

## Research Article



## Removal of Nickel (II) Using Fly Ash as Adsorbent

Ashok Kumar Popuri<sup>\*1#</sup>, Prashanti Guttikonda<sup>2</sup>

<sup>1</sup>VFSTR University, Vadlamudi, Dist.: Guntur (A.P.), India.

<sup>#</sup>Department of Chemical Engineering, S.V.U. College of Engineering, S.V. University, Tirupati, Dist.: Chittoor (A.P.), India.

<sup>2</sup>VLITS, Vadlamudi, Dist.: Guntur (A.P.), India.

**\*Corresponding author's E-mail:** [ashok\\_kumar\\_popuri@yahoo.com](mailto:ashok_kumar_popuri@yahoo.com)

Accepted on: 18-10-2015; Finalized on: 30-11-2015.

### ABSTRACT

Removal of toxic metals from industrial wastewaters is essential from the stand point of environmental pollution control. Among all heavy toxic metals nickel, mercury, lead, chromium and cadmium are in limelight due to their major impact on environment. Heavy metals have a tendency to accumulate and end up as permanent additions to the environment. It is evident that adsorption using fly ash is an effective method for the removal of nickel(II) from industrial wastewaters. The usage of fly ash is simple and economically viable. By this method 100% of Ni(II) removal is possible. From our studies it is evident that as adsorption time increases % removal of Ni(II) also increases. As the temperature increases the % removal of Ni(II) decreases. The activity of adsorbent is maximum and high % removal of Ni(II) was identified at pH of 9.4 to 10 because of chemical precipitation of Ni.

**Keywords:** Nickel(II), Fly ash, Adsorption, Dosage, Time, Temperature, pH.

### INTRODUCTION

The permissible limits of Ni(II) in drinking water is 0.07 mg/lit. It causes various types of acute and chronic disorders like hyper sensitivity reactions in the immune system, respiratory illness such as asthma, liver necrosis and carcinoma.<sup>1</sup>

Nickel does not occur in natural water. Metal plating wastes when discharged into water courses contribute nickel. Increased use of stainless steel and other nickel containing alloys in water systems also contribute nickel.<sup>2</sup>

Many physicochemical wastewater treatment processes viz. oxidation-reduction, precipitation, ion exchange, biosorption and liquid membranes are being used to remove nickel(II) present in wastewaters. However, all these processes have their limitations of technical and economical constraints. Adsorption is a viable and attractive method for removal of heavy metals from effluents due to its high efficiency, easy handling and less expensive.<sup>3-4</sup>

The effects of different parameters such as contact time, dosage of adsorbent, pH and temperature have been studied. Calorimetric method is used to measure the amount of nickel(II) present in the solution. Optical density of solution increases with increase in nickel(II) concentration.

Dimethylglyoxime is added to nickel(II) in the presence of an alkaline oxidizing agent to form a characteristic red colored complex. The optical densities were measured at a wavelength of 470 nm.<sup>5-6</sup>

### MATERIALS AND METHODS

Materials used: Nickel sulphate, dimethylglyoxime, hydrochloric acid, sodium citrate, Fly ash.

### Treatment of effluent

Methods for treating wastewaters consist of various chemical, physical and biological processes. These include adsorption, nanofiltration, colloidal gas aprons, ultrasonic decomposition, electro coagulation, precipitation, photo-oxidation, predispersed solvent extraction, ozonation, supported liquid membrane and liquid-liquid extraction. Natural materials that are available in abundance or certain waste products from industrial or agricultural operations may have great potential as an inexpensive sorbents. Due to their low cost, after these materials have been expended, they can be disposed off without expensive regeneration. The abundance and availability of agricultural by-products make them good sources of raw materials for activated carbons. Many carbonaceous materials such as bark, coal, lignite, coconut shells, wood, dead biomass, seaweed, and peat are used in the production of commercial activated carbons.<sup>7-8</sup>

