

## Effectiveness of Infiltration Type of Household Waste in Urban Land Against Pollution

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**Key words:** Infiltration, BOD, TSS, ammonia and MPN coliform, qualifying

**Abstract:** According to microbiological pollution pattern, distance between infiltration against clean water source is at least 10 m in order to prevent water or soil pollution. Qualifying distance requirements according to pollution pattern is contrary with land ownership in urban areas which on average; urban people have narrow land. This research aims to analyse the effectiveness of infiltration in tripikon type and spiral type based on the decrease of BOD level, TSS level, Ammonia and Coliform level. This research was an experimental research by using one group pre and post-test design. The sample in this research was household liquid waste and measured the decrease of BOD level, TSS level, Ammonia level and Coliform level as an indication of pollution minimization. The result, infiltration in spiral type was more effective in reducing BOD, TSS, Ammonia and MPN Coliform parameters rather than infiltration in tripikon type. When it was compared to septic tank outlets, the infiltration in either tripikon type or spiral type could reduce the level of BOD, TSS and MPN Coliform but could not reduce ammonia parameters. This was occurred because system that was occurred in infiltration was anaerobic, thus, the ammonia levels increased after being through the infiltration.

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## INTRODUCTION

The development of property world that emphasizes minimalist concept for small families in urban areas makes developers build house or housings with limited land. This supports people with lower middle income to compete in fulfilling basic needs in urban areas. In fulfilling these basic human needs, besides it is adjusted to the income, it is also necessary to be considered in fulfilling health requirements. According to Regulation of Minister of Public Works Indonesia concerning National Policy and Strategy for the Development of Wastewater Management Systems in Settlements, one of the requirements of home health is the house has healthy

latrine criteria. Healthy latrines have provisions that do not cause odor, it fulfills the aesthetics and health requirements and the feces that is processed does not pollute the environment.

Latrine is a household waste treatment building that is consisted of septic tanks and infiltration tanks. Construction of latrines must qualify so that it does not pollute the environment around the latrines. If these requirements are not fulfilled, the pollution can be occurred, especially, against groundwater. In order to make the pollution can be prevented, it is necessary to calculate the distance between septic tank infiltration and clean water source that is at least 10 m according to microbiological pollution patterns<sup>[1]</sup>. Logically, it is

required a large area, so that, the distance between clean water source and infiltration is in accordance with the pollution pattern. Qualifying the distance based on the pollution pattern is contrary to land ownership in urban areas which on average, the urban people have narrow land. The use of latrines on narrow land like in urban areas needs to consider the size of the land, the cost that is incurred for constructing latrines as well as the effectiveness of infiltration types in reducing pollution.

New innovation of fecal wastewater infiltration from septic showed that minimizing the size of infiltration area to be 2.5 m<sup>2</sup> with spiral method can reduce *E. coli* level like horizontal distance in 10 m of infiltration trenches from groundwater sources<sup>[2]</sup>. Likewise, the tripikon model which showed that tripikon model could reduce BOD level until 36.8% by using silica sand infiltration with size of infiltration land in 3 m<sup>2</sup><sup>[3]</sup>. Through these two types of researches, making an idea of infiltration form that is more effective in reducing chemical and microbiological parameters of household wastewater can reduce land use as infiltration in urban area.

Biological Oxygen Demand (BOD), Total Suspended Solid (TSS) and Ammonia are important chemical parameters that need to be measured in order to determine the occurrence of pollution around infiltration area. Whereas, MPN Coliform is a microbiological parameter which is also important in order to know the pollution from bacteria. According to Regulation of Minister of environment and forestry of the Republic of Indonesia concerning Quality Standard of Domestic Liquid Waste states that maximum level of BOD, TSS, Ammonia and MPN Coliform are 30, 30, 10, 10 and 3000 amount 100 mL<sup>-1</sup>. Furthermore, the purpose of this research was in order to compare the effectiveness between spiral design and tripikon design as household wastewater infiltration in urban area through the measurement of BOD, TSS, ammonia and MPN Coliform parameters.

