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Removal of Nickel using Activated Carbon of Fresh Water Algae (FWA)

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Abstract: The efficiency of activated carbon of fresh water algae (FWA) a low cost adsorbent for removing Ni ions from aqueous solution and was evaluated by varying various parameters such as pH, contact time, FWA dose and initial Ni ion concentration. With increasing adsorbent dose and contact time the percentage of Ni removal increases. The percentage removal of Ni at low concentration (20mg/l) was found to be 84.17% in 120 min. for 1gm adsorbent dose. The percentage removal of Ni at high concentration (100mg/l) was found to be 86.70% in 120 min. for 1gm adsorbent dose. The percent removal of Ni at low concentration (20mg/l) and low contact time (30min) was found to be 45.35%. The percent removal of Ni at high concentration (100mg/l) and low contact time (30min) was found to be 48.50%. The maximum removal percentage of Ni at pH = 5 were found to be 84.25% for 100 mg/l at 120 min. The percentage removal of Ni at low adsorbent dose (0.2g) was found to be 57.29% for 100 mg/l at 120 min. The results revealed that the Nickel is considerably adsorbed on FWA and it could be an economically viable method for the removal of nickel ions from aqueous solution.

Keywords: Adsorption, Fresh water algae, Nickel.

I. INTRODUCTION

Due to increase industrial and agricultural activities the pollution load on the environment is increasing. Every industrial process released some kind of individual and different types of pollutants which increases the pollution load on water bodies [1]. The continuous increasing the level of heavy metals in environment and dangerous to all living species, even in at low concentrations [2]. Most of the heavy metals came from metal plating industries, mining operations, fertilizer industries, tanneries, batteries, paper industries, pesticides industry, stabilizers, thermoplastics manufacturing plants, and it contains high amount of heavy metals when it is discharged into water body [3-4]. These industries discharge their wastewater into the water body without any treatment and day by day there is increase the concentration of heavy metals in water body. So heavy metals are one of the most distractive types of water pollutants. Due to their non- biodegradability, they are accumulated by living organism and due to their toxicity they cause diseases and disorders. Zinc, copper, nickel, mercury, cadmium, lead and chromium are known as toxic metals. Thus, to increase the quality of water, the treatment of industrial wastewater containing heavy metals is necessary. Out of several toxic heavy metals, nickel is one of them. Nickel is the naturally occurring element. Nickel is the most abundant element in the Earth's crust, comprising about 3% of the composition of the earth [5]. It comes into the environment from both natural sources and anthropogenic activity. These sources may be stationary or mobile [6]. Adverse health effect produce by pure Nickel are negligible [7] and the adverse health effects of nickel depend on the route of exposure (inhalation, oral or dermal). Sulphide and oxide forms of nickel are highly carcinogenic [8] and cause of high risk of lungs and nasal cancer [9]. When both human and animal expose with Nickel compound free radical are formed in various tissues which can modified DNA [10].

The exposure to oxide of nickel also cause asthma and respiratory diseases [11] and skin allergy from nickel chloride [12]. There are numbers of treatment processes have been used to remove heavy metals from water and wastewater such as ion exchange, precipitation and coagulation, membrane filtration electro dialysis and reverse osmosis [13]. The low cost of activated carbon and simplicity of activation process to make carbon adsorbents attractive for removal of toxic heavy metals [14]. Different types of adsorbents have been tried for preparation from agricultural and industrial wastes such as wood sawdust and sugarcane bagasse [15], rice husk [16], waste biomass, waste activated sludge [17], and chitosan [18]. Due to this, desirable nickel concentration in drinking water and industrial effluents as standards 0.02mg/l and 3.0 mg/l respectively which is described by World Health Organization (WHO). Therefore, it is necessary to bring the nickel concentration below the prescribed limits. The aim of the study is removal of nickel from activated carbon of fresh water algae (FWA).

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II. MATERIALS AND METHODS

Adsorbent Preparation

A fresh water alga (FWA) was collected from a local water tank of public health department, Hisar. It was washed with water and dried in sunlight until all the moisture had evaporated. Subsequently it was kept in a muffle furnace for 5HOURS at 550 oC for carbonization. The FWA was treated with a 0.1 N HCl solution and kept overnight. After thoroughly washed with distilled water the carbonized FWA was kept in an oven at 120 oC- 140 oC for 24 hrs. The dried material was ground and sieved through standard sieves (170BSS). Dried activated FWA adsorbent storage in plastic bottle for further use.

