International Journal of GEOMATE, July, 2018 Vol.15, Issue 47, pp.32-41
Geotec., Const. Mat. & Env., DOI: https://doi.org/10.21660/2018.47.06582
ISSN: 2186-2982 (Print), 2186-2990 (Online), Japan

DOMESTIC WASTEWATER IN INDONESIA: CHALLENGE IN THE FUTURE RELATED TO NITROGEN CONTENT

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ABSTRACT: The option of reusing treated wastewater is becoming necessary for environment sustainability approach. In fact, wastewater effluent discharge regulations have become stricter leading to a better water quality. Municipal activities, agriculture, and rapid urbanization led to increased nitrogen and phosphorus discharge to the water system. More often, the effluents from municipal wastewater treatment plant failed to meet the national standard for effluent quality. Excess nutrients, mostly N and P is the main cause of eutrophication the which results in oxygen depletion, biodiversity reduction, fish kills, odor, and increased toxicity. Biological nutrient removal technologies are preferred and widely used to remove nitrogen and phosphorus from domestic wastewater and protect water quality. Chemical compositions in wastewater are highly diverse substances from simple compounds to complex polymers. Some wastewater samples were analyzed in this research. Conventional technology still retains the basic principle of complete nitrogen cycle through nitrification and denitrification. Anammox is a sustainable and cost-effective alternative to the basic method of nitrogen removal. Anammox has been identified as a new biotechnology for nitrogen reduction from wastewater. Compared to the common process of nitrogen removal, anammox can reduce 64% off aeration, 100% of an exogenous electron donor, and sludge production by 80-90%. Some benefits from anammox include high nitrogen removal rate, lower operational cost, and small space requirements. Anaerobic baffled reactor (ABR) in Indonesia has been used commonly as communal wastewater treatment. Promoting anammox process in ABR potentially become an improvement for ABR in removing nitrogen better. This combination process still outlined for further research.

Keywords: Anammox, Domestic wastewater, Eutrophication, Nitrogen, Wastewater treatment

1. INTRODUCTION

The high density of the citizens is known as one of the causes of environmental problems. The rapid growth of population in the urban area has significantly influenced the rate of water consumption and combined with increasing wastewater generation. In addition to industrials, municipal wastewater which is discharged from the households is also the main contributor of wastewater as well. Domestic wastewater effluent becomes a contributor to diverse water pollution. Water pollution is a big problem particularly with improvement in the living standard of community in most of developing countries (1,2). The problem will be more serious if the receiving water will be used by the people for basic needs. Wastewater treatment is one of indicator that really related to sanitation development in the community because poor sanitation affects public health and environment. In another side, the investment by local government in sanitation service or infrastructure remains low, including wastewater treatment provision (3,4). Even today, domestic wastewater is still disposed to drainage, river, or lake without proper treatment before (4). Some of the problems caused by wastewater, such as eutrophication, increasing treatment cost, decreasing the recreational value of water, health risks to humans and livestock, loss of oxygen and undesirable changes in the aquatic ecosystem. In order to prevent the pollution risks, wastewater treatment urgently needed before the wastewater discharged to the environment (5,6). Most of the domestic wastewater is generated as result of living habits, human disposal, residual liquid product, and waste from artificial installation (7). Wastewater treatment should be considered as part of ecological sustainability. Many aspects are very closely related with for the wastewater treatment, such as wastewater characteristic, space availability, technology, human resources, cost, and policy. Besides that, sustainability development of wastewater treatment plan is including many aspects, such as technology, financial, institutional, community involved, and environment (8). The lack of public infrastructure investment by the government resulted the communities have to make their own infrastructure for accessing proper sanitation. It also has led to widespread the pollution of surface water and groundwater and a deterioration in environmental health (9). For example, the use of waterborne toilets is very common and well established in many areas in Indonesia, especially in the poor area. Besides, the law enforcement from the government is still weak, so most of the communities still dispose of their wastewater unsafely. In most cases, wastewater is untreated or partially treated in open channel, rivers, or pond.

