Survey of septic tank quality data to support sludge treatment projects in decentralised sanitation

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With the expansion of sanitation services in Brazil, decentralised systems are expected to be adopted in small communities. Studies on the quality of septic tanks are scarce, making it difficult to obtain parameters for designing sludge treatment systems. The study in question sought to determine the most significant pollutant concentrations and loads for this purpose.

Keywords: decentralised systems; septic tanks; sewage sludge.

INTRODUCTION

With the forecast for the expansion of sanitation services in Brazil, due to the publication of the legal framework for basic sanitation, by 2033, 90% of the Brazilian population should have access to sewage collection and treatment services.

In densely populated municipalities and urban centres, the implementation of a traditional sewage system, is more technically and economically viable. However, in small communities and isolated localities with low population density, the implementation of this type of infrastructure proves to be unfeasible, making it difficult to achieve the coverage target of the legal framework.

An alternative to be considered in these cases is the adoption of a decentralised sewage services system, which consists of adopting individualised treatment systems through the installation of individual septic tanks in residences.

In order to maintain this sanitation model, septic tanks must be drained periodically. The resulting waste must then be sent for proper treatment in sludge treatment systems.

One of the challenges presented by this model is the lack of data on the quality of residential septic tanks that can be used to subsidise projects to implement sludge treatment systems, since this material has different characteristics to domestic sewage sludge generated in Sewage Treatment Plants (STPs), which has been widely studied and is the subject of a vast bibliography.

The work carried out within the scope of this article sought to monitor the quality of septic tank contents on a monthly basis over a period of one year in a real residential development.

METHODOLOGY

To carry out the monitoring of septic tanks, a housing estate was chosen in the municipality of Assaí, in the north of the state of Paraná, Brazil, containing homes with similar architectural and construction dimensions, with standard hydraulic design for the collection and treatment of sewage through septic tanks, not served by a sewage collection network.

This project monitored 15 households with varying numbers of residents and water consumption, as shown in Table 1. The water consumption data was obtained from the sanitation company that serves the municipality of Assaí.

Table 1: Monitored households:

Residence	**N° of Residents**	**Average Water Consumption (m^3/month)**
1	4	5.10
2	2	12.00
3	2	9.14
4	2	6.50
5	4	5.67
6	not informed	20.20
7	5	5.75
8	3	4.90
9	4	7.33
10	3	10.10
11	3	9.10
12	2	8.60
13	6	16.00
14	4	17.40
15	9	23.72
Average	**3.78**	**10.76**
Sum	**53**	**161.51**

Groundwater samplers, better known as "Bailer tubes", were used to collect water from the wells. These consist of rigid polyethylene tubes with a length of 1,000 mm and a diameter of 41 mm, which are usually used to collect water from groundwater wells and enable sampling to be carried out at different depths.

The parameters analysed were Chemical Oxygen Demand (COD), Total Suspended Solids (TSS) and Sedimentable Solids (SS). The samples were collected monthly from March 2022 to March 2023 (no samples were collected in December 2022 because it is an atypical month for household occupancy, with people travelling or receiving family members at home). Based on the results obtained, the corresponding loads of COD and Total Suspended Solids and the total volumes of Sedimentable Solids generated were calculated.

RESULTS AND CONCLUSIONS

The analytical results and calculations of the corresponding quality loads for the 15 septic tanks that were the subject of this study are detailed in Table 2.

Table 2: Analytical results obtained:

Residence	Average of COD (mg/L)	Average of TSS (mg/L)	Average of SS (mL/L)	Load of COD (kg/day)	Load of TSS (kg/day)	Volume of SS (L/day)
1	723.40	464.22	5.39	124.40	77.17	0.92
2	719.89	680.82	9.83	287.36	285.10	3.93
3	951.00	614.00	13.78	309.32	191.50	4.20
4	764.33	614.17	4.58	167.48	141.39	0.99
5	876.33	1042.67	134.33	122.70	24.90	25.39
6	1138.20	1346.80	7.76	737.84	905.81	5.22
7	2869.75	17480.35	283.60	505.22	2331.12	54.36
8	1110.82	1413.54	38.95	181.32	245.89	6.36
9	908.89	1462.62	3.62	218.18	262.22	0.89
10	595.10	651.40	3.60	200.14	214.52	1.21
11	903.30	1107.55	5.11	265.26	327.97	1.55
12	1849.70	2034.10	49.60	527.87	570.60	14.22
13	1637.75	1861.25	18.81	859.16	954.13	10.03
14	2026.10	5398.00	77.20	1202.08	3375.48	44.78
15	1162.20	1913.36	26.25	910.79	1506.09	20.75
Média	**1215.78**	**2538.99**	**45.49**	**441.27**	**760.93**	**12.99**
Soma	**-**	**-**		**6619.12**	**11413.89**	**194.80**

COD = Chemical Oxygen Demand; TSS = Total Suspended Solids; SS = Sedimentable Solids.

From the data obtained, it can be concluded that:

- - During the research period, 53 residents lived in the 15 houses studied, an average of 3.78 residents per house. These residents consumed an average of 161.51 m³/month of water, 10.76 m³/month per household and 3.05 m³/month per capita;
- - The total COD load was 6,619.12 kg/day, 441.27 kg/day per household and 124.89 kg/day per capita;
- - The total load of Total Suspended Solids was 11,413.89 kg/day, 760.93 kg/day per household and 215.36 kg TSS/day per capita;
- - The total volume of sedimentable solids was 194.80 L/day, 13.25 L/day per household and 3.75 L/day per capita.

These results can serve as design parameters for septic tank sludge treatment systems. COD and Total Suspended Solids loads are essential for biological treatment systems, and the volumes of Sedimentable Solids generated are important indicators for decanter and sedimenter designs. In this way, the results reinforce the importance of further monitoring studies of cesspits to guarantee their operation and reduce their impact on the environment. They can also be used to develop strategies to improve effluent management.

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