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Research Paper

Domestic sewage disposal in a rural family property: case study and proposition of alternative biological treatment and energy reuse

Destinação de esgoto doméstico em propriedade rural unifamiliar: estudo de caso e proposição de alternativas de tratamento e reaproveitamento energético

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ABSTRACT: Decentralized systems applied for the collection, treatment, disposal, and reuse of wastewater are a promising alternative to deal with environmental degradation and public health problems faced in rural areas and isolated urban communities. In this context, this study carried out a technical-financial comparison between two alternatives (septic tank and a Canadian biodigester) to treat domestic sewage produced in a rural property located in the municipality of São Pedro do Turvo / SP. The experimental design of this investigation included: a study of local data, analysis of project requirements, calculations, and design in Autocad, and a comparative study of technical/economic feasibility of both systems. From a technical point of view, both alternatives are simple and easy to execute, as applied regulations are followed. The Canadian biodigester showed a lower implantation cost (R$ 911,88) when compared to the septic tank (R$ 1.314,67).

Keywords: Decentralized treatments, Biodigester, Biogas, Septic tank

RESUMO: *Sistemas descentralizados, definidos pela coleta, tratamento e disposição ou reuso de águas residuárias mostram-se como alternativas interessantes para lidar com a degradação ambiental e problemática de saúde pública enfrentada em áreas rurais e comunidades urbanas isoladas. O objetivo deste trabalho foi comparar, sob o ponto de vista técnico/financeiro, duas alternativas (tanque séptico e um biodigestor Canadense) para o tratamento individualizado do esgoto doméstico produzido em uma propriedade rural, localizada no município de São Pedro do Turvo/SP. O artigo contemplou: levantamento de dados do local de estudo, levantamento dos critérios de projeto, dimensionamento e projeto em Autocad dos sistemas de tratamento e estudo comparativo da viabilidade técnico/econômica de implantação destes sistemas. Sob o ponto de vista técnico, ambas alternativas de tratamento demonstraram-se simples e eficazes para o tratamento individualizado do esgoto doméstico produzido na propriedade rural, desde que seguidas as normativas adequadas. Observou-se que o biodigestor Canadense apresentou menor valor total de implantação (R$ 911,88) quando comparado ao tanque séptico (R$ 1.314,67).*

Palavras-chave*: Tratamento descentralizado, Biodigestor, Biogás, Tanque séptico*

INTRODUCTION

In developing countries, waterborne diseases and environmental degradation are caused mainly due to a lack of essential sanitation services. An evaluation of basic sanitation services in Brazil shows that sanitary sewage has the lowest municipal coverage (LANDAU e MOURA, 2016; TONETTI et al., 2018). According to the Diagnosis of Water and Sewage Services carried out by the National Sanitation Secretariat, in 2018, the rate of urban service with sewage network in Brazil was 53.2% (SNS, 2019). The primary reasons for this scenario are the disordered growth of cities and the lack of urban planning by public agencies (FUNASA, 2015).

In rural areas and isolated urban communities, access to basic sanitation infrastructure is virtually non-existent, either due to the distance from localities, lack of information, or simple lack of public investment, of technologies that could enable the treatment of this domestic sewage (TONETTI et al., 2018).

According to a Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE), only 8% of the rural households surveyed have access to the sewage collection network, and 13% do not have any sewage treatment system (IBGE, 2013). Among households with sewage treatment systems, 58% need immediate improvement since there are cesspits, or sewage is released in ditches, water bodies, and other localities in these properties (IBGE, 2013). Currently, there is a worldwide trend regarding the proposition of decentralized sanitary sewage treatment technologies, which have the advantage of reducing the extension of the main interceptors. Such pipes are responsible for receiving and transporting the collected sewage to wastewater treatment plants (WWTPs) (METCALF & EDY, 2018). Among the decentralized alternatives of domestic sewage treatment, implementing septic tanks or biodigesters is an economically viable option for the care of residents of rural areas and isolated communities (TONETTI et al., 2018).

