Developing of Performance Testing Scheme for Decentralized Domestic Wastewater Treatment Plant in Indonesia

Sri Darwati^{*}, Elis Hastuti

Research Institute for Human Settlements and Housing, Ministry of Public Works and Housing Jl. Panyaungan Cileunyi Wetan Kabupaten Bandung 40393, Indonesia, Tel. +62-227798393, Fax. +62-227798392 *Email: sridarwati924@gmail.com

Abstract. Most of the urban and rural areas in Indonesia still use individual scale of decentralized on-site domestic wastewater treatment such as pit latrines and septic tank. For some building and small community using communal scale of wastewater treatment plant such as fabricated biofilter tank, UASB (up-flow anaerobic sludge blanket), Rotating Biological Contactor (RBC) and wetland. Many application of the decentralized Wastewater Treatment Plants (WWTP) have low performance and the effluent does not meet standard effluent. To ensure the compliance to the regulation, it is necessary to develop the performance testing scheme for decentralized domestic wastewater treatment plant. The objective of the study is to review performance testing scheme in Indonesia, include the legal aspects, existing performance testing procedure for inspection and certification. The target is to develop performance testing schemes consists of testing standard and institutions scheme. The methodology of research are primary and secondary data collection done through field observation and discussion in stakeholder meeting with stakeholder related. The data analysis of this study are comparative study of certification system of decentralized WWTP in Japan, Thailand and Indonesia, descriptive analysis of performance testing method and the role of stakeholders. In conclusion Indonesia has not have regulation regarding certification schemes for decentralized WWTP. The certification schemes is needed to guarantee the WWTP product compliance with the performance testing standard, competent testing body, equipment and human resources.

Keywords: Decentralized, Performance, Plant wastewater, Scheme, Testing, Treatment

INTRODUCTION

Indonesia access to the sanitation reached 60,91%, consist of 77,15% in urban area and 44,74% in rural area. Approximately 74,15% of the urban population live in *unsewered* area (Ministry of Public Works, Directorate of Human Settlements, 2013). The impact of bad system of treatment and disposal had polluted 76,2% of river in Java, Sumatera, Bali and Sulawesi Islands. Most of river that flow through the city, about 34,48% of 29 big and metropolitan cities have been extremely altered and polluted more than 10 mg/L of BOD and 20 mg/L of COD (Ministry of Environment, 2006).

Decentralized domestic wastewater systems convey, treat and dispose or reuse domestic wastewater from small communities, buildings and dwellings in. Most of the urban and rural areas in Indonesia, still use decentralized on-site system such as pit latrines or anaerobic underground concrete box, mostly without absorption field for the treatment of effluent from the tank, continue to dispose into water body. In some areas had applied biological process such as biofilter, Up-Flow Anaerobic Sludge Blanket (UASB), Rotating Biological Contactor (RBC) or wetland.

The biological processes with attached growth system for wastewater treatment can adapt with local condition, such as structured media growth system (submerged or mobile biofilter), Rotating Biological Contactor (RBC) or semi-aquatic plant system (constructed wetland) (Metcalf and Eddy, 2007). The principal advantages of biological technologies for the removal of pollutants, including biological processes can be carried out in situ at the contaminated site, bioprocess technologies are usually no secondary pollution, and they are cost-effective (Vijayaraghavan,, 2013). The communal wastewater system applied the treatment train of plug flow system/anaerobic baffled reactor (ABR), submerged media growth system and rotating biological contactor (RBC) system has low area requirement and has to concern optimization energy. The communal system applied the treatment train of hybrid up-flow anaerobic sludge blanketsubmerged media growth system and hybrid subsurface of constructed wetland has low-cost operation and maintenance and depend on community participation (Darwati & Hastuti, 2017).

The sewers of cities are intended primarily to carry domestic wastewater, mainly for housing with supported by water supply system from PDAM (Municipality Water Works). There are 13 cities have sewerage system (conventional sewerage and shallow sewerage), the treatment process applied are pond system, UASB, and RBC.

