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Removal of Heavy Metals Ions from Wastewater with Conventional Activated Sludge Process: Case study in Isfahan (Iran)

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Abstract: The pollution of industrial and municipal wastewater, which mixes with the toxic metal ions, is an environmental important matter. The discharge of industrial wastewater, which contains heavy metals, is toxic for the life of aquatic organisms although it makes water supplies undesirable for drinking. Due to these materials is accumulative, so determination and removal these materials are necessary. This study was done in WWTP of Isfahan (Iran). The data were compared with the standards of US-EPA and Environmental Agency of Iran. In this comparison, some metal concentration of effluent was higher according to standard limits of Iran. Results of research illustrate, conventional activated sludge process only cannot remove heavy metal sufficiently.

Key words: Effluent, Iran standard, EPA standard, wastewater treatment plant, Isfahan

INTRODUCTION

Now a days, increasing pollution of industrial and municipal wastewater with toxic metals ions, is an environmental important matter. These inorganic compounds, consider due to non-degradability, high toxicity, accumulation and carcinogenic problems. The discharge of industrials wastewater, which contains heavy metals, is toxic for the life of aquatic organisms although it makes water supplies undesirable for drinking (Metcalf and Eddy, 2003).

Generally, polluted wastewater with heavy metals, were treated by chemical processes such precipitation, electrochemical treatment and ion exchange. These processes only can treat portion of heavy metals of wastewater. So, it will be so expensive when concentration of heavy metals is low. Therefore, using of biological processes may be economical and effectiveness alternative to removal of heavy metals (Leung and Wong, 2000; Kanluen and Amer, 1998).

Isfahan has many small and big industries that discharge their wastewater in collection network without any treatment and increase heavy metals concentration in influent. Wastewater treatment plant of Isfahan is a conventional activated sludge process. Figure 1 show an schematically diagram of this plant (Nirumand and Ghofrani, 2002).

Dela Rosa *et al*. (2003) was found, effectiveness removal of heavy metals in aquatic environments provides with using of biological organisms. In this research, a column of silica and humin was used for absorbing of Copper, Nickle, Lead, Chromium (III) and Kd. Results were shown, this media is sui table to remove of heavy metals.

Hussein and Ibrahim (2004) accomplished a research about biosorption of Copper, Nickle, Chromium(III) and Kd with different species of pseudomonas. Maximum level percentage was nickel, Copper and Chromium respectively. Maximum level for Chromium(VI) was 38%. It is increased with increasing of Chromium in influent flow. Removal of Copper, in presence of Chromium(VI), was 93%. Generally, total percentage of heavy metal removal was 35-88%.

However, Amer (1998) was shown, conventional activated sludge process don't have desired removal efficiency of heavy metals. For this reason, there was need to resistant microorganisms against heavy metals.

In this study, determined removal percentage of Copper, Nickle, lead, and Chromium, the most consumption heavy metals in industries of Isfahan, with biological treatment process and compared with Iran and BPT of US-EPA standards.

The objectives of this study were:

- Treat ability of heavy metals with conventional activated sludge process
- Efficiency of treatment plant for removal of heavy metals
- Using of effluent for agriculture and irrigation.

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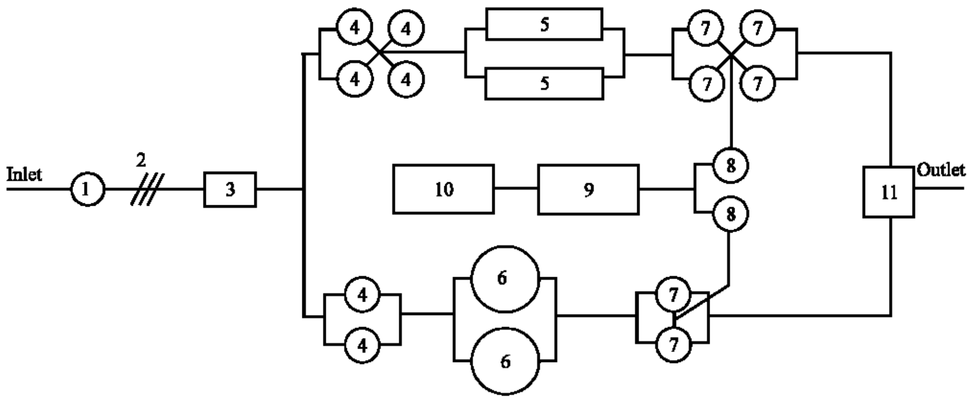

