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MOVING BED BIOLOGICAL TREATMENT SYSTEM FOR WASTEWATER TREATMENT CONTAINING HEAVY METALS OF CHROMIUM AND NICKEL

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ABSTRACT

Heavy metals are one of the main pollutants in wastewater of many industries that affect the treatment responses and the kinetics of the microorganisms and reduce the system efficiency by free access to wastewater treatment systems [1].

Biological methods are the best alternative to conventional chemical and physical methods to remove the heavy metals from groundwater and wastewater [2].

In this study in order to efficiency and study of biological systems moving bed reactor in treatment of wastewater containing heavy metals, 2 reactors made of Plexiglas to a total volume of 40 liters and 32 liters of useful volume that was set up by the activated sludge return line treatment of Ekbatan. First phase of the study is the adaptation of microorganisms to the circumstances; the second phase was to investigate the effect forof chrome metal only on thesystem performance, and third phase was to examine the impact of both mixed nickel and chromium in the reactor system performance.The results showed that the percentage of COD removal in this system took 85% of microorganisms' compatibility. The percentage of heavy metal of chromium removal alone in the MBBR reactor at a concentration of 1 mg per liter was 42/7percent. Increasing concentration of 30 mg per liter, it increases to 72/35%.

Removal percentage of heavy metals (chromium and nickel) as mixed in a reactor at a concentration of 1 mg per liter is respectively67/16% and 45/27% by increasing the

concentration of 30 mg per liter increases up to89/8% and 84/49%. Increased concentration will continue until the system is able to uninstall it here concentrationshave been increased up to 250 mg per liter.

Keywords: MBBR, packing, heavy metals, electroplating wastewater treatment, biofilm

INTRODUCTION

Untreated industrial waste, especially wastewater containing heavy metals makes damage to soil and water resources annually. The most important risk to the discharge of such waste water is the disposal of plant and animal species, as well as the accumulation of these elements in vivo and entering the human body [3]. So,it seems necessary to avoid the deleterious effects of these substances as a result of human activity. There are various physical and chemical methods to remove and eliminate the presence of heavy metals in waste water. But each of these methods is not affordable due to the high cost of construction, maintenance, operation and use of chemicals. Moreover, waste from treatment with chemicals can also be a strategy to remove them must be considered. Therefore, there is a tendency to use biological methods. This is important from two aspects. First, the method of biological treatment of the wastewater is done using living organisms that are environmentally and secondly there is no need to remove or chemical transformation did not have cheap and affordable [3]. The study aimed to investigate the biological system performance mobile bed (MBBR) in wastewater containing heavy metals is nickel chromium. It is more than a century of use bioreactors for wastewater treatment, there are drawbacks and limitations of biological treatment in different ways,has led to a result to do extensive research and continuous view of usage and implementation, many changes are created for the use of a new treatment, purification systems and new technologies have been developed, including a fluid bed reactor design ideaswas considered in the late nineteenth century in Europe makes the acquisition MBBR technology in Norway [5,4].MBBR reactors are the evolved type of reactor fixed bed activated sludge that are defined based on the main characteristic by biofilm reactors grown on small acne with effective levelsfloat above the tank, as well as a tank isused to growth of biomass. The reactor can be aerobic or anaerobic, the aerobic process during which coarse bubble aeration system is possible, in addition to providing oxygen required for biodegradation and oxidation of organic materials, mixing enough acne to move in all the reactors [6].

Acne are usually low-density polyethylene than water that the role of the carrieris to maintain system in a high concentration of microorganisms whose most important feature of this high specific surface acne is a good environment for the growth of provide micro-organisms [7]. The amount depends on the severity of acne in reactor design parameters such as sewage pollution and hydraulic retention time. But theyare used in an anaerobic system of a mechanical device such as a mixer with rotating blades that move horizontally in the reactor used for acne [9, 8].

