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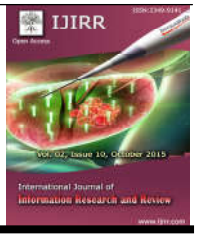

Research Article

WASTEWATER TREATMENT USING ATTACHED GROWTH BATCH REACTOR (AGBR) TECHNOLOGY

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ABSTRACT

Discharge of domestic and industrial wastewater to surface or groundwater is very dangerous to the environment. Therefore treatment of any kind of wastewater to produce effluent with good quality is necessary. In this regard choosing an effective treatment system is important. Attached Growth Batch Reactor is a modification of Sequencing Batch Reactor process which has been successfully used to treat municipal and industrial wastewater .The process could be applied for nutrient removal, high biochemical oxygen demand containing industrial wastewater. Of the process advantage are single-tank configuration, small foot print, easily expandable, sample operations and low capital costs. Sewage water was collected from the River Coovam and it was filled in the reactor tank. In one single day two batches were conducted and the process were followed such as fill, react, settle and decant. Sample from decantable volume was taken and its physical and chemical test were analyzed. Physical test include TSS, colour, odour and appearance. Chemical test include BOD, COD, oil and grease and pH.

INTRODUCTION

Various types of high-performance biological reactors have been developed which are characterized by a high degradation performance when compared to conventional plants, as well as compact construction and an operation favourable to the environment have been developed. Accordingly, biological processes are being employed in wastewater treatment plants worldwide. These processes primarily include the anoxic–anaerobic–aerobic (A2O) process, oxidation ditch process, biofilm process etc. The sequencing batch reactor (SBR) is considered as an attractive method of treatment because it has good performance for the removal of BOD and COD. Recently, the attached growth batch reactor (AGBR) system has attracted a great deal of attention due to its ability to take advantages of both a biofilm reactor and a SBR. Specifically, AGBR systems show improved biomass concentration in reactors with corresponding higher specific removal efficiencies, greater volumetric loads, increased process stability toward shock loadings and are capable of covering small areas. AGBR systems remove BOD and COD more efficiently.

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Furthermore, the presence of an anoxic microzone in the biofilm could result in simultaneous nitrification and denitrification (SND) in the AGBR during the aeration phase. In such cases, nitrification occurs on the surface of the biofilm, whereas denitrification occurs in the inner layers due to a dissolved oxygen (DO) gradient within the biofilm. A biofilm configured sequencing batch reactor with periodic discontinuous batch mode operation was able to treat larger shock loads than the continuous flow process when treating low-biodegradable composite chemical wastewater. To the best of our knowledge, few experimental studies have been conducted to evaluate the treatment of wastewater by AGBR.

MATERIALS AND METHODS

Laboratory scale AGBR

In this study, one typical operation cycle contains three procedures: Fill (instantaneous), React and Settling (1 h), and draw (1 h). A laboratory scale reactor with the dimensions of 59 cm×30 cm×37 cm (L×W×H) and a working volume of 44 L wasfabricated using moutainious rock material, because moutainious rock material is not easy to be broken or deformed, and easy toobserve the biofilm carriers and sludge in the reactor. Weight of the mountainious rocky material taken was

15.7 kg. Decantable volume is 18 litre and volume of water to be remain in the tank was 26 litre.

Wastewater

In this study, River Coovam water was used during the start-up period and normal operation to evaluate the performance of the AGBR.

The characteristicsof the raw domestic sewage were (average value):

pH (7.08)
temperature (25 °C)
COD (344 mg L−1)
BOD (112 mg L−1)
TSS (138 mg L−1)

When a steady state was achieved, the characterizations of the AGBR were analyzed by batch test.

RESULTS AND DISCUSSION

- The feeding and draining can be conducted simultaneously for the AGBR with the mountainous rock material as packing, and the maximum volumetric exchange rate in the AGBR is about 70%.
- Application of the mode of feeding and draining at the same time can lead to the reduction of the cycle time of the AGBR, the increase of the utilization of the reactor volume and the simplification of the reactor structure.
- The AGBR can effectively remove both COD and BOD from the wastewater, resulting in a good effluent quality.
- The fact that COD and BOD could be removed more completely under constant aeration (aerobic condition) of the AGBR operation mode is very interesting and can be explained in several respects.