The challenge of wastewater treatment is increasing as still high degradation of water sources and low coverage of sewerage system in Indonesia. Many applications of the decentralized WWTP (Waste Water Treatment Plant) are potential not be sustainable because of inadequate wastewater treatment, risk to human health and environment due to short lifetime of treatment tank, improper installation, or no meet effluent standard, specification of material such as Fiber Reinforced Plastics (FRP) have not meet the standard. To ensure the compliance to the regulation, it is necessary to develop the performance testing scheme for decentralized domestic wastewater. The objective of the study is to review performance testing scheme in Indonesia, include the legal aspects, existing performance testing procedure for inspection and certification. The target is to develop performance testing schemes consists of standard and institutions role.

MATERIALS AND METHODS

The primary data collection done through field observation of testing method performance in Japan and Thailand, discussion meeting with stakeholders related (Inspection body Research Institute for Human Settlements and Housing (RIHS) Ministry of Public Works and Housing, Ministry of Environment and Forestry, Local Government City Planning Agency, and Environmental Agency) and NIES (National Institute for Environmental Studies) Japan, Drinking Water and Waste Water Service Company (PDAM), ITB, Manufactures of Decentralized WWTP. The secondary data from literature review of regulation of WWTP management in Indonesia. The data analysis of this study are:

- Comparative study of certification system of decentralized WWTP in Japan and Indonesia.
- Descriptive analysis of performance testing method in Indonesia for decentralized WWTP by Inspection Body WWTP RIHS.
- Descriptive analysis from some workshops of role of institutions related to wastewater performance.
- Comparison from standard testing for wastewater treatment plant.

RESULTS AND DISCUSSION

Comparison Study of Testing Performance Scheme Between Japan and Indonesia

Comparative study of testing performance schemes for decentralized wastewater treatment plant has been conducted in Japan in January 2016. The comparison testing performance can be described in table 1 below.

Table 1. Comparison study of testing performance scheme between Japan and Indonesia.

| Stage of WWTP Implementation | Japan | Indonesia |
|---|---|---|
| Testing performance before production | is done by BCJ (Building Center of Japan) Minister Land Infrastructure and Transport | Still do not have any Certification body |
| Inspection of performance after installation Operational and maintenance | Local Government as inspection body, regular monitoring Usually the users' contract for operational maintenance with third party/manufacturer | Still do not have any inspection body for domestic wastewater treatment By owner (private, household, community- based management) |
| Legal aspect | Compulsory <i>jouhkaso</i> certified by Minister Land Infrastructure and Transport | Not compulsory, however, some Local Government give requirement for WWTP manufacturer have to be certified by Puskim (RIHS) Inspection Body, Ministry of Public Works and Housing |
| Performance test before production of WWTP (time, capacity, raw water, lab testing) | WWTP performance testing conducted in laboratories min. for 16 weeks and in the field for 48 weeks by BCJ (Building Center of Japan) Capacity variation of testing : 100%, 150% and 50% raw water for testing comes from the city WWTP with a system of reservoirs, capacity arrangements testing, laboratory testing of biological and chemical parameters testing Testing of leakage and structure | Not yet, There is no performance test standard for WWTP before it is produced |
| Performance testing post-production | Regular inspection by Local Government, each 6 months | No regular inspection and monitoring from Local Government For purpose of PU Inspection method : WWTP performance testing conducted assessment of document, design of WWTP, testing of design, performance, capacity, OM, testing of WWTP implementation in the field and testing the process at laboratory Laboratory analysis quality of inlet, at some compartment of process stage and outlet, 3 sampling test, 3 daysTesting material FRP (tensile strength, compressive strength flavural strength |

Performance Testing Method by Inspection Body RIHS

Legal Aspect WTP/WWTP Inspection Body for performance testing of water treatment package plant and wastewater treatment package plant are :

- Instruction of Human Settlement Directorate, No.Ku.03.03-DC/214, 21st February 1992: Research Institute for Human Settlements (RIHS)/Puskim is assigned for the WTP and WWTP certification.
- Instruction of Ministry of Kimpraswil (Public Works) No. 09/SPRINT/M/2003: project quality reliability test is assigned to RD Agency of Ministry of Kimpraswil (Public Works).
- Instruction of Ministry of Public Works No. 02/IN/M/2005: standard, guideline, and manual implementation in the project contract documents.
- 4) Accreditation certificate from national committee accreditation (KAN) for Puskim:
- 5) Testing laboratory of environment, No. LP-229-IDN, conforming to the SNI ISO/IEC 17025:2008 requirement.
- 6) Degree of KAN No. LI-035-IDN, inspection body has valid date 18th April 2013 17th April 2017.
- 7) SNI ISO/IEC 17020:2012, general requirements of inspection bodies operation.
- 8) PP No 38 Tahun 2012: tariff of non-tax revenue in the ministry of public works