Table 1: Details the moving bed biofilm reactor

Reactor number	2
Reactor material	Plexiglas
Acne in Reactor(%)	66-70
Total Volume (Lit)	40
Effective Volume (Lit)	32
Total Length (m)	1
Effective Length (m)	0/8
Width (m)	0/2
Length (m)	0/2
Thickness (mm)	5

RESEARCH METHODOLOGY

The study was conducted in pilot scale in the Faculty of Environmental and energy, Science and Research Branch of Islamic Azad University in September 2014 and May 2015

MATERIALS AND METHODS

Pilot Specification

Rectangular cube reactor made of Plexiglas with a capacity of 32 liters, useful height 0.8 m, the length and width of 0.2 meters and a thickness of 5 mm was used. The reactor use acnes of polyethylene and of Kaldns type 1 with a filling density of 70% were used. Specifications of pilot acne presented in Tables 1 and 2. Air stone embedded in the bottom of the reactor by hose connected to the air compressor, which in addition to the oxygen in the reactor, it provides the acne rotation. The capacity of the compressor is 60 liters per minute; also a mesh was embedded in exit of reactor to keep acne. For sampling, four valves with a distance of 20 cm were installed on the reactor. For feeding the reactor, a 500-liter tank was used that was connected to a reactor by hose, the feed entry from tank to the reactor was adjustedby dosing of pumps with certain flow rate.

Table 2: The used acne in MBBR

Density (Kg/m^3)	Average Weight Of acne (g)	Acne number In lit	Special surface Area (m^2/m^3)	Acne type
150	0/48	324	500	Kaldnes(K1)

Synthetic sewage specification

Molasses as a source of carbon was used for the manufacture of artificial wastewater which was supplies from Varamin Sugar factory and potassium di hydrogen phosphate and di potassium hydrogen phosphate were used as a source of phosphorus and urea as nitrogen source. The ratio of C / N / P was considered equal to 100/5/1. This synthetic wastewater was used to feed the system and r the growth of biofilm and microorganisms compatibility with existing conditions. Different concentrations of salts of heavy metals nickel and Chrome ($NiN_2O_6.6H_2O$, $Cr(NO_3)_3.9H_2O$) was added to synthetic sewage.

Table 3: The composition of synthetic wastewater

phosphate (KH_2PO_4,K_2HPO_4) (gr/100lit)	Nitrogen azote gr/100lit (gr/100lit)	Molasses (gr/100lit)	The concentration Of heavy metals Nickel &Chorome (Ni $N_2O_6.6H_2O$,$CrN_3O_9.9H_2O$) (mg/lit)	Reactor COD
1/82	3/77	120	250-1	**Reactor1 COD=800 mg/lit**
1/82	3/77	120	-	**Reactor2 COD=800 mg/Lit**

METHODOLOGY

Installing and sealing the reactor

First, to ensure that system is safe without leakage of valves or reactor, the reactor filled with water for 3 days and air compressor is installed and acne are also installed inside the bioreactor to set the intake air quantity for a full rotation of acne. Then, if the system had a leak, we fix it and otherwise, we start it up.

Launch and adoption of reactor

Two pilots in experimental scale were used. One of them is control and other the sample .The control is used if there is a change in the system because of environment and feeding type. In fact the only difference between control and sample is that control was free of heavy metals to our attention the change because of the metal or the environment. In order to launch the reactor, the return sludge of Ecbatana treatment plant has used. 70% of reactor is added by acne and 30% by the return sludge and the rest of those on the artificial sewage that contains molasses and water was added with COD 800 mg. At first system has batch work for 4 days that at this time we cut aeration to add the feed so that the sludge is deposited on the bottom of the reactor and then1.3 to 1.2 volume of the reactor is then emptied out and the same amount of artificial sewage was added. At a later stage, we used the continuous feed suitable for the growth of bio-film reactor with synthetic wastewater containing molasses and that water was fed with a hydraulic retention time of about 9 hours.After 3 weeks , urea and phosphate salts was added to increase the speed of growth of microorganisms , after 88 days and micro-organisms adaption to the circumstances , the biofilm growth on acne was done and appropriate conditions has met to add contaminants. The heavy metal Chrome at a concentration of 1 mg per liter added to the system and after a few days to a concentration of 30 milligrams per liter increased so that the system is prepared to add different metal concentrations and don’t suffering from shock, then both metals are added to the system at a concentration of 1 to 250.

Analysis of samples All tests were performed according to standard methods. In order to measure the COD , the open -reflex method according to instructions B 5220 and DR5000, for measuring MLSS and MLVSS , the gravimetric method according to recipe 2540, CRISON with PH range 0- 14 took place. For measuring temperature and DO, the DO meter from HACH was used. To measure metal, the ICP system was used according to instructions 3500.