S. No.	Parameter	Raw coovam water	Treated coovam water			
			Week 1	Week 2	Week 3	Week 4
1	Appearance	Slightly turbid	Slightly turbid	Slightly turbid	Slightly turbid	Slightly turbid
2	Colour	Blackish	Pale yellowish	Pale yellowish	Pale yellowish	Pale yellowish
3	Odour	Characteristic	Odourless	Odourless	Odourless	Odourless
4	Ph (ppm)	7.08	6.84	6.83	6.82	6.82
5	Tss (ppm)	138	46	44	38	36
6	Cod (ppm as o2)	344	182	182	104	102
7	Bod (ppm as o2)	112	56	52	30	28
8	O&g (ppm)	Traces	Traces	Traces	Traces	Traces

Inoculums

The reactor was seeded with
cow dung (1mg)
phosphate (1mg)
urea (1mg)
jaggery (1mg)

Reactor start-up and operation

Wastewater was instantaneously poured into the reactor manually and drawn through the outlet after an operation cycle. To avoid aging of the sludge due to an extended sludge retention time (SRT), a small amount of sludge (about 1.5 g) was with drawn from the reactor every day. In order to provide enough oxygen for the living of microorganisms, according to our previous study, the AGBR was operated at room temperature (25±2 °C).

In the first and second week of treatment of sewage water a total of 24 cycle was conducted in which aeration (2 h), settling (1 h) and decanting (1 h) processes were performed. In one day 8 hrs cycle was conducted in the AGBR, treating 18 litre of water per cycle. In the third and fourth week of treatment of sewage water a total of 24 cycle was conducted in which aeration (3 h), settling (1 h) and decanting (1 h) processes were performed. . In one day 10hrs cycle was conducted in the SBR, treating 18 litre of water per cycle. Again in the fifth and sixth week 24 cycles were conducted in which aeration (4 h), settling (1 h) and decanting (1 h) were done and n one day 12 hrs cycle were conducted treating 18 litre of water per cycle.
Initially, a start-up period of the AGBR was carried out with the objective of forming the biofilm. The AGBR was subsequently operated to obtain steady performance.

REFERENCES

Abasaeed, A.E. 1997. "Sensitivity analysis on a sequencing batch reactor model.

Abufayed, A.A. and Schroeder, E.D. 1986a. "Kinetics and stoechiometry ofSBR/denitrification with a primary sludge carbon source." J.WaterPollut.ControlFed. 58(5): 398-405.

Abufayed, A.A. and Schroeder, E.D. 1986b. "Performance of SBR/denitrificationwith a primary sludge carbon source." J.WaterPollut.Control Fed. 58(5): 387-397.

Ahmet Uygur, 2006. Specific nutrient removal rates in saline wastewater treatment using sequencing batchreactor, *Process Biochemistry,* 41: 61–66

Akın, B.S. and Ugurlu, A. 2005. Monitoring and control of biological nutrient removal in a Sequencing BatchReactor. *Process Biochemistry,* 40: 2873–2878

Albertson, O.E., Scott, R.F., Stensel, H.D. and Okey, R.W. 1992. "Expansion andupgrading of Columbus WWTPs to advanced wastewater treatment." WaterSci.Technol. 25(4-5): 1-8.

Alleman, J.E. 1978. "Nitrogen removal from wastewater using sequencing batchreactor." Notre Dame, : 188.

Alleman, J.E. and Irvine, R.L. 1980a. "Nitrification in the sequencing batchbiological reactor." J.WaterPollut.Control Fed. 52(11): 2747-2754.

Alleman, J.E. and Irvine, R.L. 1980b. "Storage-induced denitrification usingsequencing batch reactor operation." Water Res. 14:1483-1488.

Andrade do Canto, C.S., Domingues Rodrigues, J.A., Ratusznei, S.M., Zaiat, M., Foresti, E. 2008. Feasibility of nitrification/denitrification in a sequencing batch biofilm

reactor with liquid circulation applied to post-treatment, Bioresour. Technol. 99 644–654.