The purpose of fabricated domestic WWTP certification

- 1) To achieve protection of public health and environment.
- 2) To guarantee the fabrication WWTP application by Ministry of PUPERA or local government meet technical requirements.
- 3) Perfomance of process units of WWTP meet effluent standard according to national, PUPERA or local standard.
- 4) To ensure that the SOP of the WWTP system is applied correctly by the owners or community.
- 5) As an important consideration of selection the manufacture for WWTP project in Ministry of PUPERA.
- 6) Implementation of standard, guideline, and manual in the Ministry of PUPERA project.

Requirements of Company at WWTP certification

- 1) Company which had applied WWTP in field scale
- 2) Experienced company in fabricated WWTP product
- 3) Capacity of WWTP is 1- 500 household
- 4) Company comply with the required inspection document
- 5) WWTP application has management by community, building operator, or company.
- 6) Company can provide inspection budget according to PP no.38/2012

Types of fabricated WWTP

- 1) WWTP manufacturing is generally made to individual or communal scale. Wastewater treatment technologies process can be classified on the trickling filter, biofilter, Rotating Biological Contactor (RBC) and the combination of attached and suspended growth.
- In its application, the WWTP system consists of: Pretreatment includes initial deposition, screen, and fat trapped

The main processing:

- Unit anaerobic treatment: Anaerobic Baffle Reactor (ABR), anaerobic biofilter, biogas tank.
- Aerobic treatment unit: Rotating Biological Contactor (RBC), trickling filter, biofilter aerobic activated, sludge, membrane bioreactor (MBR)
- 3) Further Processing

Further processing for denitrification, final sedimentation, shelter, and disinfection. WWTP supporting component consists of a manhole, screen, communicator, fat catcher unit, the air blower (if using aeration system).

Standard related inspection off WWTP are:

- 1) SNI 03-2398-2002, The procedure for septic tanks with leach system.
- 2) SNI 19-6447-2000, Performance testing methods of activated sludge system.
- 3) Pd T-04-2005-C, Procedure for the planning and installation of biofilter system for domestic wastewater treatment.
- 4) Pd T-02-2004-C, Operation and maintenance of biofilter system for domestic wastewater treatment
- 5) SNI 7504:2011, Specification of Fiberglass reinforced plastic material for water treatment plant.
- 6) Regulation of Ministry of Environment No. 68 year 2016 Domestic wastewater quality standard.
- 7) Regional regulations of wastewater quality standard.
- 8) Regulations and other relevant references related to materials, pipes, water testing laboratory, and criteria design of WWTP..

Requirements of WWTP Sampling Site are :

- 1) Wastewater source: domestic wastewater
- 2) Number of sampling location: min. 1
- 3) Capacity of communal WWTP: max. 500 households
- 4) Capacity of treatment in sampling site has been in the range of proposed capacity WWTP
- 5) WWTP can treat wastewater properly and well operated
- 6) Treatment process in the stable stage (after seeding or acclimatization process)
- 7) Less site disturbance
- 8) Availability of appropriate WWTP manager

The procedure of inspection can be seen at figure 1 below:



Figure 1. Flowchart of WWTP inspection process.

Institution's Role Regarding Wastewater Management

Based on institution survey, there is some institution role regarding the wastewater management that can be described in table 2.

| T | able | 2. | Institution | 's role | regarding | waste | water | management | in | Indonesia. |
|---|------|----|-------------|---------|-----------|-------|-------|------------|----|------------|
| | | | | | | | | 6 | | |