RESULTS

Check the bioreactor in the compatibility

One of the most important steps in installation of biological systems is adaptation of microorganisms to environmental conditions. As you can be seen in Figures 1 and 2 in the first days of operation , the biological mass concentration and removal percentage of COD per 2 reactors was small, but the adaptation of microorganisms , we have been facing the increasing the MLSS and COD . After the adaptation of microorganisms, these changes remain stable when the growth of biofilms taken place on acne so that with total COD of 800 mg/ liter, the COD removal efficiency was increased to 85 for 88days.

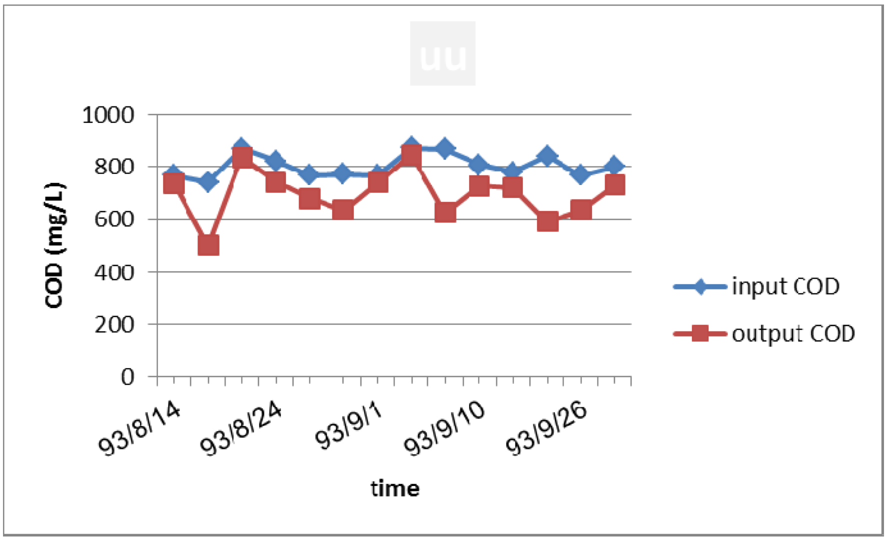

Figure 1: Output and inputCOD changes of sample reactor in startup time mg/L800COD

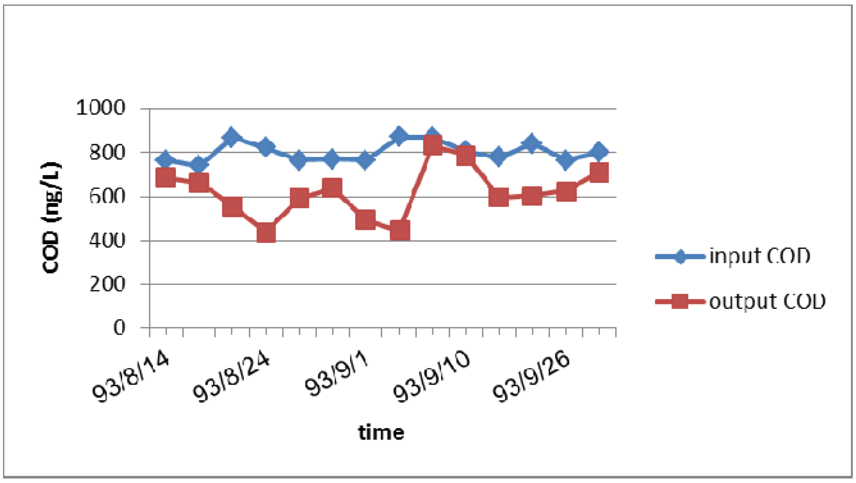

Figure 2: Output and input COD changes of control reactor in startup time mg/L800COD