Preparation of reference solution

For all experiments analytical grade reagents were used. A reference solution of Ni was prepared by dissolving 2.63 gm nickel sulphate (NiSO4) in one litre double distilled water. This solution was diluted 10 times and called the reference solution in this study. The Ni concentration was measured with Atomic Absorption Spectrophotometer (Shimadzu AAS 6600).

III. RESULTS AND DISCUSSION

The present study deals with the removal of Ni from synthetic wastewater by using activated carbon of FWA as low cost adsorbent. The adsorption capacity of Ni on FWA was studied in batch experiments with five concentrations (20, 40, 60, 80 and 100 mg/l), and different doses of FWA (0.2-1.0g/50 ml) and different contact times (30, 60, 90 and 120 min) in the test solution at room temperature (28±1oC) shaking with the help of rotatory shaker at 60rpm. All the batch experiments were performed at constant pH (5.0).

Effect of adsorbent dose

The maximum removal of Ni (48.5%) was observed at 100 mg/l for 30min of at pH=5 for one gm dose of FWA. The maximum removal of Ni (66.80%) was observed at 80 mg/l for 60min at pH=5 for 1 gm dose of FWA.

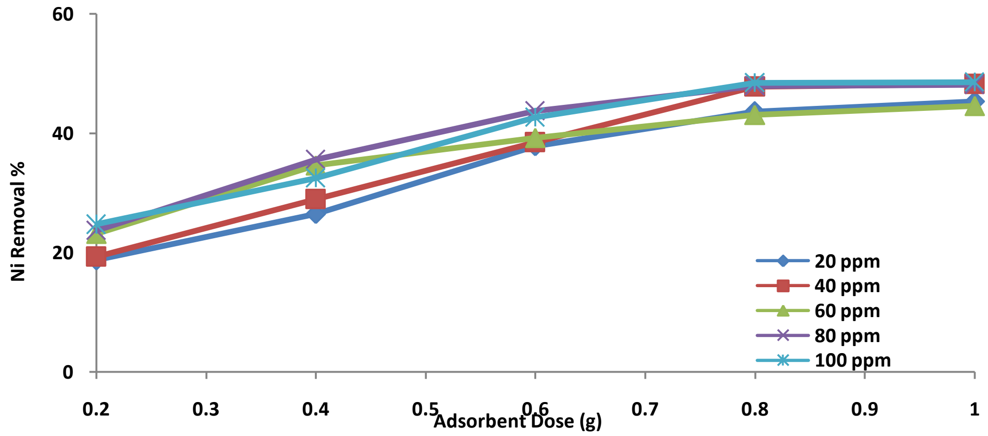

Fig. 1: Effect of adsorbent dose (30 min)

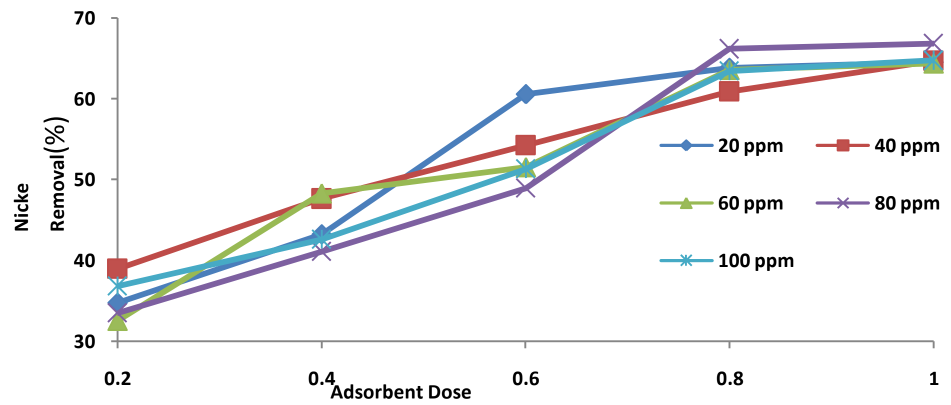

Fig. 2: Effect of adsorbent dose (60 min)

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The maximum removal of Ni (76.21%) was observed at 100mg/l for 90min at pH=5 for 1 gm dose of FWA. The maximum removal of Ni (86.83%) was observed at 80 mg/l for 120min at pH=5 for 1 gm dose of FWA. The results are shown figures 1-4. This increase in adsorption capacity with FWA dose may be attributed to increased adsorbent surface area and availability of more adsorption sites on AC.

