Wastewater Management And Reuse Wastewater For Agriculture In Diem Thuy-Phu Binh-Thai Nguyen-Viet Nam

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Abstract

The state of water pollution and its treatment in Vietnam is very alarming and it directly affects lives of the people and countries' economy on many fields, especially agriculture, which is the main production sector of the country. The main solutions to improve the current situation are to invest in construction of wastewater treatment systems and plants and promoting propaganda activities.

Diem Thuy wastewater treatment plant is one of the large wastewater treatment and reuse plants in Vietnam with a capacity of 3000 m^3 / day. The amount of treated wastewater, which contains a huge amount of nutrients for plants, can ensures sufficient supply for 180 ha of agricultural land every year. Fertilizing substances, phosphorus and nitrogen, received from wastewater are worth accordingly 16 million VND and 35 million VND. Using treated water for watering the crops would save local farmers about 50 million VND per year. It is suggested to encourage research and application of simple and affordable wastewater treatment methods, based on biotechnology, at small and medium production facilities.

Keyword: wastewater, treatment, nutrient, management, reuse wastewater.

1. Introduction

Status of wastewater

In the developing countries, up to 90% of domestic wastewater is discharged without any treatment, releasing valuable nutrients into aquatic systems, leading to poor water quality, eutrophication, and dead zones (FAO UN, 2015). Modern wastewater treatment technologies and intensive farming methods may at first appear to provide a solution, but these are typically restricted to developed areas, require large amounts of energy and often release excess nutrients and untreated contaminants into aquatic systems (Roman et al., 2019). A study on small scale pig farms in china, the leading pork producer in the world, indicated the generation of about 1300 tons of wastewater per year per pig farm, including manure, urine and washing wastewater (Zhang et al., 2017). In fact, in Vietnam, the economic growth has so far relied heavily on the exploitation of natural resources and is associated with increasing pressure on the environment. Industrial production activities from industrial parks, clusters, production facilities and trade villages and constant economic development continue to be major sources of waste, causing environmental pollution areas.

Shortage of water

The environmental pollution caused by climate change, the development of industrial activities and a rapid increase of the world population has a big impact on people's lives. Typically, the agricultural sector is the largest consumer of water, accounting for 65% of 70% of global water demand and is also affected by water pollution (World Bank, 2010; Aquastat, 2013). In Vietnam, agriculture is the main sector. More than 80% of agricultural production supplies rice. According to statistics, Phubinh currently lacks of water for 700 ha of land so that agricultural productivity can remain stable. In terms of wastewater reuse, the World Bank in 2010 reported that one-tenth of global crops is irrigated with wastewater; in which only 10%, unfortunately, is properly treated. Demand for water resources is increasing in Vietnam in particular and the world in general.

2. Wastewater management in the World

Wastewater treatment methods

Many methods have been developed and implemented for wastewater disposal. Some of these methods are aerobic treatment (Falas et al., 2016), anaerobic treatment (Abbasi et al., 2016), chemical treatment (Ahmed et al., 2017), electrocoagulation (Elabbas et al., 2016; Kobya et al.,2016), adsorption (Zhou et al.,2016; De Gisi et al., 2016), advanced oxidation processes (Atalay and Ersoz, 2016), membrane processes(Neoh et al., 2016), and glow discharge plasma process (Wang et al., 2012). There are 3 kinds of distinguished wastewater treatment methods: physical, chemical and physio-chemical and biological.

The physical method can remove 60% of suspended solids and reduce pollutants capable of biodegradable BOD to 20%.

Chemical-physicochemical methods like cotton flocculation technology, precipitation technology, reverse osmosis, ultrafiltration and microfiltration. For instance, inorganic or alkaline acids was neutralized to a pH of 6.5-8.5 before being discharged into further processing technology or applying absorption methods that can separate 58-95% of the substances Organic colored dye. In addition, the osmosis method is used with Reserve Osmosis and Utral Filter technologies - Nano Filter consist of Super Filter.

Biological methods are commonly used in wastewater treatment plants. They are based on the activity of microorganisms to decomposing organic pollutants. Aerobic organisms operating under oxygen conditions are used in the technologies as Aerotank, SBR, sticky growth biotechnology AFBR and trickling filter.