1) Pumping station
2) Bar screen
3) Grit chamber
4) Primary settling tank
5) Aeration tank
6) Trickling filter
7) Secondary settling tank
8) Thickener
9) Digester
10) Drying bed
11) Chlorination

Fig. 1: Diagram of Isfahan wastewater treatment plant

MATERIALS AND METHODS

In this study, were taken 25 samples of influent and effluent of Isfahan wastewater treatment plant in December, January and February on 2005. Transfer a 100 mL of well-mixed sample and add 1 mL conc. HNO_3 to decrease of pH below 2, for the expected metals concentration to a beaker. In a hood add 5 mL conc. HNO_3 and cover beaker with a ribbed watch glass to minimize contamination. Bring to slow boil and evaporate on a hot plate (90-95°C) to the lowest volume possible (about 10-20 mL) before precipitation occurs. Continue heating and adding conc. HNO_3 as necessary until digestion is complete as shown by light-colored, clear solution. Don't let sample dry during digestion. Wash down beaker wall and watch glass cover with metal free water and then filter with wattman-40. Transfer filtrate to a 100 mL volumetric flask with two 5 mL portions of water, adding these rinsing to the volumetric flask. Cool and mix thoroughly. Take portion of this solution for required metal concentration (APHA *et al*., 2005).

The heavy metal concentration was determined by the use of atomic absorption spectrophotometer, model 2380 Perkin-Elmer. Determination of copper, chromium, cadmium and nickel was done by using its specific lamp for each metal and at a specific wavelength.

RESULTS AND DISCUSSION

The metal removal studies were illustrated graphically in Fig. (2-5) which showed that their removals don't differed with the different operating conditions activated sludge. Maximum Chromium removal was found to be around 83%, its removal decreases with the increase of Chromium influent. Generally Chromium removal was ranged between 29 to 31% of metal influent. In other hand, Copper removal reached its maximum value in presence of Chromium metal, which reached 89% of its influent concentration. The Copper removal increased gradually in January. The percentage Copper removal ranged between 32 and 89%. In case of Nickle and plumb similar removal ratios was obtained since it was ranged between 86 to 71%. Nickle and plumb Concentration in influent and effluent generally are lower than standards that depend on season condition; many facilities that produce Nickle and plumb don't work on winter.

Comparison concentration of heavy metals in effluent with IRAN-EPA and US-EPA standards, Table 1, illustrate all metals concentration were lower than permissible MCL of US-EPA standards (US-EPA, PART 433, 2003; Environmental Department of Iran, 1998) However, some of them such Copper and Chromium concentration were higher than permissible MCL of IRAN-EPA.

The obtained results are in good agreement with the previous results. It was found that conventional activated sludge process couldn't remove heavy metal sufficiently. It confirms the results of Amer (1998) Chromium removal

Table 1: Permissible MCL of IRAN and US-EPA standards

		MCL of IRAN-EPA		MCL of US-EPA	
Pollutant	Unit	Discharge on surface water	Agriculture	$Max._{day}$	$Ave._{month}$
Chromiun (III)	mg L^{-1}	0.5	1.0	2.77	1.71
Chromium (VI)	mg L^{-1}	2.0	2.0		
Copper	mg L^{-1}	1.0	0.2	3.38	2.07
Plumb	mg L^{-1}	1.0	1.0	0.69	0.43
Nickle	mg L^{-1}	2.0	2.0	2.98	2.28