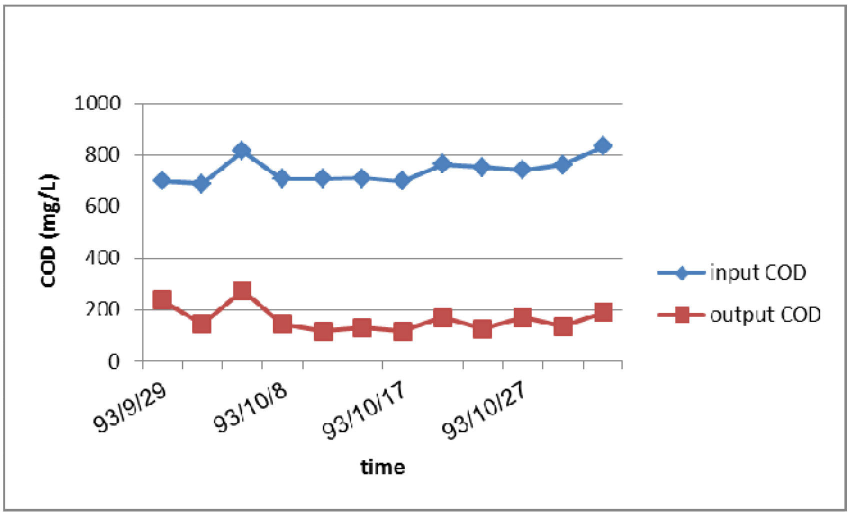

Figure 3: Output and input COD changes of sample reactor in adaption period to microorganism and COD=800mg/L

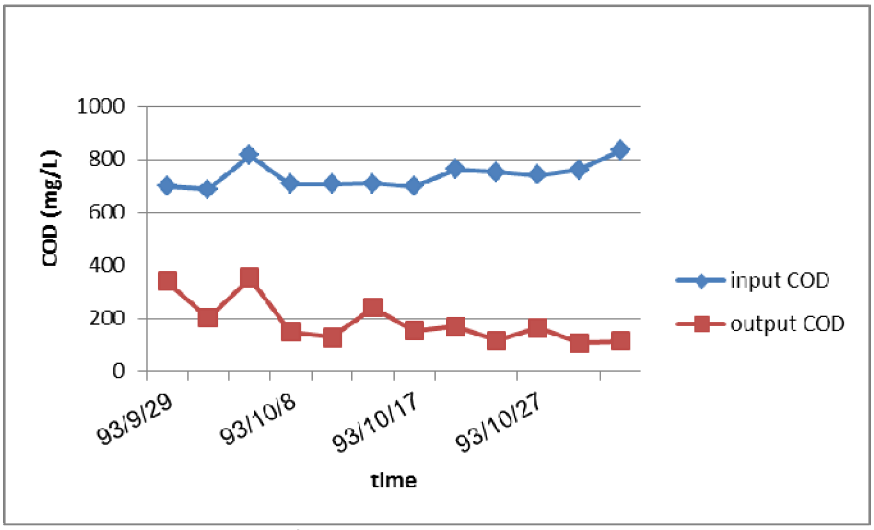

Figure 4: Output COD changes and MLSS of control reactor in adaption period to microorganism andCOD=800mg/L

Removal of heavy metal Chrome

In the next phase of research to evaluate performance in the removal of heavy metals, at first heavy metal of chrome as chrome nitrate salt in concentration of 1, 5 and 30 mg/L with 800 mg fixed COD added to the system. Results show by adding chrome, the COD removal efficiency decreased from 85% to 61% andafter 10 days at a concentration of 1 mg per liter, this system has been able to remove 42/7%Chrome and COD removal efficiency increased up to 79.5. The concentration of 5, 10and 30 mg/liter has been seen the removal of nickel as 49/96%,68/13%and72/35% respectively over 25 days. So we can conclude that with the passage of time in a constant concentration of input, the organic matter and heavy metals has been reduced and output of metal removal has increased. Also, by increasing the concentration of metalinput to the system, the efficiency of metal removal is increased in system.

