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ORIGINAL ARTICLE

Environmental Performances of Underground Septic Tanks in Sibu Sarawak, East Malaysia

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ABSTRACT - The compulsory desludging work on underground septic tank was gazetted on 30 March 2021 in peninsular Malaysia. The amended regulations have enforced the mandatory emptying or desludging works which should be carried out once in every 2 and 3 years for underground septic tanks that situated within and outside the boundary of any local authority area. In Sarawak, desludging frequencies have been implemented since 1998 for once in every half, 1, 3 and 4 year(s) for industrial, public administrative, commercial and residential areas, respectively. However, the performances yet the effectiveness are not known. Series of environmental laboratory tests were proposed and carried out on the collected effluents from the underground septic tanks with respect to the existing measured faecal sludge (%). The results have revealed: Higher BOD_5 were observed for higher faecal sludge (%); 75% of the tested effluents were exceeded the absolute allowable design threshold as required in Standard B; No significant correlation was observed for COD with respect to faecal sludge (%); 25% of tested effluents showed the normalised BOD_5/COD ratio < 0.3 were observed; The measured pH on the effluents were within 6 to 9; and, All the TSS readings were well below than allowable absolute design = 100mg/L. Due to the scope and site constraint of this research work, the complex influences such as the microbiological activities, micro-environmental factors and sizes or geometries of underground septic tanks on the measured environmental parameters as reported by the literatures were not considered in this study.

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INTRODUCTION

The compulsory desludging work on underground septic tank has been gazetted on 30 March 2021 in peninsular Malaysia. The regulations have stated clearly the required mandatory desludging works should be carried out once in every 2 and 3 years for underground septic tanks that situated within and outside the boundary of any local authority area [1]. In Sarawak, the current scheduled desludging frequencies for underground septic tanks are half year for industrial area; once a year for public or administrative agency; 2 years for commercial area; and 4 years for residential area, which have been enforced since 1998 [2]. However, the performances as well as the effectiveness for such scheduled desludging works are still less understood particularly for commercial and residential areas as observed by various stakeholders yet substantial financial expenditures are still being allocated and subsidised by Sarawak State Government annually [3].

The rationale behind the prescribed pumping intervals are actually achievable by appropriate engineering approaches rather than based on yearly basis blindly which are unsupported by scientific evidence [4];[5]. In general, the required desludging frequencies for septic tanks can be based upon on (a) Adequate hydraulic retention times for biological process to develop satisfactory for organic solids

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digestion [6];[7], (b) Existing volumetric accumulation rate [7];[8];[9];[10], and (c) Provided existing effective working volume [6];[11];[12].

In this research study, the environmental performances of underground septic tanks were evaluated and assessed qualitatively by a series of typical environmental laboratory tests namely Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Potential Hydrogen (pH) and Total Suspended Solid (TSS). Correlation or relationship of the measured environmental parameters were discerned with respect to the existing measured scum and sludge volumes in percentage. The measured wastewater's strengths on the discharged effluent were compared to the absolute allowable design thresholds as specified in Standard B, Malaysian Sewerage Industry Guidelines (1999) [13]. Due to the site constraint and scope of this research work, the complex influences such as the microbiological activities, micro-environmental factors and sizes or geometries of underground septic tanks on the measured environmental parameters as reported by the literatures [5];[9];[10] were not considered in this study.

MATERIALS AND METHODOLOGY

Total 45 wastewater samples were managed to be collected from the identified outlets of the underground septic tanks. However, only those be able to be tested were presented here. Table 1 summarized the adopted standards by American Public Health Association (APHA) [14] which are commonly used for examination of water and wastewater industry. The detailed standard experimental procedures can be referred to the published manuals and it will not be repeated here. For detailed measurement and discussion of yielded faecal sludge in percentage with respect to the known retention periods, kindly refer to the comprehensive works as carried out and reported by Leong *et. al.* (2022) [3].

Table 1. APHA Standards for Environmental Laboratory Tests [14]

Environmental Laboratory Test	Standard
Biochemical Oxygen Demand (BOD_5)	5210 B
Chemical Oxygen Demand (COD)	5220 C
Potential Hydrogen (pH)	4500-H+ B
Total Suspended Solid (TSS)	2540 B

RESULTS AND DISCUSSION

Figure 1 and Figure 2 show the measured BOD_5 and COD with respect to existing faecal sludge in percentage. The ratio of BOD_5/COD is shown in Figure 3. The measured pH and TSS against faecal sludge in percentage are plotted in Figure 4 and Figure 5, respectively.