| No | Institutions | Level | Role | Descriptions |
|----|--|---|-----------------------|---|
| 1 | Ministry of Public Works and Housing | Central government | Policy | Technical Policy, Standard, Guideline, Manual sanitation infrastructure |
| 2 | Ministry Environment and Forestry KLHK | Central government | Policy | Policy for environmental quality, monitoring, evaluation |
| 4 | RIHS (Research Institute for Human Settlement and Housing) | Central government | Inspection Body | R and D, Inspection, Laboratory, Technical Adviser |
| 5 | Local Government | Province City/ Regency | Executor, operator | regional/cross-regional/city/regency Governors and Mayors can establish WWTP in the form of regional companies to handle domestic wastewater management. |
| 6 | Environmental services | City/regency | Executor, operator | Environmental permit for wastewater management and monitoring evaluation |
| 7 | Housing and Settlement Area Service | City/regency | Executor, operator | Organizers of residential environmental wastewater management infrastructure |
| 8 | Spatial Planning Office | City/regency | Executor, operator | Spatial/Building permit |
| 9 | Conformity Assessment Institute | Technical Service Unit under the ministry/Private | Executor, operator | Certification and testing institutions (but currently not yet have service for WWTP |
| 10 | Regional Waste Water Company/Regional Company | Regional company under Province/City/Reg ency | Executor, operator | Centralized domestic wastewater management company/sludge management |
| 11 | Investment Services and One Stop Services | City/Regency | | For permission to discharge waste into the river, |
| 12 | Manufacture | Private company | Service provider | Contractor |

Some Testing Standard for Wastewater Treatment Plant

The testing method in Indonesia is set by RIHS, compared with the draft standard from AIT Borda and other standards En, NSF/ANSI that can be seen in table 3.

 Table 3. Comparison of testing method of wastewater treatment plant.

| No | Item | En 12566-3 (2005) | NSF/ANSI 40 (2013) | Draft Standard AIT Borda | Inspection Body RIHS | |
|----|-----------------------------------|---|---|--|---|--|
| | | | | | Eksisting inspection | Draft SNI |
| 1 | Scope | For packaged and/or he assembled domestic waste water treatment plants used for population up to 50 inhabitants | For residential wastewater treatment systems having capacities 1,514- 5,678L/day (400-1,500 gal/day) | Up 6,000 L/da (6m3/day) | For packaged and/or he assembled domestic waste water treatment plants used for population up to 500 inhabitants | Package WWTP UP 500 inhabitans |
| 2 | Materials | Concrete, steel, PVC-U, Polyethylene (PE), Polypropylene (PP) and Glass Reinforced Polyester (GRP-UP) | Material shall be durable and capable and wear during shipping, assembly, installation and operation) | Concrete, steel, PVC-U, Polyethylene (PE), Polypropylene (PP) and Glass Reinforced Polyester (GRP-UP) | FRP, PP, stainless steel | FRP, PE |
| 3 | Monitoring parameters | BOD, TSS, Temperature, Power consumptions, daily hydraulic flow | pH, SS, BOD, COD (regular monitor), color, odor, oily film and foam (3 sampler over testing period | pH, BOD, TSS, Power consumptions, daily hydraulic flow (compulsory), TDS,TKN, TP (optional) | pH, BOD, COD, TSS,Tempera ture, oil and grease | pH, BOD, COD, TSS, oil and grease ammonia, detergent, total coly (Reg Min Environment and Forestry no 68 year 2016 |
| 4 | Influent characteristic s | BOD 150-500 mg/L (or COD 300-1000 mg/L), TSS 200-700 mg/L, TKN 25-100 mg/L (for NH3-N < 22-80 mg/L, TP = 5-20 mg/L | BOD 100-300 mg/L BOD =150-500 mg/L mg/L), TSS 100-350 TSS =200-700 mg/L mg/L, Alkalinity >175 TSS =200-700 mg/L mg/L as CaCO3(note values are averaged for 30 days) BOD =150-500 mg/L | | Existing quality of inlet | BOD 150-350 mg/L COD 180-550 mg/L), TSS 145- 175 mg/L, oil grease 20-30 mg/L, NH3 27-52 mg/L, T-N 40-50 mg/L, T- P 3-7 mg/L |
| 5 | Hydraulic daily flow | Based on volume of the daily hydraulic capacity of the system | Based on volume of the daily hydraulic capacity of the system | Based on volume of the daily hydraulic capacity of the system | Existing condition of service scope | Based on volume of the daily hydraulic capacity of the system |
| 6 | Flow pattern | Time of day % of daily patten 06.00-09.00 30 09.00-12.00 15 12.00-16.00 0 16.00-20.00 40 20.00-23.00 15 23.00-06.00 0 | Time of day % of daily pattern 06.00-09.00 35 11.00-14.00 25 17.00-20.00 40 | Time of day % of daily pattern 06.00-09.00 30 09.00-12.00 15 12.00-18.00 8 18.00-20.00 40 20.00-23.00 15 23.00-06.00 0 | | Still in research |
| 7 | Tested period | Consecutive 38 plus X weeks | Consecutive 28 weeks | Consecutive 16 plus X weeks Normal load 6 weeks Overload 2weeks Normal loads 6 weeks Underload2 weeks Normal load 2 weeks No load 2 weeks | 3 times in 3 days, 1 sample/day | 20 weeks Seeding 10 weeksNormal loads .8 weeks Overload 1 week Under load 1 week |
| 8 | Number of sample data | 26 data | 96 data | 32 data (twice a week) | 3x2 data (inlet and outlet) | |
| 9 | Method of sample collection | 24 hours composite sampling | 24 hours composite sampling | 24 hours composite sampling | Composite 3 times a day (morning, at noon, afternoon) | Composite |