**Simple summary:** About 10 m in order to prevent water or soil pollution, its according to microbiological pollution pattern. In urban area, this pattern contra with land ownership which on average have narrow land. This research explain effectiveness of infiltration in tripikon type and spiral type based on the decrease of BOD level, TSS level, Ammonia and Coliform level in narrow urban area.

## MATERIALS AND METHODS

This research was experimental research with one group pre and posttest design because the researchers wanted to investigate the decrease of BOD level, TSS level, Ammonia level and MPN Coliform level in the infiltration of tripikon and spiral modification design for household wastewater in urban land. Examining BOD

level, TSS level, Ammonia level and MPN Coliform level in tripikon and spiral modification infiltration outlet were by using statistical methods which were Annova and it was presented in chart or table form.

## RESULTS AND DISCUSSION

**BOD:** The decrease of BOD in spiral type of infiltration was higher than tripikon type of infiltration that contained sand in diameter of either 3 mesh or 5 mesh. This was occurred because the spiral type of infiltration at the end of the inlet directly related to free air. Due to this factor, BOD could decrease more than closed tripikon type of infiltration without directly bordering with the free air.

If it was compared with Regulation of Minister of Environment and Forestry, the liquid waste from infiltration still was not in accordance with the required quality standards (Fig. 1 and 2).

**TSS:** In this research, TSS content also decreased significantly from septic tank outlets into infiltration outlets. Spiral type of infiltration was higher in its decrease level rather than the other types of infiltration. Just like BOD parameter, additional air was as an oxygen supply for microorganisms to smash organic material that was contained in waste, so the TSS content could decrease. Moreover, filtration process that used sand as its filtration material was as an active sedimentation material, which was effective in changing the color of turbid waste to become clearer one.

If it was compared with the Regulation of Minister of Environment and Forestry, TSS had been in accordance with the government regulations which was 30 mg L<sup>-1</sup>. However, there was still instability of TSS value that was obtained, thus, further treatment required to be given, so that, TSS value that was obtained remained 30 mg L<sup>-1</sup>.

**Ammonia:** Purpose of using infiltration as a filtration model in household waste for reducing ammonia content was in order to pass the waste on a material that had been grown by biofilm, so that, the ammonia in waste could be decomposed by microorganisms that grew on biofilms. According to the result of this research, ammonia levels in liquid waste could drop significantly because of being through the process of smashing material by microorganisms in infiltration.

**MPN coliform:** MPN Coliform parameter was one of the most important parameter which were used as indicators of pollution of pathogenic bacteria in water. According to the result of this research, MPN Coliform content decreased from the inlet into the infiltration outlet. Although, it was not yet in accordance with the Regulation of Minister of Environment and Forestry, either tripikon type or spiral type of infiltration could significantly reduce MPN Coliform content.

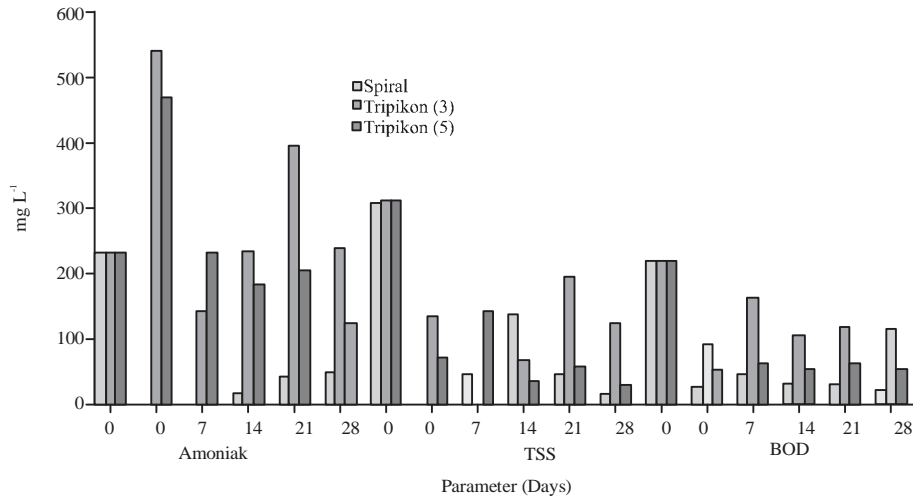


Fig. 1: Comparison between the content of ammonia, TSS and BOD in household liquid waste in Tripikon type and spiral type of infiltration