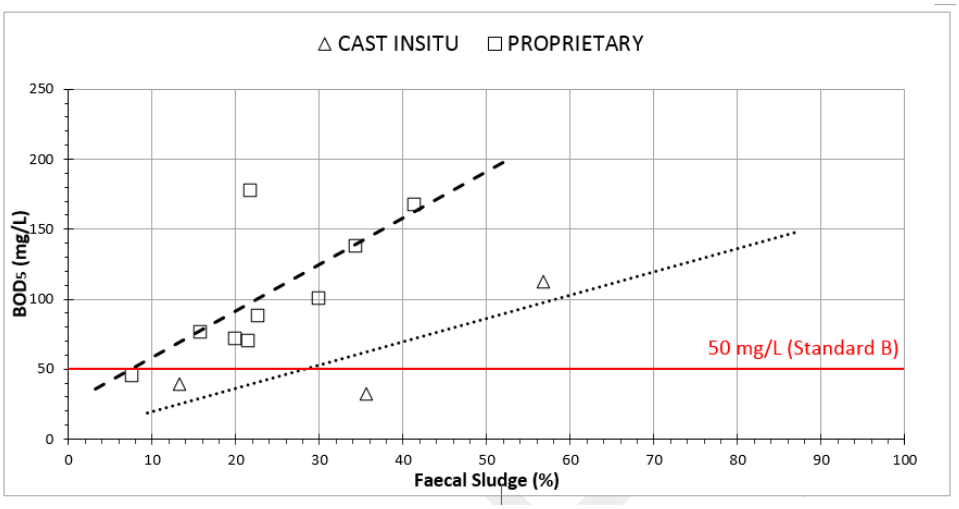

Figure 1. Linear relationship were observed for cast in-situ (concrete type) and proprietary (polyethylene type) underground septic tanks, for measured Biochemical Oxygen Demand (BOD_5) with respect to existing faecal sludge (%).

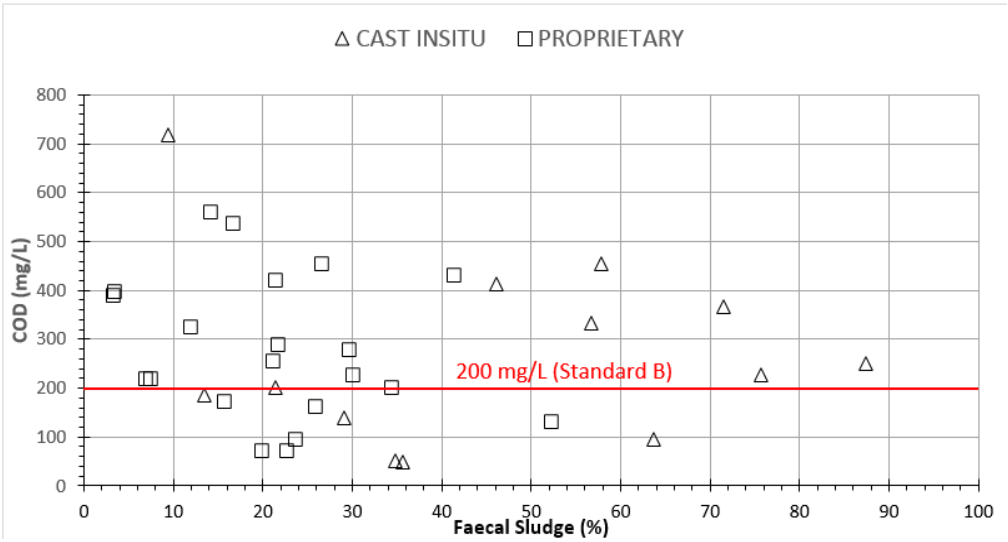

Figure 2. Scatter plots were observed for measured Chemical Oxygen Demand (COD) with respect to faecal sludge (%). 200mg/L is absolute allowable design threshold prescribed by Standard B, Malaysian Sewerage Industry Guidelines (1999) [13]