These decentralized treatment systems contribute to the universalization of basic sanitation, improves the population's quality of life, and acts to conserve natural resources (water, soil, fauna, and flora). In addition, in the sphere of public policies, it allows the reduction of the occurrence of water-transmitting diseases and enables adequate management of water resources (FUNASA, 2015). The present work made a technical-economic comparison between two alternatives (septic tank and a Canadian biodigester) for the individualized treatment of domestic sewage produced in a rural property located in the municipality of São Pedro do Turvo, São Paulo State, Brazil.

THEORETICAL REFERENCE

Domestic sewage is liquid waste from hygienic and/or cleaning activities (ABNT, 1993). It contains approximately 99.9% of water, with the remaining volume composed of organic and inorganic solids, as well as microorganisms, fungi, protozoa, helminths, and viruses (CONTERATO, 2018).

As mentioned earlier, the septic tank is considered a satisfactory alternative for domestic sewage treatment and be used instead of a cesspit, commonly adopted in areas of vulnerability (TONETTI et al., 2018). The cesspit, also known as absorbent, rudimentary, or hillbilly tank, consists of a well or hole made in the soil to receive domestic sewage. Because it does not have any waterproofing, it allows the infiltration of the liquid fraction into the soil, resulting in risks of contamination of soil and groundwater (FUNASA, 2015; TONETTI et al., 2018).

Septic tanks allow the retention of sedimentable and floating solids contained in sewage and partial removal of organic matter (ABNT, 1993), characterizing itself as a primary and secondary treatment unit. The Brazilian regulatory standard NBR 7.229/1993 - Design, operation, and construction of septic tank systems - set the conditions required for these systems' design, construction, and operation, including treatment and disposal of effluents and sedimented sludge (ABNT, 1993). As a complement, there is also NBR 13.969/1997 – Septic tanks: Complementary treatment units and final disposal of effluents, which presents alternatives of complementary treatment units and final disposal of liquid effluents from the septic tank. Regarding the sludge produced in the septic tank, NBR 7.229/1993 provides for cleaning septic tanks at intervals of 1 to 5 years (ABNT, 1993).

According to Tonetti et al. (2018), sludge removal should be done carefully, avoiding contact between people and the removed sludge. In addition, approximately 10% of the sludge volume should remain in the septic tank, with the aim of not harming treatment after cleaning (TONETTI et al., 2018). The collected sludge can be disposed of in drying beds, according to criteria exposed in NBR 12.209/2011 - Elaboration of hydraulic-sanitary projects of sewage treatment plants (ABNT, 2011). After its stabilization can be used as an agricultural compound. However, there is still no specific legislation regulating the management of sludge systems for agricultural application (TONETTI et al., 2018).