Andreottola, G., Bortone, G. and Tilche, A. 1997. "Experimental validation of asimulation and design model for nitrogen removal in sequencing batch reactors."Water Sci.Technol. 35(1): 113-120.

Ardern, E. and Lockett, W.T. (1915a). "Experiments on the oxidation of sewagewithout the aid of filters." J.Soc.Chem.Ind. 33(10): 523-539.

Ardern, E. and Lockett, W.T. 1915b. "The oxidation of sewage without the aid offilters. Part III." J. Soc. Chem. Ind. 34(18): 937-943.

Arnaldo, S., Bruna, S. F., Marcelo Z., Eugenio, F. 2007 Anaerobic sequencing batch reactors in pilot-scale fordomestic sewage treatment. *Desalination* 216, 174–182 53.

Arnold, E., Bohm, B., Wilderer, P.A. 2000. Application of activated sludge and biofilmsequencing batch reactor technology to treat reject water sludge dewateringsystems: a comparison, Water Sci. Technol. 41 115–122.

Arora, M.L., Barth, E.F. and Umphres, M.B. 1985. "Technology evaluation ofsequencing batch reactors." J.WaterPollut.Control Fed. 57(8): 867-875.

Baikun Li. and Shannon Irvin. 2007. The comparison of alkalinity and ORP as indicators for nitrification anddenitrification in a sequencing batch reactor (SBR). *Biochemical Engineering Journal*, 34: 248–255

Bing, L., Ying, l. S., Yu, Y. L. 2005 Pretreatment of coking wastewater using anaerobic sequencing batchreactor (ASBR). *Journal of Zhejiang University Science*

Cheong, D.Y. and Conly L. H. 2007. Effect of feeding strategy on the stability of anaerobic sequencing batchreactor responses to organic loading conditions. *Bioresource Technology*.

EPA 1999. Wastewater Technology Fact Sheet Sequencing Batch Reactors

Gieseke, A., Arnz, P., Amann, R., Schramm, A., Simultaneous, P. and N removal in asequencingbatch biofilm reactor: insights from reactor- andmicroscale investigations,*Water Res*., 36 (2002) 501–509.

Goh, C.P., Seng, C.E., Sujari, A.N.A. and Lim, P.E. 2009. Performance of sequencing batch biofilmand sequencing batch reactors in simultaneous p-nitrophenol and nitrogenremoval, Environ. Technol. 30 725–736.

González, O., Esplugas, M., Sans, C., Torres, A. and Esplugas, S. 2009. Performance of a sequencingbatch biofilm reactor for the treatment of pre-oxidized sulfamethoxazole solutions,Water Res. 43 2149–2158.

Gregor, D., Zupanbib.;Straqinbar, M. and Milenko, R. 2007. Treatment of brewery slurry in thermophilicanaerobic sequencing batch reactor. *Bioresource Technology* 98: 2714–2722

Kim, D.S., Jung, N.S. and Park, Y.S. 2008. Characteristics of nitrogen and phosphorus removal in SBR and SBBR with different ammonium loading rates, Korean J. Chem. Eng. 25 793–800.

Li, J., Xing, X.H. and Wang, B.Z. 2003. Characteristics of phosphorus removal from wastewater by biofilmsequencing batch reactor (SBR). *Biochemical-Engineering-Journal*, 16(3): 279-285

Lim, E.T., Jeong, G.T. Bhang, S.H. Park, S.H. and Park, D.H. 2009. Evaluation of pilot-scalemodified A2O processes for the removal of nitrogen compounds from sewage,Bioresour. Technol. 100 6149–6154.

Liu, Y.C., Shi, H.C., Xia, L., Shi, H.M., Shen, T.G. Wang, Z.Q., Wang, G. and Wang, Y.Z. 2010. Studyof operational conditions of simultaneous nitrification and denitrification in aCarrousel oxidation ditch for domestic wastewater treatment, Bioresour. Technol.101 901–906.

Lübbecke, S., Vogelpohl, A. and Dewjanin, W. 1995. Wastewater treatment in a biologicalhigh-performance system with high biomass concentration, Water Res. 29 793–802.

