BILOGICAL TREATMENT OF A WASTEWATER CONTAINING HEAVY METALS AND CYANIDE

Syahril Effendi Pasaribu
Universitas Muhammadiyah Sumatera Utara

Abstract: A research is being conducted to study the performance of aerobic biological process in the treatment of a simulated wastewater containing heavy metals and cyanides. Two laboratory scale completely mixed reactors operated in a fill-and-draw mode were used for the study of the simulated wastewater and control. After 54 days of acclimatization period, the significant decrease in MLSS and low reduction in COD values were found in the wastewater containing heavy metals and cyanide due to the occurrence of growth inhibition. The highest and lowest percentages of heavy metals removal of 82.5% and 37.6% were found in copper and cadmium, respectively.

Key words: aerobic, fill and draw, simulated wastewater, heavy metals, cyanide.

INTRODUCTION
Wastewaters from metal works such as plating industry contain heavy and cyanide in most cases. The presence of these substances may manifest a variety of problems in the aerobic treatment, depending on the type and the concentration of substances present. Toxicity of heavy metals to biological sludges of aerobic process has been mentioned elsewhere (Eckenfelder, 1989).

In contrast, Neufeld and Hermann, (1975) stated that a constant input level of heavy metals does not affect the biological treatment performance. Acclimatized sludge maintain high removal efficiency even if exposed to high concentrations of cadmium, zinc and mercury.

This paper reports an on-going research on aerobic treatment of wastewaters containing heavy metals and cyanide. The objective of the research was a study the susceptibility to treatment of wastewaters containing heavy metals and cyanide by aerobic biological methods and to study the kinetic and treatment efficiency under varying solids retention time (SRT).

MATERIALS AND METHODS
Experimental set-up and procedure
Two separate laboratory scale activated sludge reactors were constructed out of glasses. The first reactor (reactor no. 1) was used to study wastewaters containing heavy metals and cyanide and the other (reactor no. 2) was to study control. Each reactor had a liquid operating volume of 10 L each unit was kept continuously mixed and aerated by means of compressed air passed through porous sparger in the base, the shape of the reactor was designed to avoid sludge settling in the base, and aeration rates ware maintained at 2 L/min.

The units were used to study two aspects of wastewater treatment in aerobic condition. The first part of experimental studies was carried out to investigate the acclimatization-metal-cyanide removal. In this experiment, waste activated sludge, obtained from the Pirngadi Hospital Sewage Treatment Plant, Banda Aceh, was acclimatized with fresh substrate in both reactors. During this period, biological solids were allowed to accumulate in the reactors as no solids were wasted.

The acclimatization metal-cyanide removal study was designed to produce an acclimatization-metal-cyanide removal study was designed to produce an acclimated microbial population for use in subsequent aerobic treatment kinetic and efficiency studies. The treatment kinetic and efficiency studies were unable to continue since microorganisms did not grow well after 54 days of acclimatization period, as shown in Figure 1.

The temperature of the mixed liquors always remained between 24 and 28°C during the acclimatization period. Since the activated sludge process is not significantly influenced by small temperature changes, it was felt that temperature controls were not necessary. The pH in the reactors were maintained between 6.5 and 7.5. however, pH above 8.5 occurred in some cases.

The reactors are operated in a daily fill-and-draw mode. At 24 hour hour intervals, a mixed liquor volume of 2 L was drawn from the reactor. Volumes of fresh substrate equal to each reactor. The mixed liquor removed was allowed to settle for about one hour. Every three days, the MLSS and MLVSS concentrations were measured and recorded. The COD, Cu, Cd, and As of the supernatant were also determined once in three days.

Chemical analysis of effluents such as COD, MLSS, MLVSS, Cu, Cd, As, total CN and free CN were carried out according to APHA (1989). The temperature and pH of the mixed liquors in the reactor were monitored every day. Due to analytical equipment problems, measurements of total CN and free CN are unable to be carried out the present time.