In another case, there is no separation between grey or black water, which it should be treated in a septic tank. In fact, many households, especially in poor/slump area, have the toilet but not equipped with the proper septic tank. This is because of the limitation of financial capability and land availability (10). Since the declaration of Indonesia Mid-Term Development Plan 2015-2019 (RPJMN 2015-2019), the government is committed to achieving the target of program 100 0 100 (100% people served for drinking water, 0% for slump settlements, and 100% for sanitation access). The inclusion of this program, Indonesia to be 100% of open defecation free (ODF), 10% of the total population to be using off-site wastewater management system and 90% of the population to have improved onsite facilities. Approximately 1700 decentralized wastewater treatment system (DEWATS) constructed in many areas with 4000 DEWATS planned to be constructed by 2015. Centralized system planned for five cities such that 32 million people or 15% of the population will be covered by this system (11). The percentage of the wastewater system in Indonesia can be seen in Fig 1. It is shown that only 4% of population are served by septic safely disposal while only 1% population have access to treated wastewater

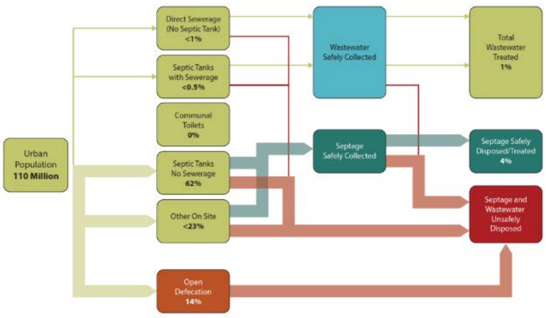

Fig 1. Wastewater and septic tank flow in urban Indonesia (11)

Several cities in Indonesia, like Jakarta, Denpasar, Batam, Bandung, Cirebon, Yogyakarta, Surakarta, Medan, Prapat, Tangerang, Balikpapan, Banjarmasin, and Manado already has a centralized wastewater treatment plant. Unavailability of space is also the problem of wastewater treatment development in many areas with high density of population. Hence, development of wastewater treatment is directed to communal scale. Currently, provision and construction of domestic wastewater treatments with communal scale are being encouraged. It is needed to serve the community which has limited land, human resources, and budget. Communal scale wastewater treatment will serve around 50-100 households and should be considered with low cost, appropriate technology and easy to operate and maintain. The current scheme of wastewater distribution in urban Indonesia can be seen in the picture above.

Based on the wastewater scheme above, the total wastewater treated in urban Indonesia is approximately 1% of total wastewater produced. The practice of open defecation free (ODF) currently still happens by 14% of the population and contributed to 95% of wastewater unsafely disposed of. This paper will describe the recent development of domestic wastewater treatment in Indonesia and its future challenges for achieving the development target in 2019, specifically in wastewater.

2. THE CURRENT WASTEWATER TREATMENT

The option of reusing treated wastewater is becoming necessary for sustainability approach. It is as the result of increased climate change effect, thus leading to droughts and water scarcity in some areas. In fact, wastewater effluent discharge regulations have become stricter leading to a better water quality (12). There are many types of treatment unit which is used in Indonesia for treating domestic wastewater. The use of treatment unit is according to the amount of the user, for example, individual, communal, public facilities, home industrials, or accommodation services. Domestic communal WWTP creates new problems associated with sustainability because the concept of its management less domestically involving all stakeholders and not be seen from various aspects (8). An approach of domestic wastewater treatment unit which is suitable for the recent condition is Decentralized Wastewater Treatment Systems (DEWATS). In this system, some households will be served with a treatment unit with the appropriate sewage system. The outlet from households will be connected to the treatment unit to collect the wastewater. It will give many advantages to be applied in an urban area with high-density population and has poor access to toilet or washing facilities (10,13). Generally, DEWATS was implemented through the community-based sanitation program which 100-200 households are involved. There are three choices for the sanitation development for the community: 1) shared septic tanks for 4-5 households, 2) enhanced communal bathing, washing, and toilet block facilities, 3) shallow sewer carrying to a communal wastewater treatment facility.

The treatment unit which is commonly used as communal domestic wastewater treatment is anaerobic baffled reactor (ABR). ABR is a series up-flow *anaerobic sludge blanket* (UASB) which has a simple design and low cost in operation and maintenance, and also it can provide a high number of people (2,14). The wastewater flows up and down in the ABR pass through the baffles and causes the flow of influent have more intensive contact with the anaerobic biomass. It improves the performance of degradation matter by bacteria (15). The treated wastewater from ABR unit usually reused for watering and discharging to the stream. There are also some other modified ABR used as domestic wastewater treatment. Said (16) has explained the use of anaerobic-aerobic bio-filter prototype in treating wastewater. It was using beehives media as the attached media in the anaerobic treatment. The effluent from aerobic zone recycled to the anaerobic zone by using recirculation pump. It resulted in about 90% of BOD and COD removal respectively, and over 80% of ammonia and MBAs removal. The operation still needs 65 watts for the electricity to serve about 55 people.