The most effective wastewater treatment systems are combining treatment methods and models. One of them are waste stabilization pounds – WSP. WSP are a series of large shallow basins for wastewater treatment which removes nutrients (N, P and K), organic matter (BOD, COD) and pollutants by microbial, chemical, physio-chemical and hydrodynamic processes (Nagarajan et al., 2019).

A unique tank with MBR (Membrane Bioreactor) is the waste water treatment method, which combines biological and filtration processes, having advantages such as: small size area; high treatment efficiency; easy operation and management (Holler et al., 2001) and ability to process high quality wastewater in output and meet water discharge regulations more stringently (Yang et al., 2006; Fuet.al., 2009). In general, there are some studies of MBR that have succeeded in the fields such as: food industry wastewater (Krauth et al., 1993; Sridang et al., 2008); waste water containing oil (Viero et el., 2008; Seo et al., 1997; Kurian et al., 2006); domestic wastewater (Yang et al., 2006); landfill leachate (Bodzek et al., 2006); drink water (Tian et al., 2009).

The Submerged Membrane Bioreactor (SMBR) system has been conducted treatment efficiency of cake shop wastewater. The Submerged Membrane Bioreactor (SMBR) system has been conducted treatment efficiency of cake shop wastewater. The SMBR used in three different conditions as follows: model 1 - the SMBR system used suspended activated sludge; model 2 – the SMBR system was combined with the substrate inside; model 3 – the SMBR system was added with PAC (Poly Aluminium Chloride) excluding substrate (Nguyen ThiThanhPhuong et al., 2018).

Wastewater quality before treatment

+ Livestock wastewater

Typical concentrations of the major pollutants in the swine wastewater could be represented as follows: 2000-30000 mg/L BOD, 200-2055 mg/L total nitrogen (TN), 110-1650 mg/L NH_4^-N, 100-620 mg/L total phosphorus (TP) (Cheng et al., 2019). Storage lagoons with pig manure emit high quantities of CO_2 (anaerobic digestion), methane (anaerobic digestion), ammonia (by volatilization of N in the manure) hydrogen sulfide (decomposition), mercaptans, and other volatile acids (Nagarajan et al., 2019)

+ Domestic wastewater

Domestic wastewater was collected from a manhole at the Asian Institute of Technology (AIT) sewer system (Pathumthani Province, Thailand). The AIT campus, with a population of 2000–2,500, generates wastewater with a mixture of greywater and blackwater mainly from dormitories, offices and a cafeteria. Wastewater samples collected daily were analyzed, giving the characteristics shown that the range of pH is 7.2-7.51, 44-136.3 mg/l of TSS, 96-272 mg/l COD, 8.6x104-2.8x105 MPN/100ml Coliform (APHA, 2012).

+ Industry wastewater

The wastewaters released from these industries are considered to be of high strength; for distillery wastewater the COD value generally found in the range of 70,000 − 100,000 mg L^{-1}, food product industrial wastewater contains chemical oxygen demand (COD) in the range of 3500–10,000 mg L^{-1}, and dairy industrial wastewater contains COD in the range of 2000–5000 mg L^{-1} (Hung et al.,2004; Sankaran et al., 2014; Lu et al., 2015; Chokshi et al., 2016).

The industrial wastewater was sampled from a nano-silver production company in Yunnan, China. Due to adopting liquid-phase chemical reduction with hydroquinone as a reductant, the produced nano-silver wastewater had a high COD concentration as well as a high level of color. The indicators are listed including 14380 mg/l COD concentration, 9270 degree color, and pH value 10.5 (Qunchao Wang et al., 2019)

Wastewater management:

Regarding the management policies, the Ministry of Natural Resources and Environment (MONRE) has issued a number of decrees, as well as circulars on planning, lake regulations, and registration of waste sources owners as Decree 18/2015; 80/2006 enforced by Vietnamese government; Circular and Decision of MONRE: 35/2015; 12/2006; 23/2006; 125/2003. In addition, MONRE also set out some criteria to assess water sources such as Vietnamese Standard (QCVN) 11: 2015; QCVN 40: 2011; QCVN 39: 2011; QCVN 40: 2011.