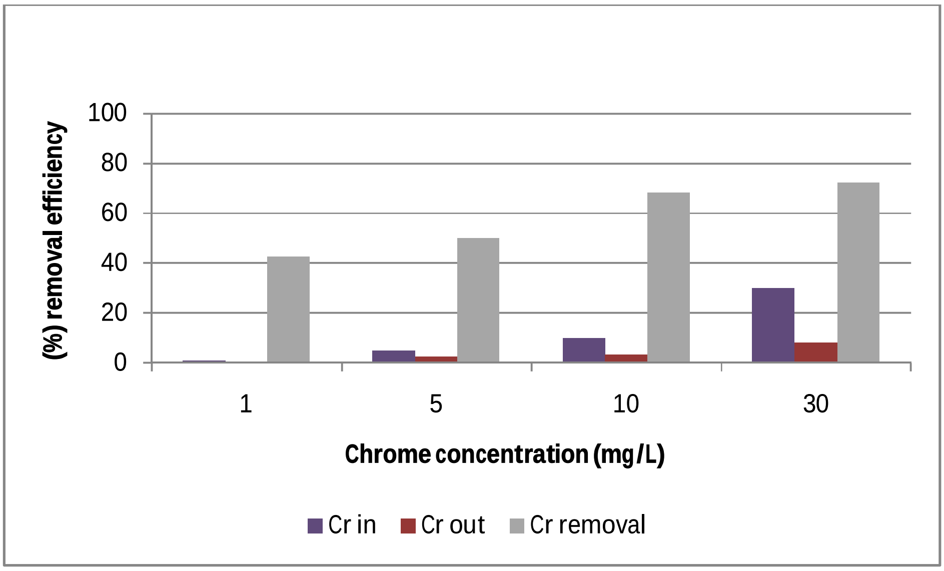

Figure 5: The removal of heavy metal of Chrome as alone in reactor in input concentrations 1, 5, 10, 30 mg/l

The removal of heavy metal nickel and chromium as mixed

Continuing research after removal of chromium metal, heavy metal nickel as nitrate was added to the system to compare the removal efficiency of chrome alone or mixed in a reactor in which the conditions are better. Therefore, after 45 days, heavy metals nickel and chromium were added at a concentration of 1 mg per liter of sample reactor. We saw that in these circumstances, and after about 13 days of removal of nickel and chromium was 43.59% and 64.11% respectively and removal efficiency of COD was 90.5 %. With increasing concentrations of nickel and chromium from 5 mg to 30 mg per Liter, the metal removal was assessed in the state in concentrations of 5, 10 and 30 mg/ l and removal efficiency of nickel equal to 55.69%, 70.2% and 83.7% respectively and removal efficiency of nickel as 73.16%, 85.7 and 89.3 percent respectively, the removal efficiency of COD is 92.6 %. .

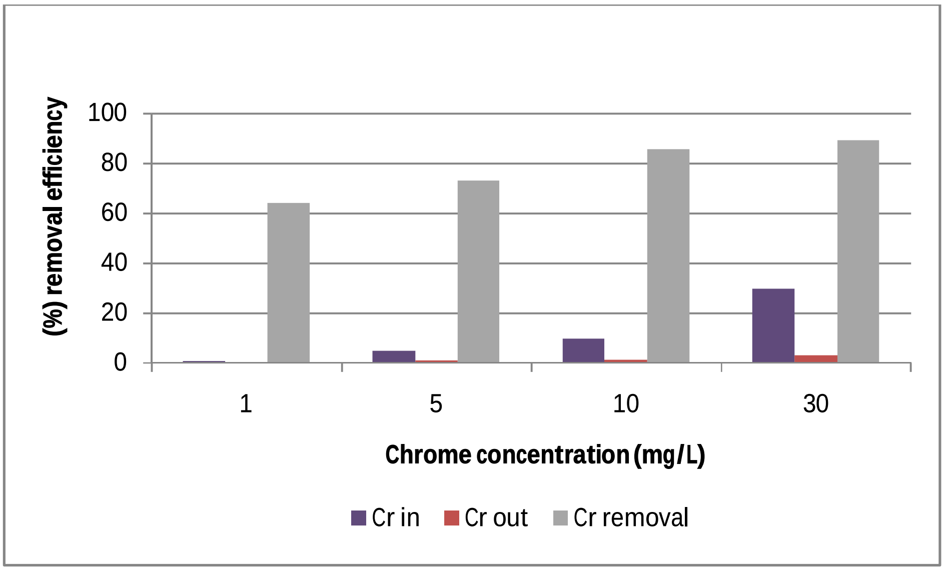

Figure 6: Removal percentage of chrome as mixture in reactor in concentrations 1,5,10,30mg/l