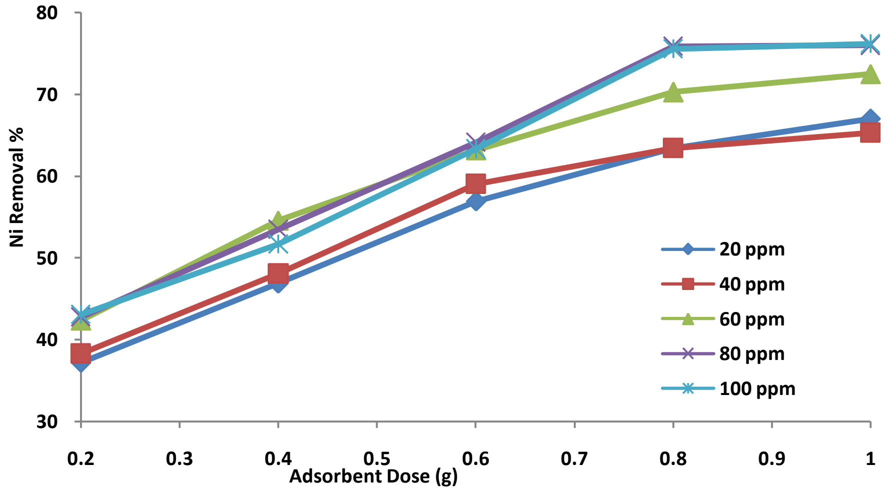

Fig. 3: Effect of adsorbent dose (90 min)

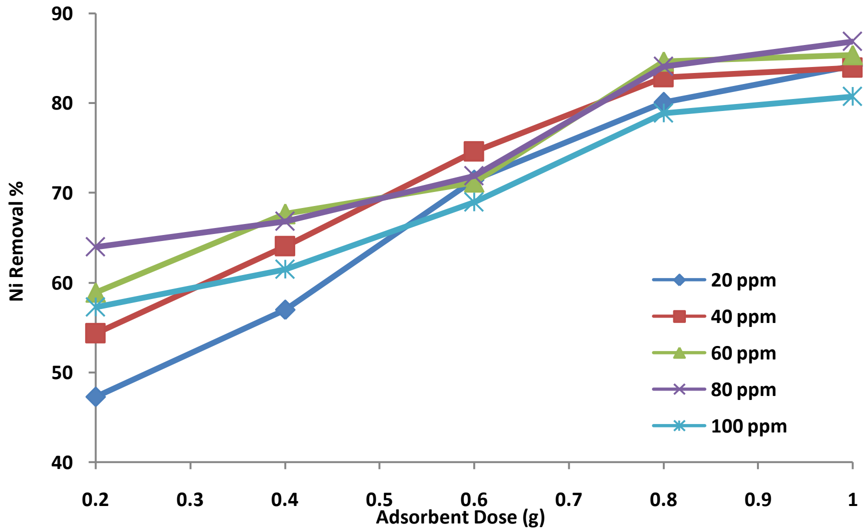

Fig. 4: Effect of adsorbent dose (120 min)

The per cent adsorption capacity was increased with an increase in FWA dose. The results of our experiments showed the effect of adsorbent dose on removal of Ni. The maximum removal of Ni was observed at pH=5 and contact time 120min at 1 gm per 50 ml test solution of Ni having concentration 100 mg/l.

Effect of contact time

The adsorption capacity of Ni on FWA was studied in batch experiments for five concentrations, different time (30, 60, 90 and 120 min) and at constant adsorbent dose of FWA was selected 0.8 gm in the test solution at room temperature (28±1^{o}C) shaking with the help of rotatory shaker at 60rpm.

The maximum removal of Ni (48.4%) observed at 20mg/l for 120min of at pH=5 for 0.8 gm dose of FWA. The maximum removal of Ni (66.15%) was observed at 40mg/l for 120min at pH=5 for 0.8 gm dose of FWA. The maximum removal of Ni (75.5%) was observed at 60mg/l for 120min at pH=5 for 0.8 gm dose of FWA. The maximum removal of Ni (84.06%) was observed at 80mg/l for 120min at pH=5 for 0.8 gm dose of FWA. The results are shown figure 5. This increase in adsorption capacity with contact time may be attributed to increased FWA surface area and availability of more adsorption sites on FWA. The percent adsorption capacity was increased with an increase in contact time.