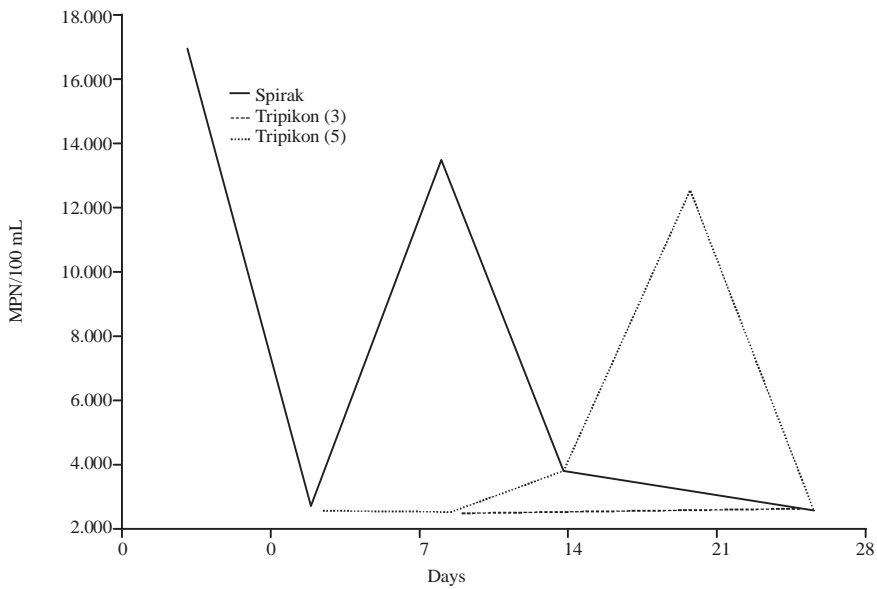


Fig. 2: Comparison between the content of MPN coliform of household liquid waste in Tripikon type and Spiral type of infiltration

**Effectiveness of septic tank infiltration:** Septic tank infiltration is effective in reducing the content of organic substances in household liquid waste. This is occurred because there is infiltration surface that becomes a biological film in order to attach which functions to decompose organic substances in waste biologically. According to the result of this research, infiltration in either tripikon model or spiral model could reduce the content of BOD, TSS, ammonia and MPN Coliform. This was occurred because of and filter that was able to become biological film method that attached and decomposed organic substances.

In accordance with the result of the analysis by using statistical tests, infiltration could reduce the content of organic substances in household liquid waste. Furthermore, infiltration in spiral model was more effective in reducing the content of organic substances and this was because the spiral model used aerobic method that contacted free air on the sand media of infiltration. The presence of air contact for the performance of microorganisms which were in spiral infiltration, could reduce the content of organic substance in household liquid waste.

Table 1: Analysis result of Anova test

Parameters	Sig.
BOD	0.001
TSS	0.007
Ammonia	0.015
MPN coliform	0.031

Although, result of this research was still not in accordance with the requirements of quality standards in Regulation of Minister of Environment and Forestry, there had been a significant decrease in BOD, TSS, ammonia and MPN Coliform. Furthermore, suggestion for further research is to use further treatment, so that, the quality standards of household liquid waste that is processed before being disposed into the environment can qualify as what is stipulated by the government in Indonesia (Table 1).

Biological process approach that uses oxygen and it is occurred in water is called as BOD. BOD number shows oxygen volume that is used by bacteria to degrade (oxidize) the dissolved organic substance and some organic substances which are suspended in water. BOD value is required in order to determine pollution load due to wastewater from either households or industries. The process of biodegradation by bacteria that is occurred in waste can be seen from the decrease BOD level that is measured. The smaller the BOD level indicates the smaller the amount of organic substance in waste because oxygen that is required is also less. Moreover, organic compounds will be converted into CO<sub>2</sub>, H<sub>2</sub>O, NH<sub>4</sub> and bacterial masses as an energy source. The smaller the decrease in BOD value in waste treatment process shows the smaller the degradation process that is occurred<sup>[4]</sup>.