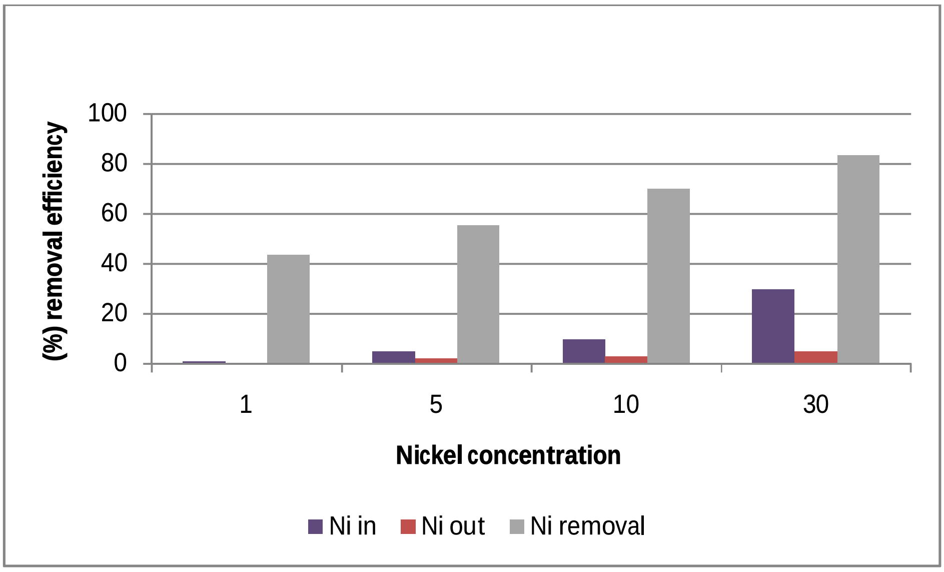

Figure 7: Removal percentage of Nickel as mixture in reactor in concentrations 1, 5, 10, 30mg/l

Increased concentration will continue until the system is not able to remove that is called shock. So the concentrations of 50 to 250 mg per liter of nickel and chromium nickel have added to the reactor so that removal efficiency of nickel at a concentration 50, 100 and 250 equal to 45.2%, 19.3% and 5% respectively and 93.52,54% and 83.37% for chrome . As we see, the removal efficiency of Cr in different concentrations is more than nickel and in concentration of 250 mg, system encountered to shock and is not able to remove much.

CONCLUSION

Results of samples with different concentration of input metals in MBRR system showed this system could be successful in regard to the ability to removal COD and also removal of metals. Time relapse and gradual increasing of metal concentration to 50mg/l caused to provide the microorganism adaption to the metal environment and in stable COD the efficiency of metal removal has increased. Of course adding metals to reactor cause to sudden changes in environment or decrease the preventative effects of existing components on the activity of microorganisms in substrate decomposition, so the removal efficiency of COD is decreased. But after a while because of compatibility with existing condition andalso the continuous increase of biomass on acne, the removal efficiency of COD is increased.

In This system, the concentration of metals increased gradually in long time so there is not significant changes on MLSS, thus biofilm attached on acne has not significant fallings and cause to increasing population of microorganism attached to the bed into the reactor.

Then, with increasing concentrations of 50 to 250 mg/l , we will face with a decrease in the efficiency of removal and this reduction is different for both metals and we see the metal chromium in the concentration of 50 mg per liter has the highest removal while the concentration of nickel in this concentration is decreased and chromium at a concentration of 100 is decreased its removal.

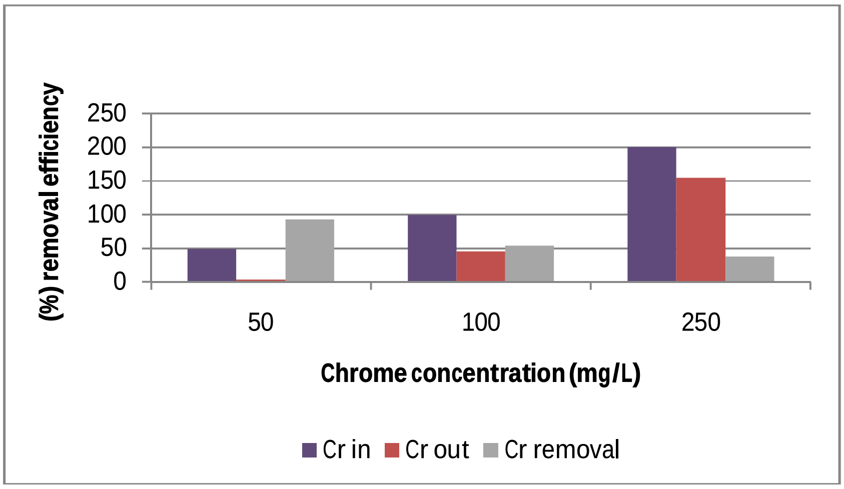

Figure 8: Removal percentage of heavy metal Chrome in concentrations50,100,250mg/l