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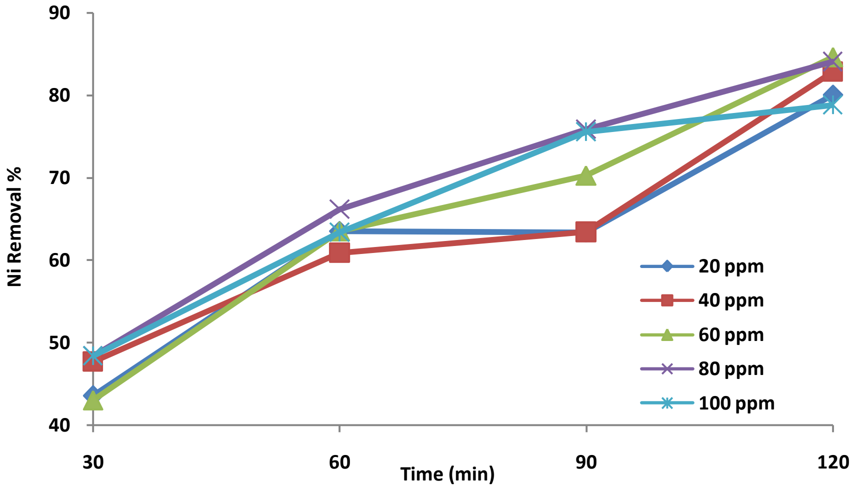

Fig. 5: Effect of contact time

The results of our experiments showed the effect of contact time on removal of Ni, the maximum removal of Ni was observed at pH=5 and contact time 120min at 0.8 gm per 50 ml test solution of Ni having concentration 80 mg/l. From the analysis it has concluded that as the contact time increases the removal of Ni increase. The Ni uptake by FWA is rapid for the first 30 min and there after it proceeds at a slower rate and finally attains saturation.

Effect of initial Ni concentration

The maximum removal of Nicke (40.43%) was observed at 100mg/l for 30min of at pH=5 for 0.8 gm dose of FWA. The maximum removal of Ni (66.15%) was observed at 100mg/l for 60min at pH=5 for 0.8 gm dose of FWA.

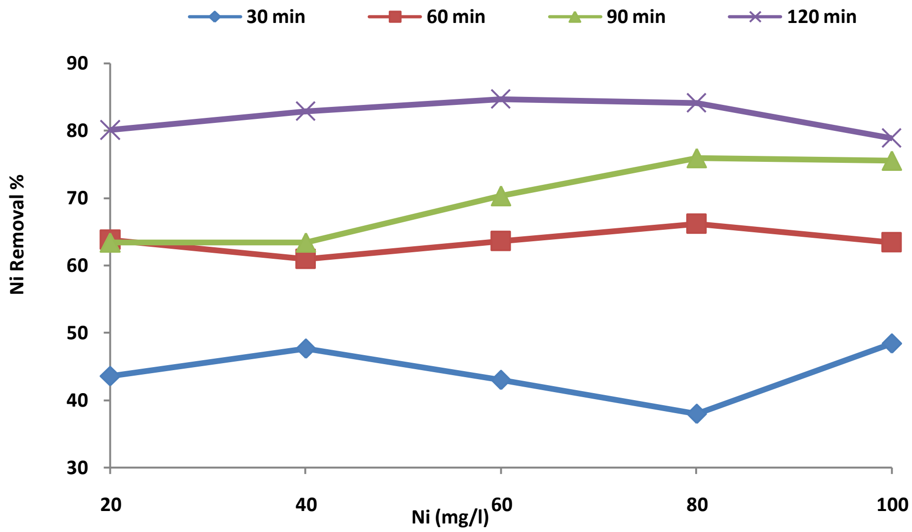

Fig. 6: Effect of initial Ni concentration

The maximum removal of Ni (75.54%) was observed at 100mg/l for 90min at pH=5 for 0.8 gm dose of FWA. The maximum removal of Ni (84.04%) was observed at 100mg/l for 120min at pH=5 for 0.8 gm dose of FWA. The results are shown in figure 6. This increase in adsorption capacity with contact time may be attributed to increased FWA t surface area and availability of more adsorption sites on FWA. The per cent adsorption capacity was increased with an increase in contact time. The results of our experiments showed the effect of contact time on removal of Ni, the maximum removal of Ni was observed at pH=5 and contact time 120min at 0.8 gm per 50 ml test solution of Ni having concentration 100mg/l.