Hendrawan (17) has conducted a research on the utilization of constructed wetland in treating domestic wastewater. Even though the use of constructed wetland is limited by the available land and cost, but it is still considered as domestic wastewater treatment unit. The BOD and COD removal for this unit was up to 90% and total-N was up to 80%. Various type of aquatic plants can be used with this treatment. Theoretically, the communities of aquatic microorganism and plants can mutually decrease the pollutants in contaminated water. Compared with the conventional treatment using chemical, the constructed wetland is more simple, inexpensive, and environmental friendly (18).

Some applications of wastewater treatment approaches have been conducted by Research Centre of Limnology of Indonesia since 1990, include: treatment of laboratory wastewater using constructed wetland, stormwater in Lake Cibuntu using constructed wetland, microphytobenthic approaches to reduce nitrogen and phosphorus in lotic ecosystem, constructed wetlands for wastewater at school, passive treatment in field scale mine waste treatment using constructed wetland, conducted ecohydrology engineering study for the restoration of aquatic system in Lake Limboto (19). Comparison between some types of treatment unit has been conducted by Kersten (20) with considering the costs and benefits for each type (**Fig. 2**). Types of treatment unit are described, such as septic tank, anaerobic baffled reactor (ABR), anaerobic filter (AF), aerated lagoon (AL), conventional activated sludge (CAS), membrane bioreactor (MBR), aerobic granular sludge (AGS), and up-flow anaerobic sludge blanket-duckweed-rotating biological contactor (UASB-DW-RBC).

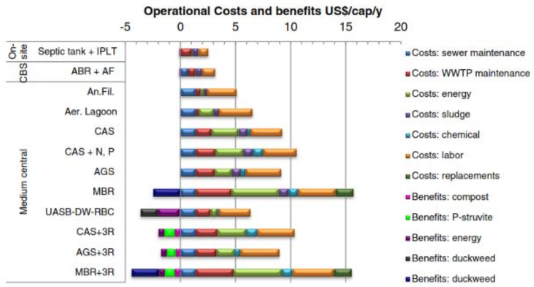

Fig 2. Comparison of operational costs and benefits from many types of wastewater treatment unit (21)

Based on the graphic above, the use of the onsite system (septic tank) and Community-Based Sanitation (CBS) has very low cost for maintenance, labor and sludge treatment. Compared to the other medium central treatment, both of onsite system and CBS has no additional benefits that can be used, like compost, struvite, energy, or biomass. The advantages of this two systems are low cost for construction and maintenance, user-friendly technology, and no need qualified a person to operate. Most of the communities in Indonesia are using the onsite system and also involve in CBS system. Additionally, in CBS system they are using ABR as common wastewater treatment unit according to cost and space availability. ABR can be built under the small street or narrow area, so it can be solved the problem of limited space for construction. Two of highest cost for all treatment units is energy consumption and labor. Electricity is very important to provide for operating some treatment unit in machine operation, for example, to increase oxygen supply by doing aeration or mixing. Advance technology needs some qualified people to operate, on other hand, they need to be paid.

3. THE DOMESTIC WASTEWATER CHARACTERISTICS

An obvious consequence of the people pressure in utilizing land and water resources is phenomena of eutrophication in water bodies. Untreated wastewater from domestic activities and some industrials in the urban area have enriched the river water and creating extensive eutrophication. In this case, rivers as the source of water cannot be utilized anymore by the people because containing hazardous materials. It is important to determine the characteristic of influent and effluent of wastewater in explaining its impact to the main water. Chemical properties in the domestic wastewater are highly diverse substances from simple compounds to complex polymers. Types and amount of substances show the characteristic of domestic wastewater.