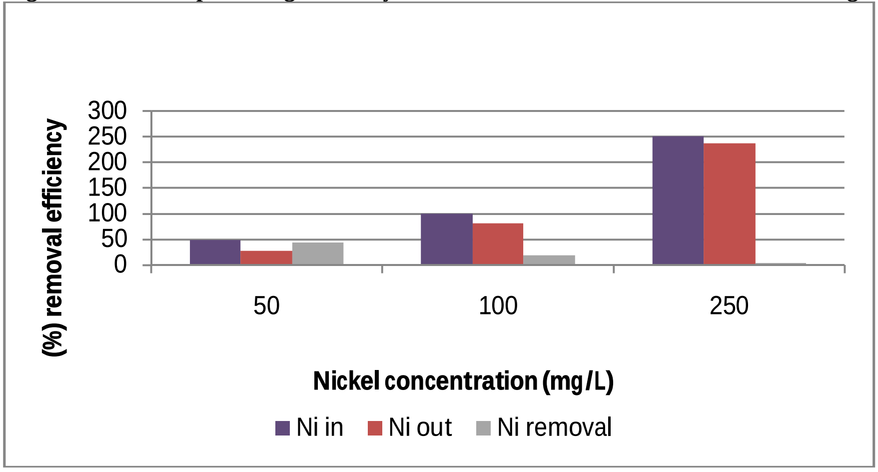

Figure 9: Removal percentage of heavy metal Nickel in concentrations 50, 100, 250mg/l

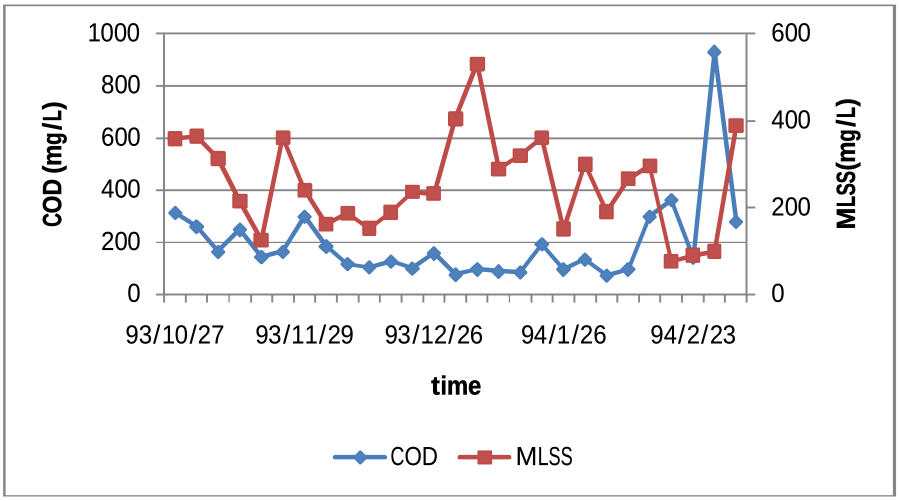

Figure 10- percent removal of COD and MLSS after the addition of heavy metals

With the sudden increase in concentrations up to 250 mg/ l , the system encounter to the shock and existing micro-organisms don't fit with these conditions , so the color inside reactor is become similar to input feeding and sample became so clear, which indicates that system is without microorganism. And this associated with reduction of pH to4.65 and increasing of DO to 7.54 .MLSS has significant decrease from 400 to 99.According to Figure 10 it is clear that the input and output COD is equal that indicates that the system is able to COD removal but not nickel metal . After 10 days, chrome in concentration of 37.86% has been removed. To realize such systems will be able to remove as before or not, 15 days after shock to the system, it was studied, then COD removal efficiency reached to 65.2% and parameters such as PH, MLSS and DO was normal.

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