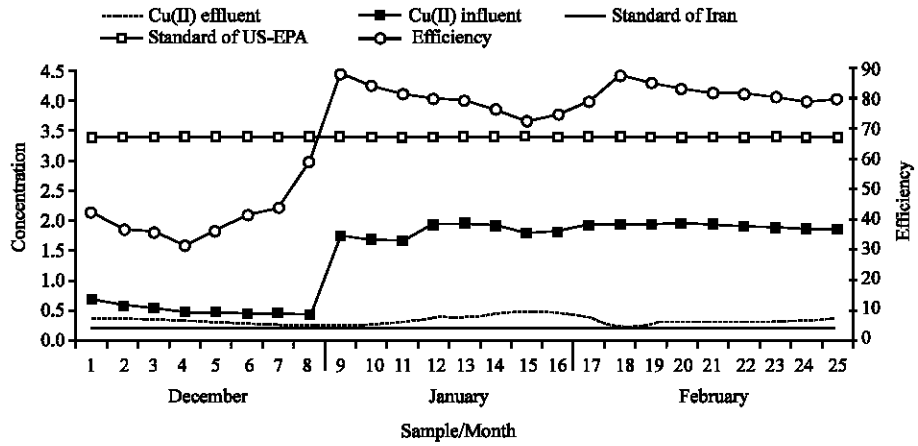

Fig. 2: Copper concentration in influent and effluent from Dec. to Feb. 2005

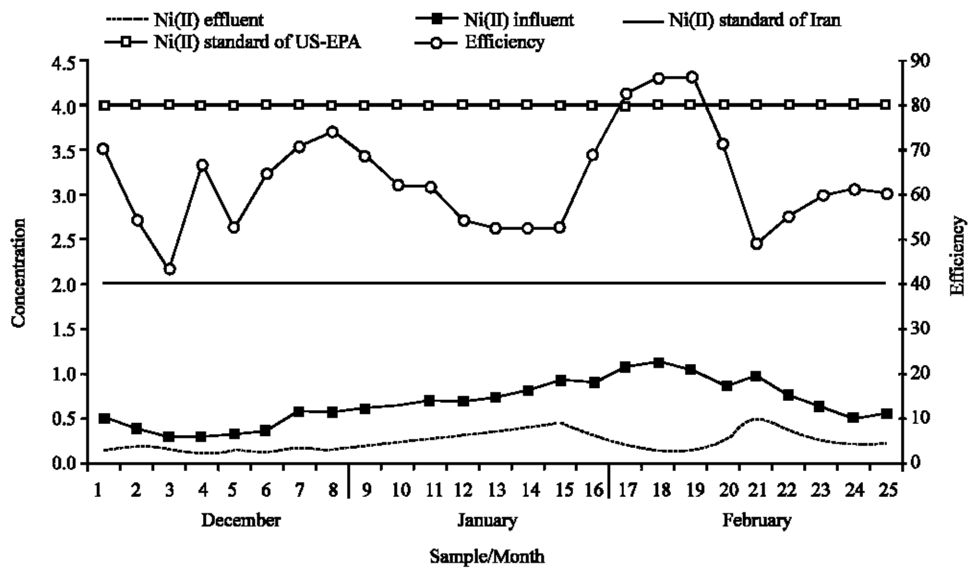

Fig. 3: Nickle concentration in influent and effluent from Dec. to Feb. 2005

efficiency in treatment plant is strongly angry. Contrary to results of Hussien and Ibrahim (2004). investigation, results of this research illustrate, removal efficiency decreased with inlet chromium concentration in December. It caused by toxicogenic effect of chromium on microorganisms and resolution of chromium in wastewater flow. However, removal efficiency of this metal increase with decreasing of its concentration in inlet flow on January and February. In that manner illustrate in investigation of Amer (1998) heavy metals adsorb with organic matters and separate of wastewater. In this study, it was observed in low concentration, heavy metals adsorb with organic matters and separate of wastewater. But resolution of heavy metals happens in high concentrations, due to toxicity of heavy metals on microorganisms. Since, concentration of Copper and Chromium in effluent is higher than standards. Therefore it cannot use for irrigation of sensitive plants to high copper and chromium concentration. However, this flow is one of the most important water supply sources for irrigation. Therefore, concentration of these metals must decrease. Following suggested two alternatives for this reason.

Adding lime to effluent: Lime increase pH and precipitate heavy metals from effluent to hydroxide form. This alternative is a good superseding to chlorination and decreasing of THM_s concentration in water. After that, adding CO_2 adjust pH in effluent flow.