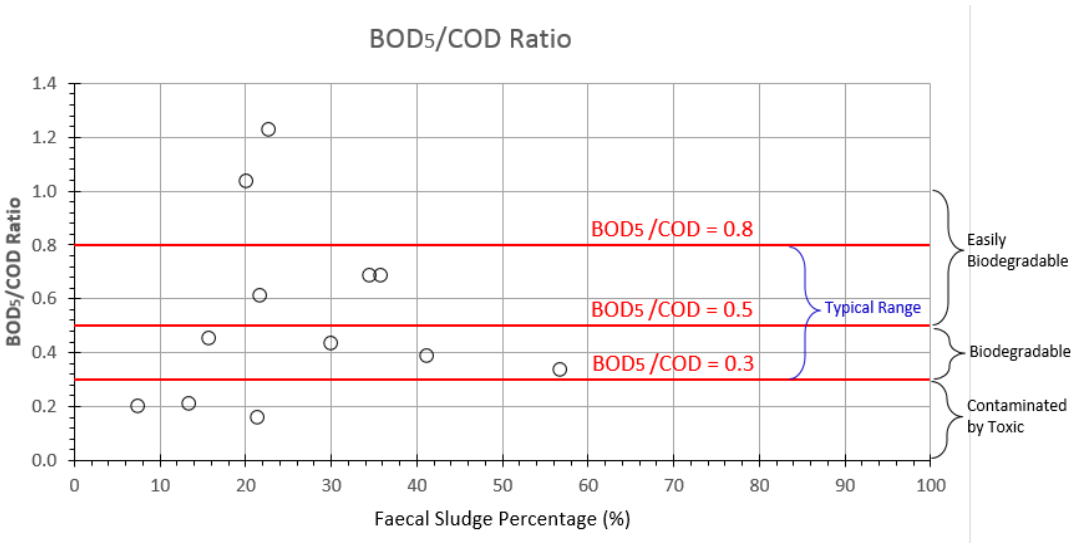

Figure 3. Ratio of BOD_5/COD with respect to faecal sludge (%).

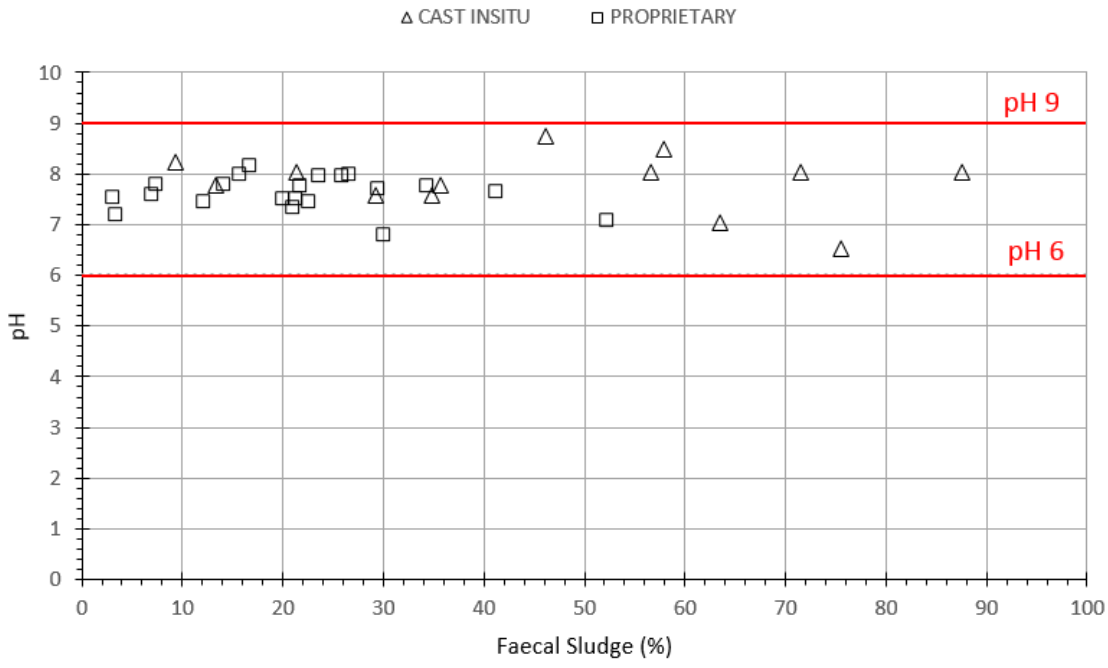

Figure 4. The measured Potential Hydrogen (pH) with respect to faecal sludge (%)