Generally, the characteristics of domestic wastewater are specifically represented by some physicochemical parameters, such as pH, chemical oxygen demand (COD), biochemical oxygen demand (BOD), total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), total nitrogen (TN), total phosphate (TP), and potassium. The other minority substances such as metal, toxic material, detergent, and bacteria (12,24,26–29). Huang (22) has investigated the characteristic of organic matters in domestic wastewater showed that fiber (20,64%) was the largest group of organic matters and followed by proteins (12,38%) and sugar (10,65%) were next largest. The sources of wastewater influent are mainly from municipal wastewater and industrial streams, and also a possible mixture of stormwater and surface water. In another word, wastewater influent quality can also be affected by the discharge of industrial streams, stormwater, surface runoff, etc. (24,30). Grey wastewater is defined as wastewater without any input from toilets, which means that it corresponds to wastewater produced from bathtubs, showers, hand basins, laundry machines and kitchen sinks, in households, office buildings, schools, etc. It is less polluted than black wastewater which is contained wastewater from the toilet, such as faces and urine (23).

Water will become the most strategic resource in many parts of the world within the next decades. The identification of critical limit in water quality parameters and their concentrations provide opportunities for improving sustainable water utilization in the future (24). According to the Indonesia discharge quality standard of a pollutant for municipal wastewater, the quality standard for pH, BOD, TSS and oil and grease corresponding are 6-9, 100 mg/L, 100 mg/l, and 10 mg/L, respectively. The treated wastewater from WWTP will be discharged into the water body for utilization. Indonesia government has been classified the water quality level to determine the appropriate utilization for each water classes. There are four water classes and each has water quality index involved some water quality parameters. The aim of present study was to investigate the physicochemical characteristic of municipal wastewater in an urban area in case of Surabaya City. That physicochemical characteristic would be presented as pH, COD, BOD, DO, TSS, Nitrogen, Phosphorus, and detergent.

Nutrient concentration is an important in determining wastewater characteristic. Wastewater with high nutrient content increases the risk of eutrophication in the water body. The concentration of nutrient should be reduced to a level protective of the receiving stream (31). Nitrogen and phosphorus become two kinds of nutrient that were measured in this study. A form of nitrogen, such as ammonium, nitrite, and nitrate was measured according to the standard method. Phosphorus in this study was measured as orthophosphate and determined using a spectrophotometric method.

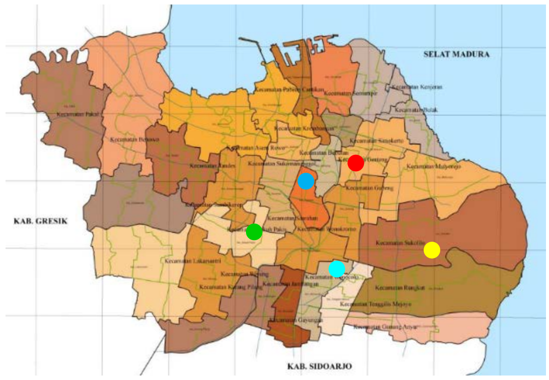

Fig 3. Sampling locations in Surabaya City (blue=Tegalsari District; red=Genteng District; yellow=Sukolilo District; cyan=Wonocolo District; green=Dukuh Pakis District) (32)

Additionally, some domestic wastewater samples were analyzed to compare with previous research. The samples were taken in five districts in Surabaya City, such as Tegalsari, Genteng, Sukolilo, Wonocolo, and Dukuh Pakis (Fig. 3). Santosa (22) has been classified all areas in Surabaya based on the health risk level. Selected locations of study belong to the low-risk level of wastewater service area. Those samples were analyzed in Water Management Laboratory, Department of Environmental Engineering, Faculty of Civil Engineering, Environment, and Earth Science, Institut Teknologi Sepuluh Nopember. The recorded domestic wastewater characteristics for the previous and recent research can be seen in Table 1.

Domestic wastewater from kitchen sinks and dishwashers contribute most of the biodegradable organic substances and particulate nitrogen. The presence of large biodegradable organic substances, kitchen wastewater is more contaminated by the thermal tolerant coliforms than other sources (7). Oxygen demand may be in the form of BOD or COD, is the amount of oxygen used by microorganisms in degrading organic material in wastewater. According to Hudson (33), BOD may cause oxygen depletion in the water body and lead to nuisance odor and fish kills. It is involved the measurement of dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter. COD is the amount of oxygen which is consumed by oxidizable matter in the wastewater (34).