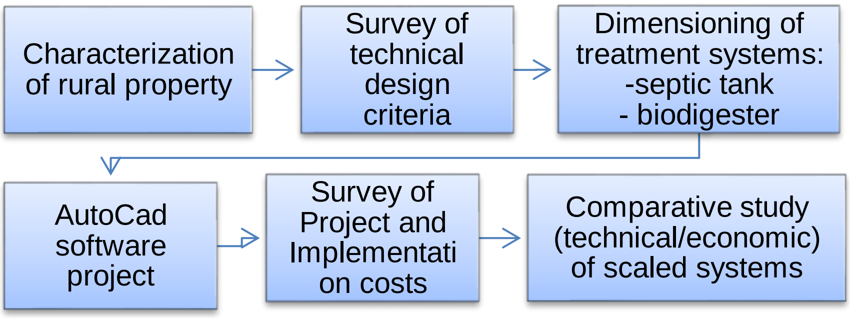
A biodigester is another alternative that can be implemented to treat domestic sewage from rural areas or isolated urban communities. A biodigester consists of the association of a closed chamber and a gasometer. In the closed chamber, organic matter (suspended or dissolved) is degraded by anaerobic bacteria (DEGANUTTI et al., 2002). This process occurs in the absence of oxygen and is characterized by a set of microorganisms capable of converting organic matter into methane (CH_4), carbon dioxide (CO_2), hydrogen sulfide (H_2S), and other compounds (CONTERATO, 2018). There are several models of biodigesters, which are classified when the type of sewage loading (ANDRADE et al., 2002). The batch model, customarily applied to biodegrade biomass, receives a total load of organic matter to be treated every 28 days (ANDRADE et al., 2002). Other configurations need to be fed continuously (usually once a day). Examples include Indian, Chinese and Canadian biodigesters, also known as covered pond biodigester (BLC) (ANDRADE et al., 2002). According to Tonetti et al. (2018), the biodigester allows the treatment of domestic sewage and other waste produced on the property, such as manure, food leftovers, and tree pruning. Biogas is rich in CH_4, enabling its use as an energy source for lighting, heating, and direct use as kitchen gas. The use of biodigester also demands the removal of sludge from 2 to 4 years, following the same criteria defined for cleaning the septic tank (TONETTI et al., 2018).

NBR 8.160/1999 recommends installing a fat box at the kitchen outlet, preceding the biological treatment units (septic tank or biodigester), aiming to retain fat present in the domestic sewage so that this material does not damage or interrupt the flow in the pipes. For the final layout, NBR 13.969/1997 recommends that complementary treatment be made at the exit of the devices and only then the final disposal of the treated effluent.

METHODOLOGICAL PROCEDURES

The experimental design of this study included: (i) the data collection of the study area; (ii) a survey of the relevant design criteria; (iii) dimensioning of treatment systems; (iv) design of systems in AutoCAD (version 2016), and (v) the study of the technical/economic feasibility of implementation of these systems. Figure 1 depicts, in a simplified way, the steps performed in the present study.

Figure1. Experimental workflow.



Characterization of rural property

São Pedro do Turvo is a municipality located in the interior of the State of São Paulo, located 39.8 km from Ourinhos, whose main economic activities are agriculture and livestock. According to IBGE data, in 2010, the total population of the municipality of São Pedro does Turvo was 7,198 inhabitants. Of this total number, 2048 residents live in rural areas. The average number of residents per household (regardless of being in urban or rural areas) corresponds to 3.06 residents (IBGE, 2010).

Criteria and sizing parameters of treatment systems

For sizing the septic tank were adopted the guidelines laid out in the technical standards of the Brazilian Association of Technical Standards (ABNT):

- NBR 7.229/1993 – Design, construction, and operation of a septic tank system;
- NBR 5.626/1996 – Cold Water Building Installations - Procedure;
- NBR 13.969/1997 – Septic tanks, complementary treatment units; and final disposal of liquid effluents - design and execution;
- NBR 8.160/1999 – Sanitary Sewer Building Installations – Procedure.

The design of the biodigester project took into account the following aspects:

a) implementation site - place with good sunlight, to assist in the fermentation process in the biodigester chamber;

b) daily volume of animal waste on the rural property;

c) daily volume of domestic sewage;

d) model of the biodigester to be used.

Next, the steps applied to the design of the studied treatment units (septic tank and biodigester) will be briefly presented. In both cases, a population of 3 inhabitants per household was adopted, according to census data from the municipality of São Pedro do Turvo (IBGE, 2010).

Septic tank sizing

According to NBR 7229/1993, the sizing of the septic tank begins by calculating the system's volume (equation 1). In Equation 1, the design parameters shown in Table 1 were adopted, obtained from the recommendations of NBR 7229/1993.

$$V = 1000 + N(C \times T + K \times L_F) \tag{1}$$

Where: V is the septic tank volume (L); N is the number of contributors (inhabitant); C is the per capita sewage contribution rate (L.inhab^{-1}.day^{-1}); T is the detention period for evictions; K is the digested sludge accumulation rate (days), and LF is the new sludge contribution rate (L.inhab^{-1}.day^{-1}).