### Physical treatment-adsorption

Adsorption is the process of transferring material from a fluid phase to a solid phase. The adsorption process has been widely used for metal removal. Adsorption is one of the processes, which besides being widely used for metal removal also has wide applicability in wastewater treatment. This process is being very low cost method and most simple method for treating metal pollutants. Adsorption results in the removal of solutes from solution and their concentration at a surface, until the amount of solute remaining in solution is in equilibrium with that at the surface.<sup>9-10</sup>

### Experimental procedure

Effluent solution is taken in reagent bottles, varying doses of adsorbent is added to study the feasibility of metal



removal and the pH of the test mixture was adjusted when required. A number of such reagent bottles containing the test mixture depending upon the requirement were employed.<sup>11</sup>

Then the reagent bottles containing test mixture was placed in an orbital shaker operating at desired rpm to facilitate effective mixing and precipitates formation. Then the reagent bottles containing reaction mixture were kept under undisturbed for 1 hr for settlement of precipitation formed. The settled precipitate is separated from the mixture by filtration with the help of a filter paper. The filtrate is analyzed for % removal using the calibration curve prepared. The effect of parameters like time, speed, dosage and pH are studied.<sup>12</sup>

## RESULTS AND DISCUSSION

### Calibration curve for estimation of nickel(II) concentration

Solutions of various nickel(II) concentrations are taken and their optical densities are measured using spectrophotometer. A calibration curve is drawn between nickel(II) concentrations and optical densities.

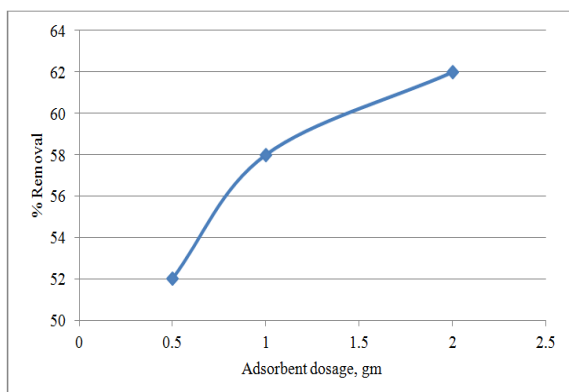
### Removal of nickel(II) using fly ash

#### Effect of adsorbent dosage on % removal

From Table-1 and Graph-1, the percentage removal of Ni(II) is increased to a certain amount and was then found to be constant. The optimum amount of adsorbent dosage is 2 gm. The parameters are kept constant at, time of adsorption: 120 min; pH of solution: 6.0; concentration of Ni in feed: 100 µgm; temperature: 30°C.

**Table 1:** Effect of adsorbent dosage on % removal

Adsorbent dosage, gm	Optical density	% Removal
0.5	0.09	52
1.0	0.08	58
2.0	0.07	62



**Graph 1:** Adsorbent dosage vs. % removal

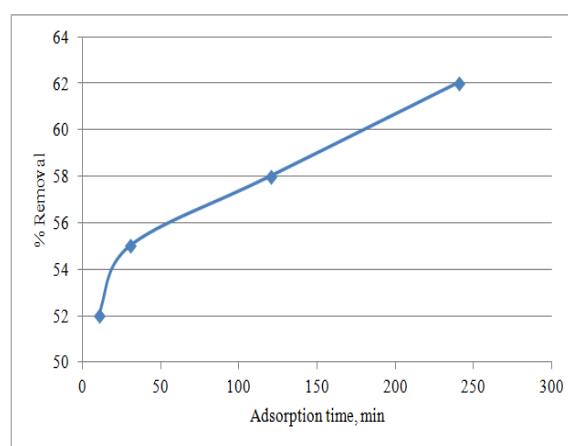
#### Effect of adsorption time on % removal

From Table-2 and Graph-2, the percentage removal of Ni(II) is increased to a certain amount and was then found to be constant. The optimum time is found to be 240 min.

The parameters are kept constant at, adsorbent dosage: 2 gm; pH of solution: 6.0; concentration of Ni in feed: 100 µgm; temperature: 30°C.