Developing Wastewater Management Scheme

Based on existing institution's role, comparison with performance testing of WWTP in Japan and the discussion from the stakeholders meeting discussion, the role of wastewater management can be divided by step of planning, construction and operational and maintenance. It is proposed that testing is a step in planning, Testing Performance of WWTP by Testing Body. The building permit or environmental permission will be given after considering the certificate given by testing body.

Table 4. Developing wastewater management scheme.

| Existing institutions for supervision of wastewater management | | | | | |
|--|--|---|--|--|--|
| Planning | Construction | Operational maintenance | | | |
| Licensing by Investment Services and One Stop Services based on technical assessment from Environmental services recommendations | Supervision of construction by the Public Works Service by Field supervisor | For permission to discharge waste into the river | | | |
| Environmental permit for wastewater management from Environmental Service | | Supervision of effluent quality of WWTP-from Environmental Service, now still focus on industrial wastewater have not covered domestic wastewater Manufacturer propose to Inspection Body for testing performance sample product that has implemented in the field- manufacture get | | | |
| Developing the institution scheme | | | | | |
| Testing performance of WWTP by Testing Body Testing that meets the requirements will be given a certificate Testing Body can be Inspection Body/other institution such as Waste water company Certificate valid for 4 years | Construction supervision (construction permit with WWTP certificate) by the Public works service/Environment service through field supervisor | For permission to discharge waste into the river, (capacity of discharge and effluent quality | | | |
| Building permit or environmental permission will be given after considering the certificate given by Testing Body | | Effluent quality supervision/inspection of WWTP by Environmental Services not only industrial waste but also domestic waste at certain frequencies | | | |
| | | Maintenance by the WWTP manager or can work with private service providers | | | |
| | | Manufacturer propose to Inspection Body for testing performance sample product that has implemented in the field- manufacture get certificate of performance Certificate valid for 4 years | | | |

Discussion

RIHS has done some inspection for post-installation of WWTP based on company application. The inspection consists of assessment the document, material and performance testing the sample of wastewater treatment plant that has been installed and operated. Indonesia hasn't have regulation regarding certification schemes for decentralized WWTP. From some stakeholders meeting recommended that the certification schemes is needed to guarantee the WWTP product compliance with the performance standard and effluent standard. It can give significant contribution to reducing water pollution since the main pollution comes from domestic wastewater. It is proposed that testing is a step in planning, Testing Performance of WWTP by Testing Body. The building permit or environmental permission will be given after considering the certificate given by testing body. Developing decentralized WWTP need the regulation regarding testing body, the provision of performance testing standard, independent and competent testing body, equipment and human resources supported by regulation.

CONCLUSIONS

Indonesia has not have regulation regarding certification schemes for decentralized WWTP. The certification schemes is needed to guarantee the WWTP product compliance with the performance standard and effluent standard. The developing decentralized WWTP need the regulation regarding testing body, the provision of performance testing standard, competent testing body, equipment and human resources.

ACKNOWLEDGMENTS

This paper would not have been possible without the essential and gracious support of many individuals. The personal support and interest of Prof (R) Dr. Ir. Arief Sabaruddin, CES Director-of Research Institute For Human Settlements, Ministry of Public Works and Housing. Thank you very much to The Human Resources Division of Research Institute For Human Settlements, Ministry of Public Works and Housing for its generous provision of funds also special thank to my husband and family who give me support to finalize this paper.

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