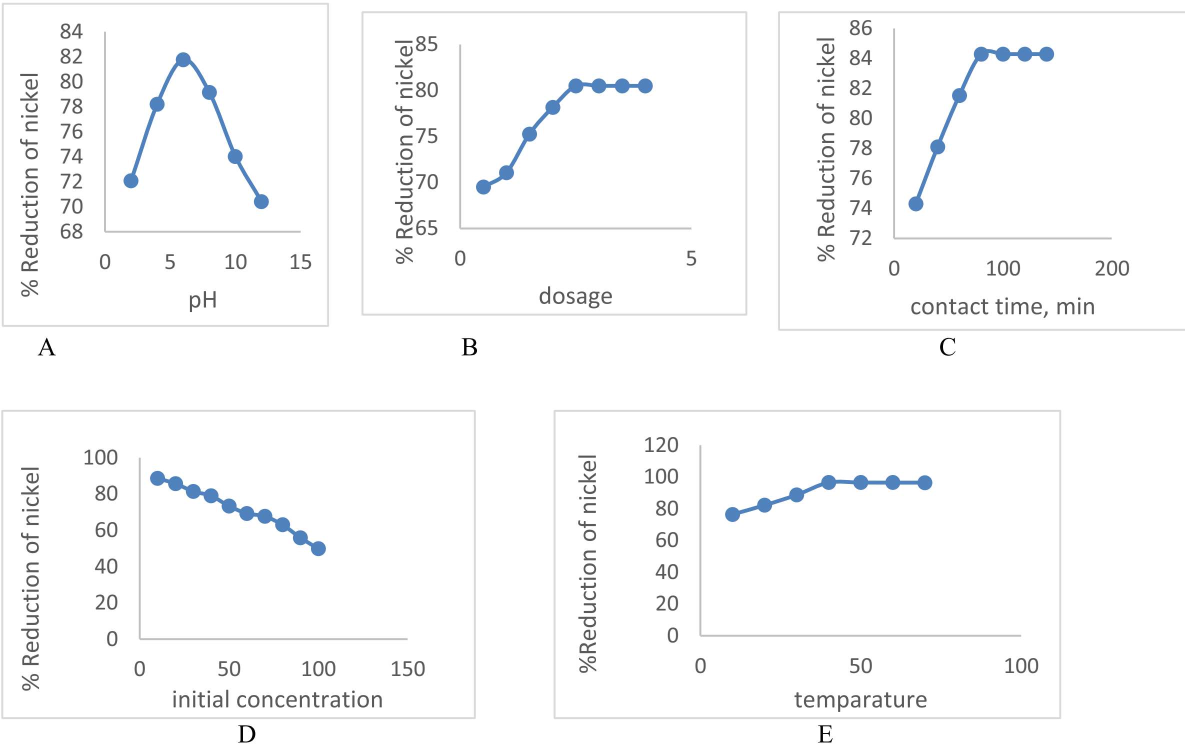


Fig. 4. Percentage reduction of nickel by various parameters - (A) pH, (b) Dosage, (C) Contact time, (D) Initial metal concentration and (E) Temperature

Conclusion

Heavy toxic metals like Zinc, cadmium, nickel, lead etc., which were present in the battery waste were being released into the environment which is causing environmental pollution. These toxic metals were reduced by photocatalytic process using synthesized nTO/ANSD composite. At the optimized conditions of pH (6), photo catalyst dosage (2.5 % W/V), contact time (80 min), initial metal concentration (10 ppm) and temperature (40°C) the percentage reduction was obtained as 96.4%. Photocatalytic technology used was of low cost and susceptible to erosion.

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