With only about 15% of wastewater adequately treated in 33 wastewater treatment plants in urban areas, the majority of domestic wastewater is discharged back to the environment and polluting the surface water. On the other hand, current treatment capacity of 850,000 m^3/day is expected to increase by another 1,600,000 m^3/day from more than 40 new wastewater treatment plants being constructed (Ministry of Construction, 2016 ; Vietnam WSB, 2017).

Most drainage and sewerage systems in Vietnam's major cities have been built more than three decades ago and more than 90% of wastewater is transported using a combined, mainly drainage system serving as rainwater drainage and taking waste water indoors to prevent flooding on the street. Some newly developed urban areas introduce separate drainage and drainage systems; however, since most urban wastewater is not treated, both rainwater and domestic sewage are eventually discharged into nearby water environments such as rivers, lakes and canals (WEPA, 2012). Meanwhile, the coverage of drainage and wastewater treatment systems is still quite low compared to the coverage of drinking water service. The average coverage of sewer networks is only 40-50%, with 70% in large urban areas and only 12% in urban areas (JICA, 2011).

Among 283 operating industrial parks in the country, 212 have built concentrated wastewater treatment systems (equivalent to 74.9%), 24 zones are building concentrated wastewater treatment systems (equivalent to 11.5%), the remaining industrial parks are building investment routes in a centralized wastewater treatment system. Although the source of waste from large industrial parks concentrated, while the management and treatment of industrial waste is still limited. The centralized wastewater treatment system in industrial zones only handles about 60% of the generated wastewater. The remaining amount of waste water, partly because the facilities have been exempted from connection and self-treatment, partly not processed but discharged directly into the environment. Waste water treatment for industrial production facilities independent of industrial zones is a problem because most small manufacturing enterprises are interspersed in residential areas. Small production facilities often do not have the funds to build a standard waste treatment system, so environmental pollution in this area has to face seriously risk. However, reuse of wastewater really has significant implications for the environment due to it has a higher concentration of nitrogen and phosphorus, such as reducing pollution from fertilizers, improving the environment, preserving and appropriately using fresh water. So increasing the number of sewage treatment plant to apply the reuse of wastewater is essential (Dang Hoang Ha et al., 2018)[b].

Wastewater quality after treatment.

According to Dang Hoang Ha' research (2018)[a], after secondary treatment, wastewater reuse can provide 15-27% of the nitrogen requirement and up to 8-17% of the phosphorus requirement for the rice fields. The quality of waste water after treatment is compared with the national standard on industrial wastewater QCVN 40: 2011.

The SMBR models in this study were able to eliminate COD at very high level when the system was stable. After the adaptation period, the COD efficiency of the models was over 96% and was stable during the operation and meets the discharging standard QCVN 40: 2011 for irrigation (Vietnam National Technical Regulation on Industrial Wastewater).

The model of wastewater treatment experiment that incorporate aquatic plants by Roman and R.A.Brennan in 2019.All metals were below the regulatory limits for fodder set by the European Parliament and US FDA. Of the analyzed metals, Fe had the highest biomass concentration, ranging from 160 to 600mg/kg duckweed biomass .

In the study of Dan et al. in 2009 there analyzed about total nitrogen content in wastewater and concluded that Sesbania sesban could absorb almost all of the ammonium and nitrate in wastewater after treatment, equivalent to about 30 % total nitrogen that can be used for
animal fodder or soil amendment.

Domestic wastewater: By the end of 2012, there were only 17 waste water treatment facilities operating in urban areas of Vietnam nationwide. Currently the most popular waste water treatment technology in Vietnam is activated sludge process with different forms, like conventional activated sludge (CAS), anaerobic-anoxic-aerobic (A2O), the oxidation ditch (OD) and bio batch processing (SBR).

Medical wastewater: At present, 100-150 of 1100 Vietnam hospitals (about 10-15%) have waste water treatment plant putting into operation. Among these, some hospitals have wastewater treatment plant applying aerobic biological treatment technology using activated sludge or combined treatment.