However, sand filters which are the contents from infiltration in either tripikton model or spiral model, require time for allowing microorganisms to form biological films. During this time, microorganisms need sufficient oxygen, so that, BOD will increase. The formation of this biofilm layer is occurred until the sand that becomes the content for infiltration becomes black due to the heap of suspended solid<sup>[5]</sup>. This was in accordance with this research result that there was an increase of BOD level on the seventh day which interpreted an increase in oxygen use by microorganisms in decomposing organic substance.

Waste that is from septic tanks must have low BOD content, so that, it does not pollute clean water source around septic tank infiltration. Infiltration time in <3000 days for saturated zones as in this research which the infiltration was placed above the surface of the soil and it enabled to be occurred disposal of infiltration into the soil, the BOD levels must be below the threshold that was stipulated by the government<sup>[6]</sup>. In accordance with the result that was obtained, BOD level had decreased from septic tank outlets into infiltration outlets. The lowest BOD content was found in spiral type of infiltration. The decrease of BOD level on wastewater contained organic

compounds and bio filter caused the material was easily destroyed<sup>[7]</sup>. The use of tripikton with the filling of quartz sand filtration in 5-mesh diameter in infiltrating septic tank waste could reduce BOD content until 36.8%<sup>[8]</sup>.

The addition of air as an oxygen supply for microorganisms that was in spiral type of infiltration could reduce BOD level in spiral type of infiltration outlets. In reactor that contained grey water waste and Iris pseudoacorus plants which were given additional air supply could reduce BOD content in waste until 96%<sup>[9]</sup>.

Biofilm layer is very influential against the decrease of TSS content in liquid waste. As a media for attaching biofilms, silica sand also functions as a media for scraping waste that contains organic material. Thus, particle size that is contained in waste is degraded<sup>[7]</sup>. TSS decrease significantly from septic tank outlets into infiltration outlets. This was occurred because the dissolved solid in waste were blocked by sand which was used as a filtration material.

Ammonia levels in liquid waste could drop significantly because of being through the process of smashing material by microorganisms in infiltration. Filtration model was effective in reducing ammonia level for slaughterhouse waste<sup>[11]</sup>.

The Regulation of Minister of Environment and Forestry explained that maximum content of ammonia in household liquid waste was 10 mg L<sup>-1</sup><sup>[12]</sup>. If the result of this research was compared, it still did not qualify as what had been stipulated. The bioreactor that was used was closed (anaerobic), thus, there was a decrease in oxygen content (O<sub>2</sub>), then, a denitrification process was suspected in which nitrogen nitrate and nitrite were reduced to be nitrogen gas under anaerobic conditions. A relatively high pH condition would dissolve nitrogen and then, it would be emitted as ammonia (NH<sub>3</sub>)<sup>[13]</sup>. Nitrite concentration in surface water was very low (mg/L) but high concentration was found in waste and swamps where anaerobic conditions were often encountered<sup>[12]</sup>.

Possible reason of high content in MPN Coliform was because collecting sampling was conducted at the time of the increase of water discharge which the activities of water use such as bathing, washing and defecating were almost all done in the morning. Thus, the residual wastewater during the treatment process was suspected to cause inefficient treatment process<sup>[14]</sup>. Besides, disinfection treatment, which had not been done, was one of the causes for high content of MPN Coliform at infiltration outlet. Therefore, for further research, it is necessary to conduct chlorination treatment of household wastewater after being through infiltration and before being disposed into the environment.

In accordance with the result of the analysis by using statistical tests, infiltration could reduce the content of organic substances in household liquid waste. This was in line with the statement that the broader the area of infiltration filter contact, the greater the efficiency in the

decrease of concentration of organic substance<sup>[17]</sup>. Furthermore, infiltration in spiral model was more effective in reducing the content of organic substances and this was because the spiral model used aerobic method that contacted free air on the sand media of infiltration. The presence of air contact for the performance of microorganisms which were in spiral infiltration could reduce the content of organic substance in household liquid waste. The statement was in accordance with conducted research which showed that treatment of household wastes from washing that was provided with additional oxygen contact could reduce 96% of BOD content in waste<sup>[9]</sup>.