Mohana, S. V., Rao, N. C. and Sarma, P. N. 2007. Low-biodegradable composite chemical wastewater treatment bybiofilm configured sequencing batch reactor (SBBR). *Journal of Hazardous Materials* 144:108–117

Muhammad Farhan, A., Sun-Kee H., Sang-Hyun, K., Dong-Hoon, K. and Hang-Sik, S. 2007. Sludgecharacteristics in anaerobic SBR system producing hydrogen gas. *WATER RESEARCH*, 41, 1177-1184.

Obaja, D. S., Mace, J., Costa, C., Sans, J. Mata-Alvarez , 2003. Nitrification, denitrification and biologicalphosphorus removal in piggery wastewater using a sequencing batch reactor. *Bioresource Technology*, 87:103–111

Peng, Y.Z., Wang, X.L. and Li, B.K. 2006. Anoxic biological phosphorus uptake and the effect ofexcessive aeration on biological phosphorus removal in the A2O process, Desalination 189 155–164.

Pinho, S. C., Ratusznei, S. M., Rodrigues A. D., Foresti, E. and Zaiat, M. 2005. Influence of bioparticle size on thedegradation of partially soluble wastewater in an anaerobic sequencing batch biofilm reactor (ASBBR). *ProcessBiochemistry,* 40; 3206–3212

Rittmann, B.E. and Langeland, W.E. 1985. Simultaneous denitrification with nitrification insingle-channel oxidation ditches, J. Water Pollut. Control Fed. 57 300–308.

Semmens, M.J., Dahm, K., Shanahan, J. and Christianson, A. 2003. COD and nitrogen removalby biofilms growing on gas permeable membranes, Water Res. 37 4343–4350.

Sheng-bing, H., Gang, X., Hai-nan, K. and Xin, L. 2007. Improving the performance of sequencing batch reactor (SBR) by the addition of zeolite powder. *Journal of Hazardous Materials,* 142, 493–499

Sirianuntapiboon, S. and Hongsrisuwan, T. 2007. Removal of Zn2+ and Cu2+ by a sequencing batch reactor(SBR) system. *Bioresource Technology,* 98, 808-818.

Sirianuntapiboon, S. and Ungkaprasatcha O. 2007. Removal of Pb2+ and Ni2+ by bio-sludge in sequencing batchreactor (SBR) and granular activated carbon-SBR (GAC-SBR) systems. *Bioresource Technology* 98: 2749–2757

Sirianuntapiboona, S., Jeeyachokb, N. and Larplaia, R. 2005. Sequencing batch reactor biofilm system fortreatment of milk industry wastewater. *Journal of Environmental Management*, 76 177–183

Venkata Mohan, S., Rao, N.C., Sarma, P.N. 2007. Low-biodegradable composite chemicalwastewater treatment by biofilm configured sequencing batch reactor (SBBR), *J. Hazard. Mater.,* 144 108–117.

Wilderer, P.A., Roske, I., Ueberschar, A., Davids, L. 1993. Continuous flow and sequencedbatch operation of biofilm reactors: a comparative study of shock loadingresponses, Biofouling 6 295–304.

Wu, G.X., Michael, N., Ketil, S., Zhan, X.M. Michael, R. 2009. Distributions and activities ofammonia oxidizing

bacteria and polyphosphate accumulating organisms in apumped-flow biofilm reactor, Water Res. 43 4599–4609.

Xia, S.Q., Li, J.Y. and Wang, R.C. 2008. Nitrogen removal performance and microbial community structure dynamics response to carbon nitrogen ratio in a compact suspended carrier biofilm reactor, *Ecol. Eng*., 32 256–262

Xiangwen, S., Dangcong, P., Zhaohua, T. and Xinghua, J. 2007. Treatment of brewery wastewater usinganaerobic sequencing batch reactor (ASBR). *Bioresource Technology*.

Ying-Chih, C., Li-Ling L., Cheng-Nan C., Allen C. Chao. 2007. Control of carbon and ammonium ratio forsimultaneous nitrification and denitrification in a sequencing batch bioreactor. *International Biodeterioration&Biodegradation*, 59 1–7

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