The COD will always be higher or same with the BOD. This is because the COD measures substances that are both chemically and biologically oxidized. The ratio of COD: BOD Fig.s the proportion of organic material contained in wastewaters. Some polysaccharides, such as cellulose, can only be degraded anaerobically, so they will not be involved in the BOD (12). COD is more resistance to treatment and may accumulate include humic residues, detergents, phenols, cyanide, residual hormones, pharmaceuticals and pesticides (33). High organic matter can lead the high oxygen consumption by the aerobic bacteria and compete with the aquatic organism (30).

BOD is the amount of organic content in the wastewater which is biologically degradable with oxygen consumption. BOD usually indicated as 5 days oxidation of biodegradable organic matter at 20^0C by a microorganism (34). BOD in the influent and effluent in Sukolilo measured of 9 mg/L and 5 mg/L, respectively. According to COD measurement, the BOD/COD ratio for influent and effluent was 0.6 and 0.55, respectively. It was similar to organic matter concentration in Genteng since the result showed that 8.00 mg/L and 3.00 mg/L of BOD for inlet and outlet, respectively. COD concentration in influent and effluent was 15 mg/L and 6 mg/L, respectively. In this case, decreasing of COD concentration needs to investigate because ABR classified as biological treatment process. The value of BOD and COD for both locations is still under the rule of water quality control for discharge of effluent on water stream.

In the septic tank process, organic nitrogen is converted to total ammonium nitrogen in an anaerobic condition and due to low oxygen present, amount of it is converted to nitrate. The concentrations were much higher than the safe limit of 1.0 mg/L for long-term exposure of aquatic micro-organisms (30). Organic and inorganic forms of nitrogen can generate eutrophication impact in the lake, river, estuarine and coastal waters. Nitrogen sources in domestic wastewater are food waste, soap, and fertilizer. Incomplete nitrogen cycle, ammonia is oxidized to nitrate, creating an oxygen demand and low dissolved oxygen in surface waters. Nitrogen in the form of ammonia is toxic to fish and exerts an oxygen demand on receiving water by nitrifiers (12).

According to the regulation from the ministry of environment and forestry 68/2016, the maximum threshold of ammonia in wastewater is 10 mg/L. The results showed that there are three locations have wastewater with exceeding in ammonia concentration. Other areas showed low ammonia concentration even below the threshold. Generally, domestic wastewater is classified as low strength nitrogen content. However, the exceeded ammonia concentration potentially raises the eutrophication rate.

Table 1. Domestic wastewater characteristics from several locations in Indonesia

Location	Wastewater characteristics	Ref.
Brantas River	Ammonia 0,13-1,14 mg/L; Nitrite 0,102-0,423 mg/L	(15)
WWTP Malang	BOD 84-1860 mg/L; COD 148-3921 mg/L; Ammonia 18-50 mg/L	(15)
Home industry of tofu, Tahu Lampaseh Aceh	BOD 1177 mg/L; ammonia 3575,5 mg/L; orthophosphate 1,81 mg/L;COD 6500 mg/L	(5)
Home industry of tofu, Tahu Sumedang	BOD 3810,2 mg/L; ammonia 129,3 mg/L; orthophosphate 95,5 mg/L; COD 5000 mg/L	(5)
Sukolilo, Surabaya	BOD 9 mg/L; COD 15 mg/L; ammonia 12,82 mg/L; orthophosphate 0,25 mg/L	(32)
Genteng, Surabaya	BOD 8 mg/L; COD 15 mg/L; ammonia 38,91 mg/L; orthophosphate 0,44 mg/L	(32)
Tegalsari, Surabaya	Ammonia 7,36 mg/L; nitrate 0,12 mg/L, orthophosphate 1,86 mg/L	(32)
Wonocolo, Surabaya	Ammonia 6,29 mg/L; nitrate 0,05 mg/L, orthophosphate 1,52 mg/L	(32)
Dukuh Pakis, Surabaya	Ammonia 35,79 mg/L; nitrate 0,052 mg/L, orthophosphate 1,61 mg/L	(32)
Kademangan, Tangerang Selatan	BOD 121-151 mg/L; TSS 121-127 mg/L; COD 79-700 mg/L; oil and fats 6-95 mg/L	(35)

Generally, domestic wastewater is classified as low strength nitrogen content. However, the exceeded ammonia concentration potentially raises the eutrophication rate. Barber and Stuckey (38) stated that 60% of nitrogen contained in the wastewater is ammonia and the rest of organic nitrogen for the 40%. Eutrophication causes rapid growth of algae and risk of oxygen depletion in the water. Competition between aquatic lives in using dissolved oxygen will be getting up. The concentration of dissolved oxygen less than 2 mg/L will cause mortality for aquatic life (39). Based on the previous study, amount of 1-2 mg/L of total nitrogen and 0.03-0.1 mg/L of total phosphorus will cause eutrophication (40).