### CONCLUSION

Spiral design in infiltration was more effective in reducing BOD, TSS, ammonia and MPN Coliform parameters rather than tripikon design in infiltration due to air contact in spiral design. Nevertheless, it still did not comply with Regulation of Minister of Environment and Forestry. Thus, further treatment needed to be conducted in order to comply with the requirement that was stipulated by the government in Indonesia. Efficiency of the decrease of BOD content was by using spiral infiltration which was in 89%. Meanwhile, in order to reduce TSS content, the efficiency of spiral infiltration was in 94% and to reduce MPN Coliform content, the efficiency of spiral infiltration was in 96%.

### REFERENCES

01. Marsono, M., 2009. [Some factors related to bacteriological quality of dug-well water on Karangom Village]. Mastes Thesis, Program Pascasarjana Universitas Diponegoro, Semarang, Indonesia. (In Indonesian).
02. Nurmayanti, D., F. Kriswandana and H.S.W. Nugroho, 2018. Faeces waste treatment design in household with narrow land area. *Indian J. Public Health Res. Dev.*, 9: 205-209.
03. Pratiwi, H., F. Rokhmalia and Darjati, 2019. Tripikon modification as an infiltration ditch of domestic waste at narrow field. *Int. J. Curr. Res.*, 11: 5135-5138.
04. Smith, P.G. and J.S. Scott, 2005. *Dictionary of Water and Waste Management*. 2nd Edn., Butterworth-Heinemann, Boston.
05. CAWST., 2010. Summary of field and laboratory testing for the biosand filter. Center for Affordable Water and Sanitation Technology, Calgary, Canada.
06. Jayanudin, J. and M. Fakhrurozi, 2016. [Modeling risk of people's well contamination by septic tank waste infiltration wells (In Indonesian)]. *Tech. J. Sci. Technol.*, 12: 1-15.
07. Widyaningsih, V., 2011. [Yongma fisip UI liquid waste management]. B.A. Thesis, Indonesia University, Jakarta, Indonesia. (In Indonesian).
08. Hermiyanti, P. and F. Rokhmalia, 2019. The use of silica sand as infiltration of tripikon model for improving quality of urban domestic waste. *Int. J. Sci. Res.*, 8: 1800-1803.
09. Hidayah, E.N., A. Djalalembah, G.A. Asmar and O.H. Cahyonugroho, 2018. [Effects of aeration in constructed wetland on domestic wastewater treatment (In Indonesian)]. *J. Environ. Sci.*, 16: 155-161.
10. Mulyana, Y., R. Purnaini and B. Sitorus, 2013. [Domestic liquid waste treatment for reuse water (In Indonesian)]. *J. Wetland Environ. Technol.*, 1: 1-10.
11. Farahdiba, A.U., E.J. Latifah and M. Mirwan, 2019. [Ammonia reduction in Slaughterhouse Liquid Waste (RPH) by using an upflow anaerobic filter (In Indonesian)]. *J. Envirotek*, 11: 31-38.
12. Widayat, W. and A. Herlambang, 2010. [Ammonia allowance in an effort to improve the quality of Bojong Renged PDAM-IPA raw water by using biofiltration processes using wasp nest type plastic media (In Indonesian)]. *J. Air Indonesia*, 6: 64-76.
13. Doraja, P.H., M. Shovitri and N.D. Kuswytasari, 2012. [Biodegradation of domestic waste using natural inoculums from septic tanks (In Indonesian)]. *J. Sains Seni ITS.*, 1: E44-E47.
14. Hardanik, A.T., 2013. [Comparison of Coliform bacteria quantities in liquid waste before and after waste treatment according to the DEWATS system in Surakarta Surakarta Hospital]. M.Sc. Thesis, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia. (In Indonesian).