Industrial wastewater: According to statistic of the Vietnam Environment Administration, over 80% industrial zones operating in Vietnam already have centralized wastewater treatment system, 20 % of the remaining industrial parks do not have or are being invested the centralized wastewater treatment system. There are 3 technological groups regarding wastewater treatment methods in industrial and export processing zones like: traditional technology with biological treatment using activated sludge and trickling filters; wastewater treatment technology with biological treatment process by aerobic microorganisms, with the other treatment facilities in the processor and wastewater treatment technology with biological treatment process using activated sludge prolonged aeration.

3. Diem Thuy-Phu Binh-Thai Nguyen-Viet Nam - one of the wastewater treatment plants

Thai Nguyen is a typical example of industrialization and modernization with its geographic location as a political, economic and educational center of the North. It is a place for socio-economic exchanges between the mountainous midland and the northern delta region. The exchange was made through the road system, railways and rivers that Thai Nguyen is the center.

As reported by preliminary statistics, the province's industrial production facilities discharges about 19 million m^3 of wastewater per year and is expected to increase by 22% per year. Among the 100 establishments causing environmental pollution in the province, there are 52 establishments having waste water sources causing environmental pollution. The water on rivers and streams receiving waste water from mineral mines and industrial production establishments has shown signs of pollution of total suspended solids (TSS) and some heavy metals (Fe, As, Cd, Pb , Zn).

These days, Diem Thuy is one of the largest industrial areas in Thai Nguyen. There are 60 enterprises and companies that have been conducting and releasing approximate 3000 m^3 per day. In order to meet the requirements of environmental protection and production needs, the Management Board of the industrial zone has invested in building a waste water treatment station for 3000 m^3 per day.

Domestic wastewater, production wastewater and storm water are types of wastewater that the station handles. The quality of the wastewater produced and collected from different 60 companies, must meet the requirements of pre-treatment quality, before being put into the central treatment station of the whole industrial zone. The metal targets reach QCVN 40: 2011 for agriculture; the remaining indicators reach QCVN 40: 2011 for industry. All wastewater of the industrial park after

being treated to meet the permitted standards (QCVN 40: 2011 for irrigation) will be discharged into the drainage ditch the receiving source is Vanduong stream, eventually flowing into Cau river. Besides, domestic wastewater from factories is pre-treated via a 15m^3 self-disintegration tank reaching QCVN 40: 2011 for industry to allow connection to the wastewater collection system of the Industrial Park to lead to the treatment station. Waste water treatment of industrial zones to continue processing then discharge to receiving sources.
Concentrated sewage treatment station Diem Thuy industrial park uses a combination of 03 main methods of physical, chemical treatment and biological treatment , which are divided into 9 stages in the operation process including waste water collection, garbage separation, regulating waste water, reaction, primary sedimentation, aerobic treatment, secondary sedimentation, sterilization and sludge compaction. The regulation is operated and supervised and strictly controlled by specialized staff Using modern machinery and equipment.
In order to assess the water quality of the wastewater treatment system during operation, the consulting agency conducted sampling and analysis from pH, COD, BOD, SS, CN, grease, total N, Total P, Cl, Cr, Hg, Cu, Zn, Mg, Fe, Pb, As, Sulfide, NH_4^+-N, Coliform, color and sampling at the inlet and outlet of the centralized wastewater treatment plant, based on the standards that QCVN 40: 2011 - National technical regulation on industrial wastewater.

Table : The results of analysis of waste water quality after treatment

	pH	TSS	N	P	BOD	COD	Coliform	Other
QCVN 40: 2011	6 - 9	50 mg/l	20 mg/l	4 mg/l	30 mg/l	75 mg/l	3000/100ml	
Wastewater quality after treatment	6,5-7mg/l	30,72-35,83 mg/l	5.04 - 9.15 mg/l	2.7 mg/l	22.8 - 23 mg/l	32 - 48 mg/l	2200 MPN/100ml	within the permitted standards

Evaluating the reuse of wastewater from this treatment station in Thai Nguyen
According to local statistics, Thai Nguyen has over 82000 hectares of agricultural land, equivalent to 23% of natural land in which a part distributed along the streams, scatterred by the harsh hydrologycal regime (sudden floods and drought) difficult to cultivate. Rice is one of the main agricultural products of this area, of which each crop requires 6000 m^3 / ha on average for plants to grow normally. While the capacity of the plant is 3000 m^3 / day, not to mention the waste, it can be ensured to supply the water demand for 180 hectares per year and natural resources like lakes and groundwater are running out. With the results after analyzing the content of substances in wastewater after treatment, this factory can produce about 35 million VND of nitrogen and 16 million VND of phosphorus each year, equivalent to around 50 million VND of chemical fertilizers the market.