Effect of pH

All the batch experiments were performed at varied pH 3, 4, 5 and 6. The maximum removal of Ni (47.93%) was observed at 80mg/l for 30min at pH=5 for 0.8gm dose of FWA.

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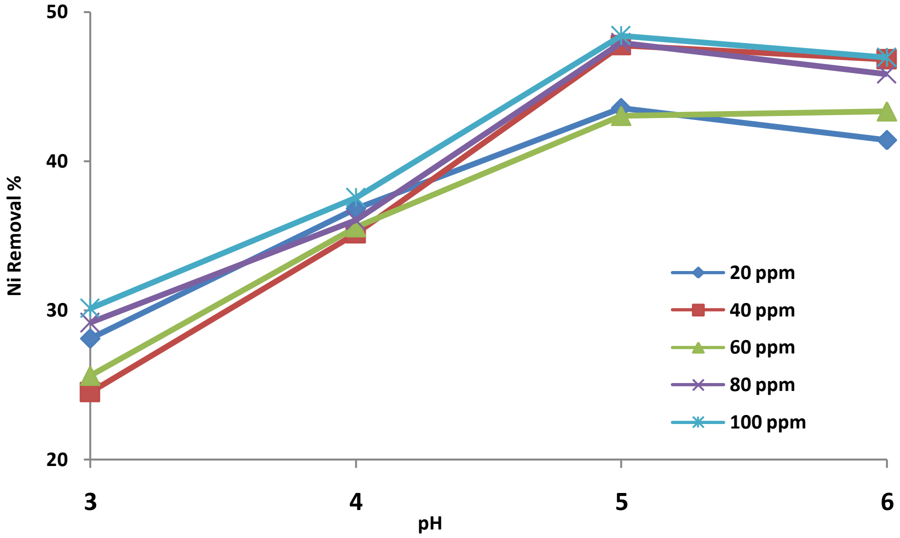

Fig. 7: Effect of pH (30 min)

The maximum removal of Ni (69.05%) was observed at 80mg/l for 60min at pH=5 for 0.8 gm dose of FWA. The maximum removal of Ni (75.90%) was observed at 80mg/l for 90min at pH=5 for 0.8 gm dose of FWA.

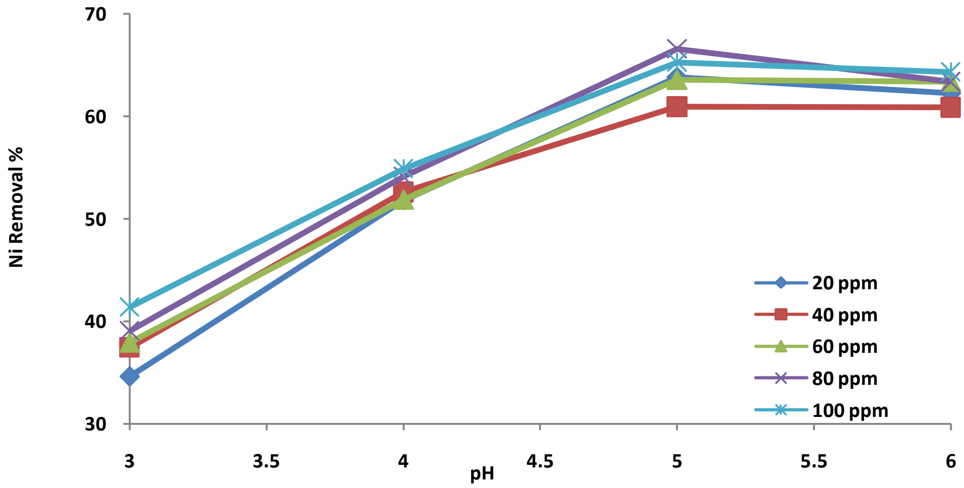

Fig. 8: Effect of pH (60 min)