The surface area (A_B) can be calculated by Equations 2 and 3 considering a rectangular prismatic shaped tank:

$$A_B = L \times B \tag{2}$$
$$V = A_B \times h \tag{3}$$

Where: L is the width of the septic tank (m); B is the septic tank length (m), and h is the septic tank depth (m).

In topic 5.9 of NBR 7229/1993, the minimum internal width is 80 cm, the minimum length/width ratio for rectangular prismatic tanks is 2:1, and the maximum is 4:1.

Tabel 1. Design criteria for sizing the septic tank according to NBR 7229/1993.

Parameter	Symbols	Adopted value
Number of contributing people	N	Three inhabitants
Eviction contribution	C	100 L.inhab^{-1}.day^{-1}
Detention period	T	Day
Digested sludge accumulation rate	K	105 day
Fresh sludge contribution	L_F	1 L.inhab^{-1}.day^{-1}
Minimum length/width ratio	L/B	2/1
Minimum internal width	L	0.80 m
Minimum depth	h	1.20 m

Canadian Biodigester Sizing

The biodigester to be adopted in this work is the Canadian type, which consists of a tank dug in the ground, waterproofed, and covered with geosynthetic material (PVC, HDPE, etc.) (AIRTON KUNZ et al., 2019). The geometry of this type of biodigester has a rectangular base with a trapezoidal section with variable slope inclination, depending on the soil characteristics. The Canadian biodigester is a low-tech system that is easy to build and operate (RIBEIRO, 2011; AIRTON KUNZ et al., 2019).

First, we calculated the sewage flow or daily volume given by (Equation 4) and volume (Equation 5) related to the daily load of effluent to be treated to estimate the dimensions of the biodigester. In Equation 4, the hydraulic retention time (HRT) represents the average time that the substrate remains inside the biodigester, aiming at the production of biogas (OLIVER et al., 2008; KUNZ et al., 2019). According to Oliver et al. (2008), the HRT can vary from 30 to 45 days, depending on the organic load added to the biodigester.

$$V_C = P \times \ q \ \times \ C \tag{4}$$

Where: V_C is the daily volume (m³. day^{-1}); q = represents the per capita consumption of water (L.inhab^{-1}.day^{-1}); P = represents the population of the property; C = the return coefficient (dimensionless, =0.8 is adopted according to ABNT Standard nº 7229/1993).

$$V_B = V_C \times TRH \tag{5}$$

Where: V_B is the volume of the biodigester (m^3); V_C is the volume of daily effluent load to be treated (domestic sewage) ($m^3.day^{-1}$) and HRT is the hydraulic retention time (days).

In Table 2, the parameters used for sizing the biodigester are listed:

Table 2. Design criteria for sizing the Canadian biodigester.

Parameter	Symbols	Adopted value
Property population	P	Three inhabitants
Per capita consumption	q	$100 L.inhab^{-1}.day^{-1}$
Hydraulic retention time	HRT	32 days
Return coefficient	C	0.80

Next, the volume of the biodigester was used to estimate the actual dimensions of the biodigester (RIBEIRO, 2011). We used the equations shown in Chart 1 to calculate the dimensions of the biodigester.

Chart 1. Necessary Equations for Dimensioning the Canadian Biodigester.