4. Discussion

Lack of the water for agriculture is becoming a major concern. Natural water sources are increasingly declining due to over-exploitation and pollution, old and not updated treatment systems and the fact that the management and construction investment policies of the managing agencies are inadequate.
Domestic wastewater from households and residential areas are almost untreated and agricultural wastewater is only treated indirectly, causing water pollution to become more and more severe.

Currently, there have been many researches confirming that the quality of wastewater after being treated meets the demand of supplying nutrients for agricultural crops instead of using chemical fertilizers and fertilizers.

Wastewater reuse has brought great benefits to the environment such as saving water resources and reducing the cost of building irrigation systems for the exploitation of natural water resources. Not only that, the source of wastewater for reuse for the inlet is easy to find, regardless of the weather.

5. Conclusion

The reuse of waste water brings a lot of benefits to the agricultural sector in particular and the environment in general. It solves the problem of water use for irrigation, saves clean water and protect the environment. Moreover, the value of nutrient sources in treated wastewater can be used as a good fertilizer for crops, while reducing the amount of chemical fertilizers. Instead of using fertilizes, famers could save up to 10 % on fertilizes each year, using the wastewater after treatment for irrigation. In addition, this also helps supply water for agriculture to contribute positively to irrigation systems.

With the great benefits of reusing wastewater, the state and the authorities need a lot of policies to expand the Diem Thuy’s system of reusing wastewater and support construction investment and rise local resident’s awareness for environmental protection. Simultaneously, the government should be to encourage research and application of measures to treat wastewater by cheap biotechnology, easily implemented for small and medium production facilities.

Reference

Abbasi, U., Jin, W., Pervez, A., Bhatti, Z.A., Tariq, M., Shaheen, S., Iqbal, A., Mahmood, Q., 2016. Anaerobic microbial fuel cell treating combined industrial wastewater: correlation of electricity generation with pollutants. Biosource Technol. 200, 1-7.

Ahmed, M.B., Zhou, J.L., Ngo, H.H., Guo, W., Thomaidis, N.S., Xu, J., 2017. Progress in the biological and chemical treatment technologies for emerging contaminant removal from wastewater: a critical review. J. Hazard. Mater. 323 Part A, 274-298.

APHA(twenty-second ed.), Standard Methods for the Examination of Water and Wastewater, vol. 3, American Water Works Association and Water Environment Federation, New York (2012).

Aquastat, 2013. Water Uses, Food and Agriculture. Organization. United Nations, (2013).

Atalay, S., Ersoz, G., 2016. Novel Catalysts in Advanced Oxidation of Organic Pollutants. SpringerBriefs in Green Chemistry for Sustainability. https://doi.org/10.1007/978-3-319-28948-9, Page 712-726

Bodzek, M., Moysa, E.L., Zamorowska, M., 2006. Removal of organic compounds from municipal landfill leachate in a membrane bioreactor. Desalination 198, 1-3.

Cheng, D.L., Ngo, H.H., Guo, W.S., Chang, S.W., Nguyen, D.D., Kumar, S.M., 2019. Microalgae biomass from swine wastewater and its conversion to bioenergy. Bioresour. Technol. 275, 109–122.

Chokshi, K., Pancha, I., Ghosh, A., Mishra, S., 2016. Microalgal biomass generation by phycoremediation of dairy industry wastewater: an integrated approach towards sustainable biofuel production. Bioresour. Technol. 221, 455–460. https://doi.org/10.1016/j.biortech.2016.09.070

Dan Truong Hoang, Le Nhat Quang, Bui Truong Tho, Truong Thi Nga (2009), The status of nitrogen concentration in constructed wetland planted Sesbania sesban, Journal of Science in can Tho University, 12:1-8.