**Table 2:** Effect of adsorption time on % removal

Adsorption time, min	Optical density	% Removal
10	0.13	52
30	0.085	55
120	0.079	58
240	0.07	62



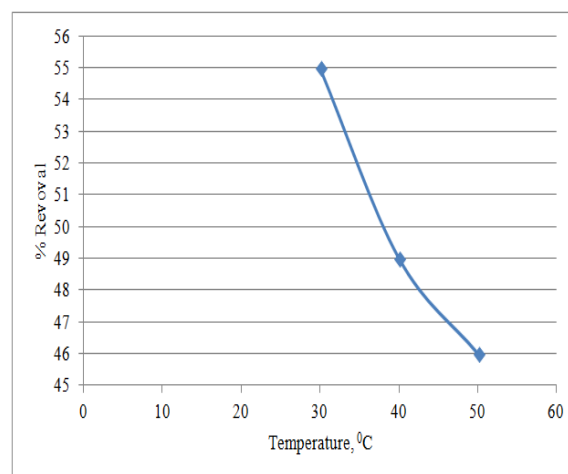
**Graph 2:** Adsorption time vs. % removal

#### Effect of temperature on % removal

From Table-3 and Graph-3, the percentage removal of Ni(II) decreased gradually with increase in temperature of solution. The optimum temperature is found to be 30°C. The parameters are kept constant at, adsorbent dosage: 2 gm; time of adsorption: 240 min; pH of solution: 6.0; concentration of Ni in feed: 100 µgm.

**Table 3:** Effect of temperature on % removal

Temperature, °C	Optical density	% Removal
30	0.08	55
40	0.09	49
50	0.10	46



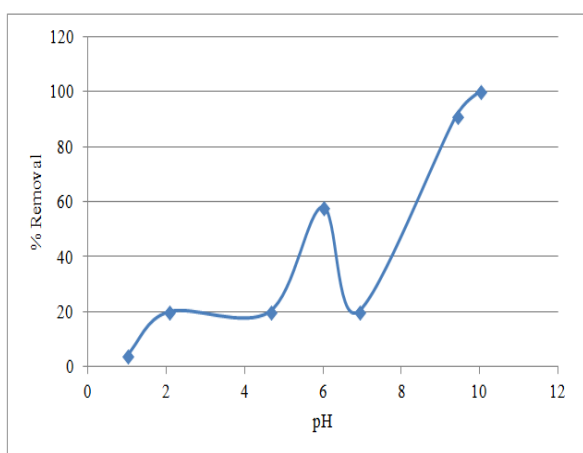
**Graph 3:** Temperature vs. % removal

### Effect of pH on % removal

From Table-4 and Graph-4, the percentage removal of Ni(II) is increased gradually with increase in pH of solution. The optimum pH is found to be 10. The parameters are kept constant at, adsorbent dosage: 2 gm; time of adsorption: 240 min; temperature: 30°C; concentration of Ni in feed: 100 µgm.

**Table 4:** Effect of pH on % removal

pH	Optical density	% Removal
1.0	0.16	4
2.07	0.14	20
4.64	0.14	20
6.0	0.08	58
6.9	0.14	20
9.4	0.02	91
10	0.00	100



**Graph 4:** pH vs. % removal

### CONCLUSION

It is evident that adsorption using fly ash is an effective method for the removal of nickel(II) from industrial wastewaters. By this method, 100% of nickel(II) removal is possible. From the experimental studies the following conclusions are arrived.

- ✓ As the amount of adsorbent increases, the % removal of nickel(II) also increases. For a constant time of 120 minutes, the optimum amount of fly ash required for nickel(II) removal is 2 grams.
- ✓ As the time of adsorption increases, the % removal of nickel(II) also increase. For a constant adsorbent weight of 2 gram, the optimum time required for nickel(II) removal is 240 minutes.

- ✓ Maximum removal of nickel(II) was observed at a pH of 10. This is due to chemical precipitation of nickel to nickel hydroxide.
- ✓ As the temperature increases, the % removal of nickel(II) decreases. So the adsorption of nickel(II) using fly ash is exothermic in nature and the phenomenon of adsorption is physisorption.

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**Source of Support:** Nil, **Conflict of Interest:** None.