Equations	Nº	Description
$\boldsymbol{P = C = 2\pi r}$	(6)	P = Total transverse perimeter (beam plus pit) (m) C = Belt circumference r = radius of the bell (m)
$\boldsymbol{A_{\%} = 0,621p^2 - 0,04p + 0,352}$	(7)	$A_{\%}$= Percentage of transverse perimeter intended for the arc. p = portion of the desired gas phase ($p \leq 0.4$)
$\boldsymbol{b = -\left(\frac{1}{3}A_{\%} + \frac{1}{3}\right) \times P}$	(8)	b = Side, base or smaller width of the pit (m) P = Total transverse perimeter (m)
$\boldsymbol{a = 1,618b}$	(9)	a = largest pit width (m) b = smaller side, base or width of the pit (m)
$\boldsymbol{h = 0,951b}$	(10)	h = depth of the pit (m) b = smaller side, base or width of the pit (m)
$\boldsymbol{A_f = 0,4755(a + b) \times b}$ $\boldsymbol{A_f = 0,4755(a + b) \times b}$	(11)	A_f= Traverse area of the pit (m^2) a = largest pit width (m) b = smaller side, base or width of the pit (m)
$\boldsymbol{A_t = \frac{A_f}{1 - p}}$	(12)	A_t = Total transverse area or transverse area of the pit plus the transverse area of the bell (m^2) p = Desired gas-phase proportion
$\boldsymbol{A_g = A_t - A_f}$	(13)	A_g= Cross-sectional area of the bell or area destined for the storage of biogas (m^2)
$\boldsymbol{V_T = A_t \times L}$	(14)	V_T = Total volume of the biodigester (bell plus pit) (m^3) L = Length of the biodigester (initial value adopted) (m)
$\boldsymbol{V_f = A_f \times L}$	(15)	V_f = Total volume of the pit (m^3) L = Length of the biodigester (initial value adopted) (m)
$\boldsymbol{V_g = A_g \times L}$	(16)	V_g= Total gas volume (m^3) L = Length of the biodigester (initial value adopted) (m)

Source: Adapted from Ribeiro (2011).

To calculate the demand for biogas and energy generation, Table 3 represents, for some animals, the average production of manure per day, and its potential for generating biogas, and the equivalent in electric energy (kWh). Table 3 shows examples of biogas production rates, energy demand (use as cooking gas (LPG), and electricity production) according to the origin and volume of waste produced daily. Only human waste will be used to assess the potential for energy reuse in the rural property under study for domestic sewage.

Table 3. Biogas, cooking gas and electricity production rates, according to the origin of the waste.

Type	Daily volume of residue (kg.day^{-1})	Biogas production (m^3. day^{-1}animal$^{-1)}$	LPG production (kg.day^{-1})	Electricity production (Kwh.day^{-1})
Human	0.25	0.01	0.00	0.01
Chicken	0.18	0.01	0.00	0.01
Goats/sheep	0.50	0.07	0.14	0.07
Swine	16.00	0.08	0.03	0.08
Milky cow	25.00	0.54	0.00	0.54
Dog	0.33	0.03	0.01	0.03

Source: Adapted from BGS Equipamentos (2018) and Ribeiro (2011).

RESULTS AND DISCUSSION

Septic tank sizing

From Equation 1, it was estimated that the septic tank's useful volume (V) was 1.615 m^3 (Table 4). For this project, a treatment chamber with a rectangular prismatic shape was adopted, which, according to NBR 7229 (ABNT, 1993), is sufficient to serve up to 30 people. By using Equation 2 and 3 and the minimum values that the standard recommends that the Base Area values can be estimated: (Lx B) = 0.80 x 1.60 = 1.28 m^2 and using the minimum depth (ABNT 7229) = 1.20 m, we have that V = AB x H, V (useful volume) = 1.615 m^3 , for an estimated volume of 1615L = 1.28 x H, where H = 1.26 m, H = 1.30 m (Depth) was adopted. Figures 2 and 3 illustrate the plan and cut detail of the projected septic tank obtained with the aid of AutoCAD.

Table 4. Dimensions of the septic tank designed for the treatment of domestic sewage produced in the studied rural property.

Parameter	Dimension
Useful volume	1.615 m^3
adopted depth	1.300 m
internal width	0.800 m
Length	1.600 m

Figure 2. Plan of the septic tank indicating the dimensions obtained.