Adding coagulant to effluent of secondary sedimentation tank: coagulants precipitate adsorbed heavy metals on microorganisms. This alternative, relatively heavy metals

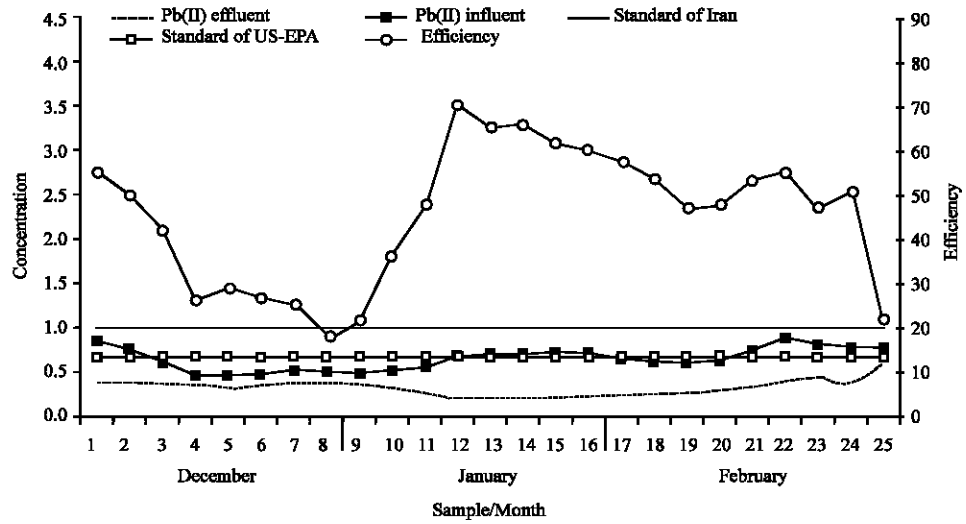

Fig. 4: Plumb concentration in influent and effluent from Dec. to Feb. 2005

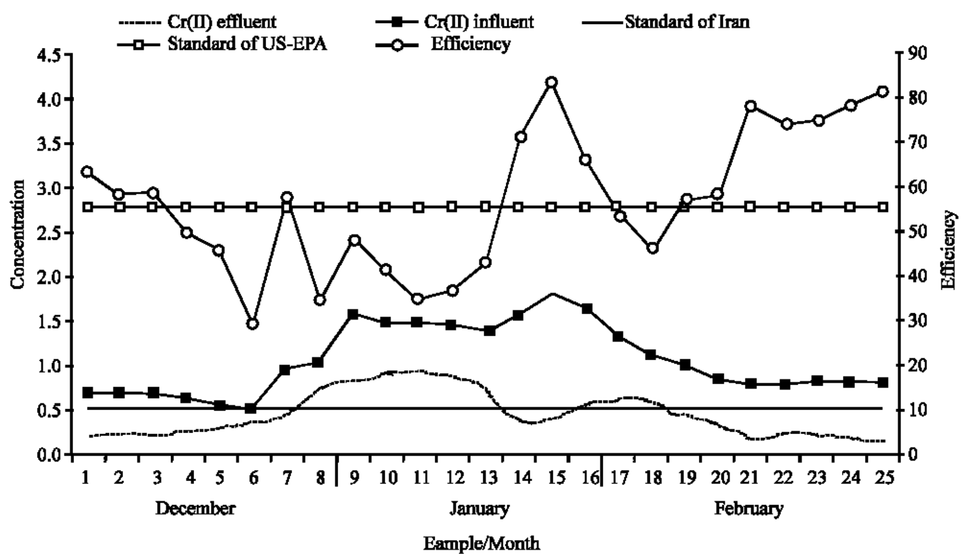

Fig. 5: Chromium concentration in influent and effluent from Dec. to Feb. 2005

concentration in effluent and increase efficiency of BOD and TSS removal in treatment plant.

Generally, inlet concentration of heavy metals increases on January and relatively increases removal efficiency. In spite of low inlet concentration of heavy metals on December, but removal efficiency has a descending rate.

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