Wastewater Characteristics.
Simulated wastewater used in the experiment of
the first reactor contained (in mg/l) glucose (500), urea (107.14) KH₂PO₄ (12.6), MgSO₄ (9.5), CaCl₂ . 2H₂O (1.2), FeCl₃, 6 H₂O (0.1), NaCN (282) which is equivalent to 150 mg/l CN, As₂O₃ (3), Cu (100 and Cd (15). In the reactor no. 2 (control), similar wastewater was also used, except without NaCN, As₂O₃, Cu and Cd (Mitani in Xing, 1995).

RESULTS AND DISCUSSION

Microbial Population

Figure 1 shows the concentration of mixed liquor suspended solids (MLSS) in both reactor during the acclimatization period. After 54 days of the acclimatization period, the MLSS concentrations in the reactor no. 1 decreased significantly from time to time which indicated microorganisms are unable to grow. The presence of heavy metals and cyanide inhibit the growth of microorganisms. On the contrary, suspended solids concentrations in the reactor no. 2 increased up to 42 days of the acclimatization period. Although the MLSS was still low for common actived sludge system, microorganisms in the reactor no. 2 grows gradually.

Figure 1. Mixed liquor suspended solids (MLSS) in each during the course of acclimatization period

Organic Removal

Figure 2 shows the COD of the mixed liquors in reactors no. 1 and 2, respectively, as a function of acclimatization time. The COD values indicated are the averages of last two or three tests during each study. The COD of the wastewater and control averaged 1040 mg/l.

Low concentration in suspended solids in the reactor no. 1 reflected in the low reduction of COD of the mixed liquors during the course of acclimatization period, as shown in Figure 2. after 54 days, reactor no. 1 was able to reduce the COD levels of the wastewater from 1040 mg/l to 520 mg/l (50% removal). Compared to the reactor no. 2, COD levels in this reactor decreased consistently, except at day 9, for 12 days of acclimation period. An increase of pH above 8.5 was measured in reactor no. 2 at day 8 which resulted in lowering microorganisme activities. Consequently, the COD levels increased at day 9.

It seemed that after 21 days, the mixed liquor in the reactor no. 2 was reaching a steady state condition, as COD levels moved almost constantly until 42 days. A reduction of 98.4 % of COD was attained in the reactor no. 2 after 54 days of acclimatization. At the same time, the reactor no. 1 only reduced COD by 50%. Significant decrease in MLSS and low reduction of COD in the reactor no. 2 indicated the occurrence of growth inhibition of microorganisms due to the presence of heavy metals and cyanides in the wastewaters.

Figure 2. COD of mixed liquor in each reactor versus acclimatization time.

Metals removal

The wastewater feed used in these studies contained copper, cadmium, and arsenic. Initial concentrations of Cu, Cd, and As were 11.50, 14.75, and 3 mg/l, respectively. Figure 3 shows the concentrations of Cu, Cd and As in the mixed liquor of the reactor no. 1 as a function of acclimatization time. During a 54-days of acclimatization period, the concentration of Cu considerably decreased from 11.50 to 2.01 mg/l, equivalent to a removal of 82.5%. This substantial reduction may be due to adsorption of Cu by biological floc. As reported by other researcher, high molecular weight extracellular
polymer of this biofloc provided many functional groupings that acted as binding sites from metals (Brown and Lester, 1979). Concentrations of Cd declined from 14.75 mg/l to 8.90 mg/l, equivalent to a removal of 39.6% and As decreased from 3.0 mg/l to 1.87 mg/l, equivalent to a removal of 37.6% of the metals analyzed, cadmium experienced the lowest percent removals, the reason being that in the presence of complexing ions, such as cyanide, cadmium is not precipitated (Eckenfelder, 1989).

CONCLUSIONS

1. Significant decrease in MLSS and low reduction in COD values during the on-going acclimatization period indicated the occurrence of growth inhibition of microorganisms due to the presence of heavy metals and cyanides.
2. Significant reduction in Cu concentrations during the on-going acclimatization period was probably caused by adsorption of the metals by biological floc in the mixed liquor.
3. Low removal in Cd concentrations during the on-going acclimatization period was due to the presence of complexing ion cyanide which limited the precipitation of Cd.

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REFERENCES