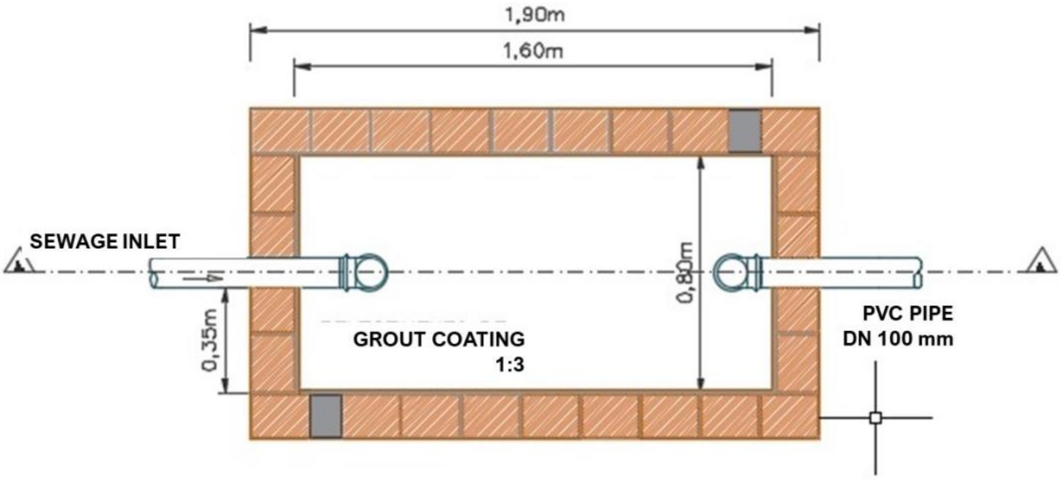
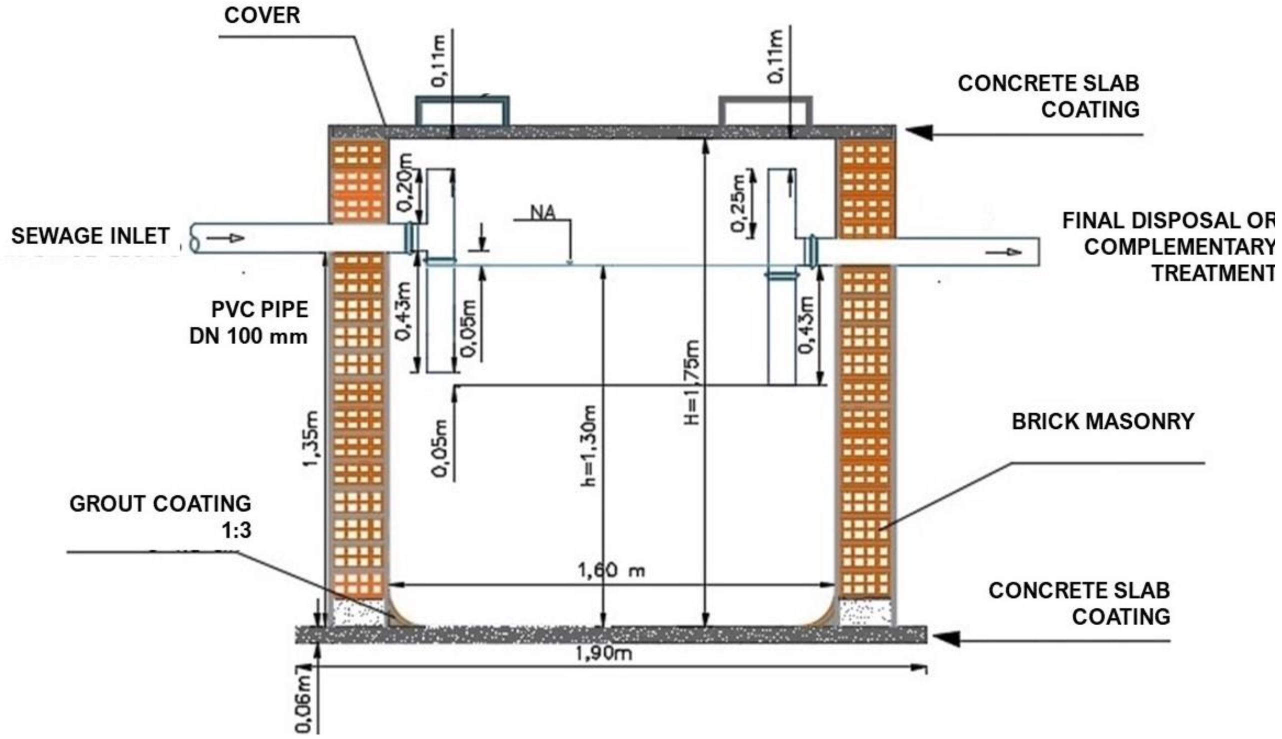