Dang Hoang Ha, M. Simon (2018)[a], Climate change impacts on water resources in Vietnam: Adaptation strategies for agriculture and hydropower – A review, Journal of technology and science-Thai Nguyen University, Page:197-204

Dang Hoang Ha, Mai Thi Phuong Ly, Tran Thi Phuong Anh (2018)[b], Wastwater Reuse In Agriculture: The opportunities, Challenges and Benefits. The Case in Viet Nam – A Review, 14th International Conference on Humanities and Social Science 2018 (IC-HUSO 2018) At Khon Kaen University, Thailand, ICHUSO-117, Page: 593-605.

De Gisi S, Lofrano G, Grassi M, Notarnicola M (2016) Characteristics and adsorption capacities of low-cost sorbents for wastewater treatment: a review. Sustain Mater Technol 9:10-40

Elabbas, S., Ouazzani, N., Mandi, L., Berrekhis, F., Perdicakis, M., Pontvianne, S.,Pons, M.N., Lapicque, F., Leclerc, J.P., 2016. Treatment of highly concentrated tannery wastewater using electrocoagulation: influence of the quality of aluminum used for electrode. J. Hazard. Mater. 319, 69-77.

Falas, P., Wick, A., Casronovo, S., Habermacher, J., Ternes, T.A., Joss, A., 2016. Tracing the limits of organic micropollutant removal in biological wastewater treatment. Water Res. 95, 240-249.

FAO - Food and Agriculture Organization of the United Nations, 2015. The improved global governance for hunger reduction program.

Fu, Z.M., Yang, F.L., Zhou, F.F., Xue, Y., 2009. Control of COD/N ratio for nutrient removal in a modified membrane bioreactor (MBR) treating high strength wastewater. Bioresour. Technol. 100, 136–141.

Holler, S., Trosch, W., 2001. Treatment of urban wastewater in a membrane bioreactor at high organic loading rates. J. Biotechnol.92
https://doi.org/10.1016/j.ecoena.2019.100004, 95–101

Hung, Y.-T., Lo, H.H., Awad, A., Salman, H., 2004. Potato wastewater treatment. In: Wang, L.K. (Ed.), Waste Treatment in the Food Processing Industry, 1st edn Taylor and Francis Group, Boca Raton, pp. 810–868 https://doi.org/10.1201/9781420037128.ch6

JICA (2011). Study Report on Water Supply, Drainage and Sewerage. Progress Report – Volume 3. Prepared by NIPPON KOEI CO., LTD and YACHIYO ENGINEERING CO., LTD.

Kobya, M., Gengec, E., Demirbas, E., 2016. Operating parameters and costs assessments of a real dye house wastewater effluent treated by a continuous electrocoagulation process. Chem. Eng. Process. Process Intensif. 101, 27-100

Krauth, K.H., Staab, K.F. 1993. Pressurized bioreactor with membrane filtration for wastewater treatment. Water Res. 27, 405-411.

Kurian, R., Nakhla, G., Bassi, A., 2006. Biodegradation kinetics of high strength oily pet food wastewater in a membrane-coupled bioreactor (MBR). Chemosphere 65 (7), 1204-1211.

Lu, W., Wang, Z., Wang, X., Yuan, Z., 2015. Cultivation of Chlorella sp. using raw dairy wastewater for nutrient removal and biodiesel production: characteristics comparison of indoor bench-scale and outdoor pilot-scale cultures. Bioresour. Technol. 192,382–388. https://doi.org/10.1016/j.biortech.2015.05.094.

Ministry of Construction & BBGV. (2016). Vietnam Water Sector: Opportunities for UK Businesses Webinar. Accessible on: http://bbgv.org/bc-eventdetail.html?event_id=238

MONRE, 2011,Vietnam National Technical Regulation on Industrial Wastewater, QCVN 40: 2011, columnA; https://emas.tdtu.edu.vn/sites/emas/files/EMAS/V%C4%83n%20b%E1%BA%A3n%20ph%C3%A1p%20lu%E1%BA%ADt/qcvn-40-n%C6%B0%E1%BB%9Bc-th%E1%BA%A3i-cn.pdf ; Accessed on: 28.07.2011

Nagarajan, D., Kusmayadi, A., Yen, H.-W., Dong, C.-D., Lee, D.-J., & Chang, J.-S. (2019). Current advances in biological swine wastewater treatment using microalgae-based processes. Bioresource Technology, doi:10.1016/j.biortech.2019.121718

Neoh, C.H., Noor, Z.Z., Mutamim, N.S., Lim, C.K., 2016. Green technology in wastewater treatment technologies: integration of membrane bioreactor with various wastewater treatment systems. Chem. Eng. J. 283, 582-594.