Phosphorus appears in wastewater as orthophosphate, polyphosphate and organically bound phosphorus. The last two components counted usually for up to 70% of the influent phosphorus. Microbes utilize phosphorus during cell synthesis and energy transport (37). Phosphorus was investigated in the present study as orthophosphate. This phosphate has dissolved the water as dominant phosphorus substance in anaerobic condition. In the present study, orthophosphate in the inlet and outlet from Sukolilo is 1,08 and 0,25 mg/L, respectively. The different result showed from Genteng area which is the outlet concentration is higher than in the inlet. It indicates that there was another phosphorus source which contributes to the higher phosphorus, such as detergent. Surfactants are the major ingredients of detergent which are commonly used in laundering activity. The presence of surfactants that belongs to synthetic compounds in natural water body leads an aesthetic loss caused by foam. Surfactants may be toxic to the organism in soil or water (4). A study from Braga and Varesche (4) showed that LAS concentration in specific laundry wastewater is 163.65 mg/L. LAS concentration contributes to the presence of phosphorus. Detergent is also the source of phosphorus due to the presence of phosphorus-five in detergents (7).

4. CHALLENGES IN WASTEWATER TREATMENT: THE RISK OF NITROGEN FOR THE WATER

Municipal activities, agriculture, and rapid urbanization led to increased nitrogen and phosphorus discharge to the water system. More often, the effluents from municipal wastewater treatment plant failed to meet the national standard for effluent quality (36). Excess nutrients, mostly N and P is the main cause of eutrophication which results in oxygen depletion, biodiversity reduction, fish kills, odor, and increased toxicity (33). Nitrogen contribution to wastewater generated from food waste, fruits, vegetables, oil, and leaves food scrap. The toilet is the repository for a large proportion of nitrogen which is contained in the domestic wastewater stream. Excreted nitrogen is a waste product from protein metabolism, which is produced from digestion proses (feces) and kidney excreted (urine). A mineralizing system occurs in the septic tank and converting protein into ammonium. The anaerobic condition makes ammonia production more favored over nitrite. Wastewater from laundry is also potentially a source of nitrogen (41).

Biological nutrient removal technologies are preferred and widely used to remove nitrogen and phosphorus from domestic wastewater and protect water quality (42). Chemical compositions in the domestic wastewater are highly diverse substances from simple compounds to complex polymers. Types and amount of substances show the characteristic of domestic wastewater. Characterization of the overall substances is important to expand the knowledge in selecting appropriate wastewater treatment processes or models (22,23). Determination of characteristic of domestic wastewater is very important in order to evaluate the existing treatment plants and selection of appropriate treatment plant. Besides that, it also necessary to determine the utilization of treated or untreated wastewater based on their contents (23). The quality of treated wastewater is important for evaluating WWTP performance and subsequent impacts or risks on human health, surrounding environment and design of advanced wastewater treatment and/or reclamation processes. Wastewater characteristic is related to water quality standard that is aimed to protect the designated use of water body (25).

Biological nitrogen removal has been widely used as a promising technology in removing nitrogen from wastewater. Conventional technology still retains the basic principle of complete nitrogen cycle through nitrification and denitrification (42). Anammox is a sustainable and cost-effective alternative to the basic method of nitrogen removal. Anammox has been identified as a new biotechnology for nitrogen reduction from wastewater. It has advantages of reducing greenhouse gas emission, low carbon consumption, the low energy needed and high performance (43). This process has been developed in many countries in treating wastewater with high nitrogen content, such as China, Netherland, USA, Japan, etc. (44–49). In this paper, some domestic wastewater around Surabaya City, Indonesia have been measured for nutrient content including nitrogen and phosphorus. Based on the results, anammox will be promoted as alternative bioprocess to be applied in Indonesia.