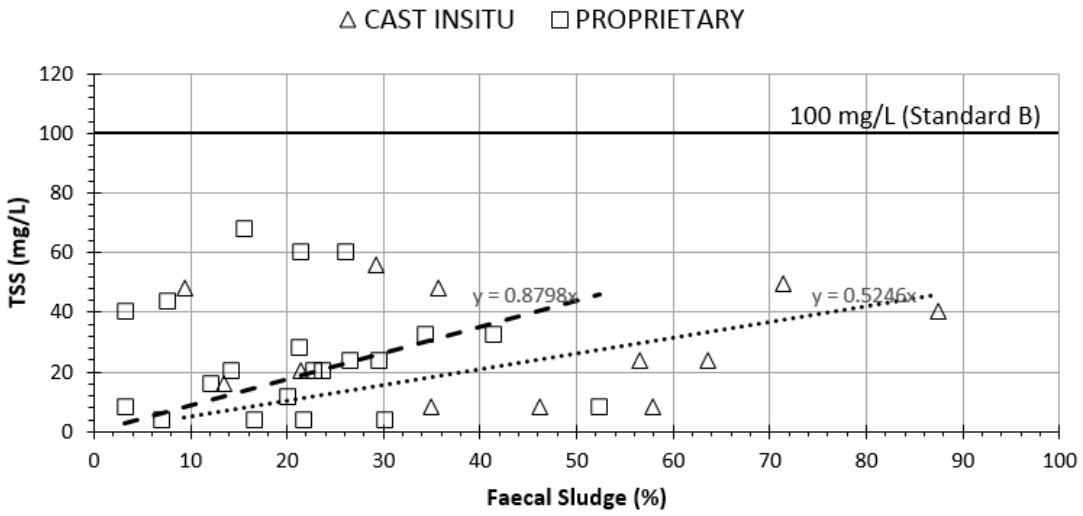

Figure 5. Total Suspended Solid (TSS) with respect to faecal sludge (%). 100mg/L is absolute allowable effluent design for TSS as prescribed by Standard B, Malaysian Sewerage Industry Guidelines (1999) [13]

Below are the findings that can be interpreted and summarised from the obtained results as observed.

(a) Linear relationships were observed in Figure 1 for both cast in-situ (concrete type) and proprietary (polyethylene type) underground septic tanks. Higher percentages of faecal sludge have yielded higher BOD_5 are observed;

(b) In Figure 1, around 75% collected effluents have revealed the BOD_5 were exceeded the allowable absolute design level as specified in Standard B, 50 mg/L. Standard B is the allowable absolute design values of discharged effluent to downstream of water supply intake as defined by Malaysian Sewerage Industry Guidelines (1999) [13];

(c) The measured COD are widely varies and were in the range of 47.33 to 718.67 mg/L as shown in Figure 2. About 69.65% (23 out of 34) are exceeded the absolute allowable design threshold 200 mg/L as specified in Standard B. It was very interesting to observe the COD did not affect by the percentage of faecal sludge as shown in Figure 2, i.e. given 9.38% faecal sludge and the corresponding COD value can achieve 718.67 mg/L;

(d) As observed from Figure 3, around 25% of evaluated effluents indicated that the BOD_5/COD below 0.3. According to Tchobanoglous *et al.* [15], it was indicated that the effluents were not be easily treated by biological means and either it may have some toxic or chemical components (i.e. excessive usage of detergent) or acclimated microorganism may be required in its stabilization.

(e) The measured pH on the collected effluents were in the range of 6 to 9 as shown in Figure 4. Guidelines by Eawag/Sandec (2008) [16] have revealed the suitable pH for underground septic tanks to function satisfactory without causing harm to the biological life of pathogens are in the range from 6 to 9. However, no significant relationship can be established on the influence of pH towards percentage of faecal sludge;

(f) Figure 5 shows the TSS determination on the collected effluents are influenced by accumulated faecal sludge in percentage. The major reason is due the reduction of effective working volume which cause the lesser hydraulic detention time for faecal solids to settle and simultaneously decomposed if any. In general, the cast in-situ underground septic tanks have shown lower TSS readings compare to proprietary type due to provided larger effective working volumes. All the TSS measurements have shown they were well below 100mg/L as prescribed by Standard B [13].

CONCLUSION

The environmental performances for underground septic tanks in Malaysia are not known despite the implementation of compulsory emptying or desludging works since 1998 and 2021 in Sarawak and peninsular Malaysia, respectively. This paper presented and summarised the environmental performances of underground septic tanks in Sibu Sarawak, East Malaysia based on identified 45 effluents from the outlets of underground septic tanks by common environmental laboratory tests. The results were compared with the measured existing faecal sludge (%). The carried-out measurement showed linear relationship were observed for BOD_5 against existing faecal sludge (%) and around 75% BOD_5 were exceeded the allowable absolute design level 50mg/L as required in Standard B. The measured COD were widely varied and do not significantly corresponded to the existing faecal sludge (%) but normalized BOD_5/COD showed that about 25% of tested effluents <0.3. These may be influenced by contamination by the synthetic chemical substances such as excessive usage of household products like bowl detergent etc. as reported by Tchobanoglous *et al*. [15]. Lastly, the measured pH were within the tolerable limit, 6 to 9 and all the TSS results showed that they were well below than allowable absolute design = 100mg/L. Kindly be noted that the complex influences of microbiological activities, micro-environmental and size of underground septic tanks as reported by the numerous literatures on these environmental parameters were unable to be considered due to impossible to acquire or identify on site. In fact, they are the potential future research that worth to be looked into in more thorough manners particularly how these factors influencing the performances of local underground septic tanks.

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