Figure 3. Detail of a cross-section of the septic tank.



Biodigester sizing

The sizing of the biodigester was started from the estimate of the total flow of domestic sewage and the useful volume of the biodigester. Tables 5 e 6 present values found, considering 32-day HRT.

Table 5. Parameters related to the calculation of the dimensions of the biodigester.

Parameters	Value
Biodigester useful volume (V_B)	7.68 m^3
Daily volume of domestic sewage (V_C)	0.24 $m^3.day^{-1}$

It is noteworthy that, to optimize the production of biogas, Ribeiro (2011) recommends that the gaseous phase occupy, at most, 40% of the volume of the biodigester. Thus, the parameters L, p, and r are related to the biodigester's estimated volume (VB = 7.68 m^3), and their values were estimated from the equation available in Chart 1 and an Excel spreadsheet.

Table 6 - Initial parameters for sizing the biodigester.

Daily volume (m^3. day $^{-1}$)	Biodigester volume (m^3)	Dimensions adopted (m)	Hydraulic chamber (m)
0.24	7.68	Raio (R): 1.30 m Comprimento (L): 1.65 m p = 0.2 (factor)	0.90 x 1.00 x 0.50

As previously mentioned, the NBR 8160/1999 recommends installing a grease trap at the kitchen exit, preceding the biodigester. This recommendation aims to remove and retain grease present in domestic sewage so that this material does not damage or interrupt the flow in the pipes. The NBR 8160/1999 also recommends that a single box of fat is sufficient for just one contributing kitchen.

This device is divided into a receiving and a spillway, separated by a fixed septum. Figure 4 depicts the floor plan and cross-section of a simple cylindrical grease trap. Minimum dimensions were indicated in Figure 4, considering the contribution of a single sink, according to the recommendations of NBR 8160/1999.

Figure 4. Floor plan (a) and section (b) of a simple fat box and its constructive details.