A complete nitrogen removal is when reactive nitrogen is stored or converted back to N_2 gas through denitrification. This process also has an intermediate product, such as nitrous oxide which contributes to the greenhouse effect and ozone depletion. This process has been challenged by discovering anaerobic ammonium oxidation (anammox). Anammox is mediated by autotrophic bacteria capable of oxidizing ammonia directly to nitrogen gas without emission of nitrous oxide (N_2O) (49). Since the first invention of anammox in a fluidized bed reactor in 1995, it has been widely investigated and frequently reported.

Anammox process was developed at the Delft University of Technology in the 1990s become a new novel and low-cost approach to removing nitrogen from wastewater (50). Compared to the common process of nitrogen removal, anammox can reduce 64% of aeration, 100% of an exogenous electron donor, and sludge production by 80-90% (51–53). Some benefits from anammox include high nitrogen removal rate, lower operational cost, and small space requirements. This process was successfully applied to treat ammonium-rich wastewater, leachate, digested sludge, and monosodium glutamate wastewater

Anammox bacteria will oxidize ammonium by using nitrate as an electron acceptor. The nitrite is obtained from nitrification which is conducted by nitrifiers in aerobic condition. In other words, the nitrogen in wastewater can be removed by combining nitrification and anammox. Another study stated that anammox also could coexist with denitrifier bacteria in a simultaneous process. Anammox bacteria dominantly existed in low carbon condition meanwhile the high carbon was favored by denitrifier (54). Presence of ammonium and nitrite become the substrates of anammox bacteria. Anammox has an important role in nitrogen gas production for anoxic water environment (55). Key factors that effecting anammox process in reducing nitrogen include substrate concentration, temperature, dissolved oxygen, organic matter and sludge retention time (42). Previous research has been done to improve anammox process through the additional substrate, intermittent aeration, and the certain pH and temperature. Research from Crowe et al., (2012) showed the using of sludge from Lower St. Lawrence increasing the dinitrogen gas production up to 33%. The mixing of sludge from wastewater treatment and anammox reactor that is conducted by Sanchez Guillen and collègues (48) has shortened the acclimatization period within 45 days. Recently research by Wang (57) showed the increase of acclimatization period up to 28 days with the mixing of denitrification sludge and anammox biomass.

Limitation of anammox process is its long start-up period due to the low of bacteria growth rate (52). In a nitrification, there are two main bacterias involved, ammonium oxidizing bacteria (AOB) with nitrite oxidizing bacteria (NOB). They need the amount of oxygen to oxidize ammonium or nitrite. NOB become the inhibitor of anammox process since there will be a competition between NOB and anammox in using nitrite (49,58,59). Maintenance of dissolved oxygen (DO) is a way to inhibit the activity of NOB. Miao et al., (2016) reported the using of intermittent aeration with combination 7 minutes aerobic (DO 0.5±0.08 mg/L) and 21 minutes anoxic has increased the total nitrogen (TN) removal up to 70%. Hou (60) has used intermittent aeration in a constructed wetland to improve the nitrogen removal. The result showed that ammonium removal up to 94.6% and TN up to 82.6% with 20 minutes aeration and 100 without aeration.

Since the nitrogen concentration in the sample has exceeded the threshold, it needs improvement on the wastewater treatment. Anaerobic baffled reactor (ABR) in Indonesia has been used commonly as communal wastewater treatment. Nitrogen removal resulted from the ABR still very low. Promoting anammox process in ABR potentially become an improvement for ABR in removing nitrogen better. This combination process still outlined for further research

5. CONCLUSION

Currently, the government of Indonesia is in the process of improving the domestic wastewater treatment services in order to achieve Government Development Plan target in 2019. The use of ABR becomes the solution of cost and limited space problem in the urban area, especially with a high density of population. Besides, quality of treated water has also be considered as it will be discharged to the water body (river, lake, sea). Low nitrogen removal is a current issue for the ABR in treating domestic wastewater. The ability of ABR in removing nitrogen have to be improved so the threshold of nitrogen (ammonia) from the government rule can be achieved. Eutrophication as one of the problems caused by nitrogen still becomes water problem in Indonesia. Anammox is one of sustainable and effective nitrogen removal technique. This technique can be combined with ABR in the future to get a better quality of treated water, so it can be safely discharged to the water.

6. ACKNOWLEDGEMENT

We are grateful for the Ministry of Research, Technology and Higher Education of Indonesia for the research funding in the scheme of PMDSU program.

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