Nguyen Thi Thanh Phuong, Tran Tan Tien, Pham Thi Thanh Hoa, Thai Van Nam, Tran Le Luu , (2018)Treatment of cake shop wastewater by pilot-scale Submerged Membrane Bioreactor (SMBR). Biteb, doi:10.1016/j.biteb.2018.09.009

Qun-chao Wang, Shu-gen Liu, Hua-ping Gao. Treatment of hydroxylquinone-containing wastewater using precipitation method with barium salt: Water Science and Engineering. Volume 12, Issue 1, March 2019, Pages 55-61 https://doi.org/10.1016/j.wse.2019.03.003

Roman, R. A. Brennan A, Beneficial by-product of ecological wastewater treatment: An evaluation of wastewater-grown duckweed as a protein supplement for sustainable agriculture. Ecological Engineering: X. Volume 1, June 2019, 100004.

Sankaran, K., Premalatha, M., Vijayasekaran, M., Somasundaram, V.T., 2014. DEPHY project: distillery wastewater treatment through anaerobic digestion and phycoremediation - a green industrial approach. Renew. Sust. Energ. Rev. 37,634–643. https://doi.org/10.1016/j.rser.2014.05.062.

Seo, G.T., Lee, T.S., Moon, B.H., Choi, K.S., Lee, H.D. 1997. Membrane separation activated sludge for residual organic removal in oil wastewater. Water Sci. Tech., 36, 275–282.

Sridang, P.C., Pottier, A., Wisniewski, C., Grasmick, A., 2008. Performance and microbial surveying in submergedmembrane bioreactor for seafood processing wastewater treatment. J. Membr. Sci. 317 (1-2), 43–49.

Tian, J.Y., Liang, H., Nan, J., Yang, Y.L., You, S.J., Li, G.B., 2009. Submerged membrane bioreactor (sMBR) for the treatment of contaminated rawwater. Chem. Eng. J. 148 (2–3), 296–305.

Viero, A. F., Melo, T. M., Torres, A. P. R., Ferreira, N.R., Anna, G. L .S., Borges, C. P., Santiago, V. M. J., 2008. The effects of long-term feeding of high organic loading in a submerged membrane bioreactor treating oil refinery wastewater. J. Membr. Sci. 31 (1-2), 223–230.

Vietnam WSB (water sector briefing), 2017, Department for International Trade, The business center, http://bbgv.org/wp-content/uploads/2017/09/DIT-BBGV-Water-Sector-

Wang, X., Zhou, M., Jin, X., 2012. Application of glow discharge plasma for wastewater treatment. Electrochim. Acta 83, 501-512.

WEPA (2012). Outlook on Water Environmental Management in Asia 2012. Published by Institute for Global Environmental Strategies (IGES) served as the WEPA Secretariat.

World Bank, 2010. In: Scheierling S.M., Bartone C., Mara D.D., Drechsel P.,editors. Improving wastewater use in agriculture: an emerging priority.Washington D.C.

Yang, W., Cicek, N., Ilg, J., 2006. State-of-the-art of membrane bioreactors: worldwide research and commercial applications in North America. J. Membr. Sci.270, 201–211.

Zhang, D., Wang, X., Zhou, Z., 2017. Impacts of small-scale industrialized swine farming on local soil, water and crop qualities in a hilly red soil region of subtropical China. Int. J. Environ. Res. Public Health 14 (12), 15-24.

Zhou, L., Liu, Y., Liu, S., Yin, Y., Zeng, G., Tan, X., et al. (2016). Investigation of the adsorption-reduction mechanisms of hexavalent chromium by ramie biochars of different pyrolytic temperatures. Bioresour. Technol. 218, 351-359. doi: 10.1016/j.biortech.2016.06.102