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Biological removal of cyanide compounds from electroplating wastewater (EPWW) by sequencing batch reactor (SBR) system

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Abstract

Biological treatment system especially, sequencing batch reactor (SBR) system could not be applied to treat the raw electroplating wastewater (EPWW) due to the low organic matter concentration of 10±3 mg-BOD_5/L and toxic of high cyanide concentration of 23.0±2.2 mg-CN/L. However, EPWW could be used as the nitrogen source for the bio-sludge of SBR system. And 10% of EPWW (the final cyanide concentration of 2.3±0.2 mg/L) was most suitable to supplement into the wastewater as the nitrogen source. SBR system showed the highest COD, BOD_5, TKN and cyanide removal efficiencies of 79±2%, 85±3%, 49.0±2.1% and 97.7±0.7%, respectively with 4-times diluted Thai-rice noodle wastewater (TRNWW) containing 10% EPWW and 138 mg/L NH_4Cl (BOD_5: TN of 100:10) at SRT of 72±13 days (under organic and cyanide loadings of 0.40 kg-BOD_5/m^3d and 0.0023 kg-CN/m^3d, respectively). However, the effluent ammonia was still high of 22.6±0.4 mg-N/L while the effluent nitrate and nitrite was only 9.9±0.4 and 1.2±0.9 mg-N/L, respectively. And SVI and effluent SS of the system were higher than 95 and 75 mg/L, respectively.

Introduction

Many industries such as photo-processing, electroplating, gold mining and chemical-fertilizer generate large amount of wastewater containing high concentration of cyanide and cyanate compounds as serious hazardous substances due to their strong effects on both the environment and human [1], [2], [3], [4], [5], [6]. The chemical treatment processes, especially, chemical oxidation and coagulation are common use and suitable to treat above wastewater due to the high concentration of cyanide compounds, but they produced large amount of hazardous sludge. Several

researchers tried to apply the biological process to remove or degrade cyanide compounds and recover some valuable materials from the wastewaters [2], [5], [7], [8], [9], [10], [11], [12]. For example, the combination of bio-sorption and biodegradation processes was applied for degradation of free and metal complexed cyanides and recover of metals from wastewater [9], [10], [12]. It is well documented that cyanide compounds at high concentration is toxic to the living organisms in aquatic environments. Many researchers reported that the cyanide compounds could be degraded and utilized by the microorganisms such as fungus and bacteria [9], [12], [13], [14], [15], [16], [17], [18]. But, cyanide compounds at high concentration are toxic to the microorganisms or the bio-sludge of biological treatment system. Anyways, bioremediation of cyanide compounds from above wastewaters is of major importance, as it offers a potential alternative to chemical oxidation (conventional process) for the recovery of the cyanide compounds and using it as the nitrogen source for the bio-sludge of biological treatment system [19], [20], [21], [22], [23], [24]. However, the bio-sludge of the biological treatment system required both carbon and nitrogen sources for growth [19], [22], [23], [24]. Then, the concentration of both cyanide and organic matter in the wastewater had to be considered [6], [14], [19], [20], [25].

To treat wastewater containing high cyanide concentration and low organic matter (BOD_5) as EPWW by biological wastewater treatment process might be difficult but the cyanide compounds of the EPWW might be used as the nitrogen source for the bio-sludge of the biological treatment process [2], [6], [19], [20]. And the ammonia was the metabolite of the biodegradation of cyanide compounds [6], [19], [26].

The SBR system is a modified activated sludge (AS) system used in solving the low-density bio-sludge and bulking sludge problems due to the large volume of clarifier [19]. Also, the SBR system can easily be modified for both carbon and nitrogen (especially, cyanide and by-products of bio-degradation of cyanide) removal, with the appropriate operational program. In this study, the biological treatment of EPWW by SBR system was tested. The application of EPWW as the nitrogen source for non-nitrogen compound contained wastewater (both synthetic wastewater and industrial wastewater: Thai rice noodle wastewater; Khanom-chin: TRNWW) on the efficiency of SBR system and bio-sludge quality was also studied.

Section snippets

Wastewater (WW)

Three types of wastewater were used in this study as electroplating wastewater (EPWW), Thai rice noodle wastewater (Khanon-chin: TRNWW) and synthetic wastewater (SWW), were mentioned as follows: …

Effects of glucose concentration on the efficiency of SBR system

The raw-EPWW which was added with glucose at the concentrations of 0, 280, 370, 564, 840 and 1120 mg/L to adjust the BOD_5: TN ratios of 10:40, 100:20, 100:15, 100:10, 100:6.7 and 100:5, respectively, was used for testing the efficiency of the SBR system. The results on the effect of glucose addition on the efficiency and performance of the SBR system were shown in Table 3, Table 4. The raw-EPWW could not be treated by the SBR system (The SBR system was operated under low organic loading of 0.01 …

Discussion

The biological treatment of raw-EPWW by SBR system was still unsuitable due to the low BOD_5 concentration of 10±3 mg/L and high cyanide concentration of 23.0±2.2 mg/L [5], [6], [16], [19], [20], [29]. According to the high cyanide concentration, the bio-sludge of the system might be killed and autolysis resulted to increase the effluent BOD_5 and SS and decrease the MLSS of the SBR system [14], [19], [30]. Also, the Cu^+ concentration of 27.0±0.5 of the raw-EPWW might effect to both efficiency and …

Conclusion

Raw-EPWW could not be biological-treated by SBR system, because of the low BOD_5 and high cyanide concentrations of 10±3 and 23.0±2.2 mg/L. But, cyanide compounds of the EPWW could be used as nitrogen source for the bio-sludge of the biological treatment system. A 2.3±0.2 mg-CN/L of cyanide compounds (about 10% of EPWW) was most suitable to supplement into the wastewater as the nitrogen source. Then, to apply the biological treatment process for EPWW, the total cyanide content of the EPWW has to …

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