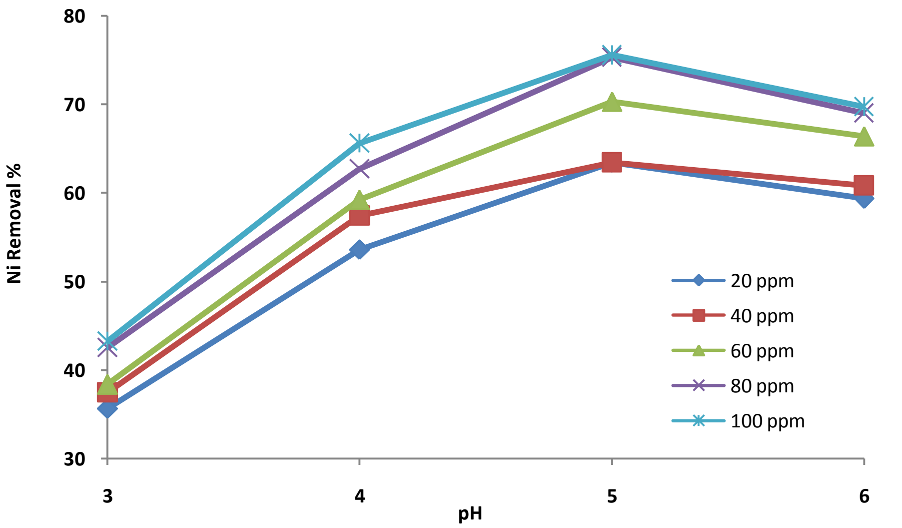

Fig. 9: Effect of pH (90 min)

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The maximum removal of Ni (89.16%) was observed at 80mg/l for 120min at pH=5 for 0.8gm dose of FWA. The results are shown in figure 7-10. The results of our experiments showed the effect of contact time on removal of Ni, the maximum removal of Ni was observed at pH=5 and contact time 120min at 0.8 gm per 50 ml test solution of Ni having concentration 80mg/l.

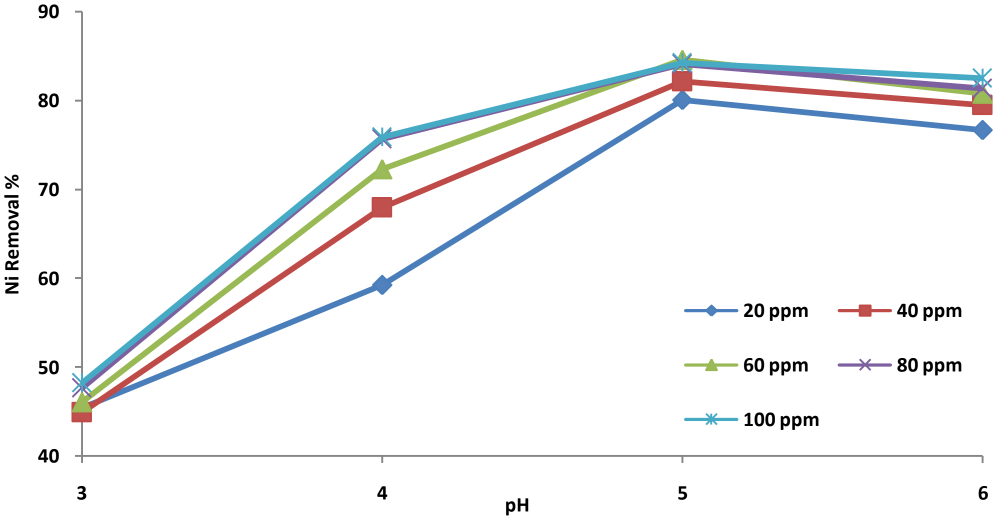

Fig.10: Effect of pH (120 min)

VI. CONCLUSION

Activated carbon was prepared from FWA for removal of Nickel from aqueous solution. The maximum removal of Ni was observed at 5 pH, 0.8g dose of FWA and contact time 120 min.. The removal of Ni decreases with pH increases. The removal rate of Ni from the aqueous solution was fast upto contact time 60min. and beyond this contact time Ni removal rate was slightly slow. Finally, it can be concluded that activated carbon of FWA has good low cost adsorbent option for removal of nickel from the aqueous solution and same can be applied for removal of nickel from industrial wastewater.

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