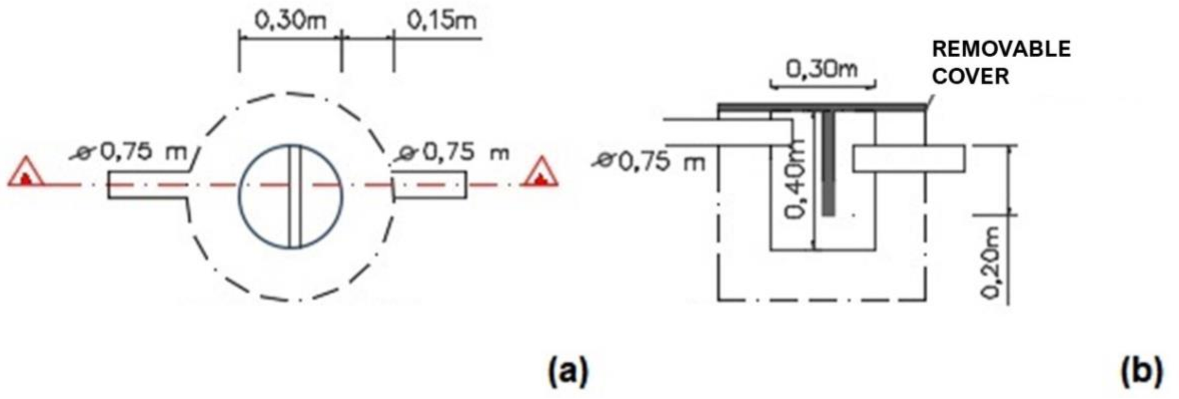
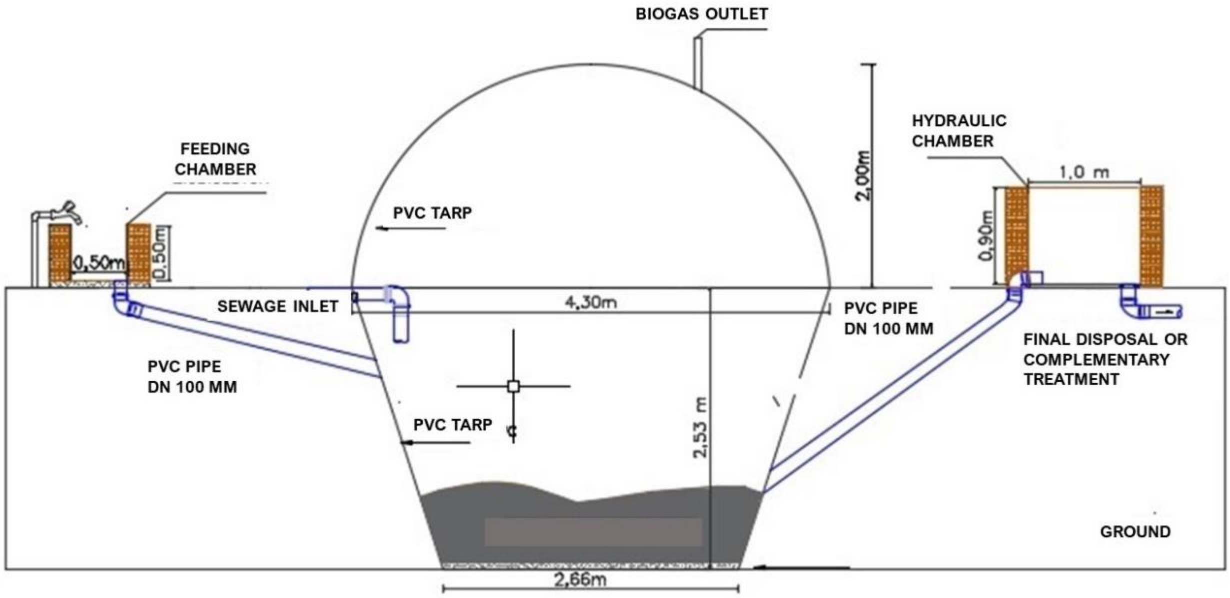


Table 7 presents the dimensions found for the Canadian biodigester. Figure 5 depicts the cross-section of the biodigester compensation box, along with the main dimensions.

Table 7. Dimensions of the Canadian biodigester dimensioned for the treatment of tailings produced on the studied rural property.

Symbol	Parameter	Dimension
P	Total perimeter (intended for gas + pit)	8.16 m
A%	Percentage of transverse perimeter intended for the arc	0.36 m³
R	Gas storage radius	1.30 m
P	The proportion of gas phase	20%
B	Side, base, or smaller width of the pit	1.73 m
A	The greater width of the pit	2.80 m
H	Depth of the pit	1.64 m
Af	Traverse area of the pit	3.72 m²
At	Total area (intended for biogas + pit)	4.65 m²
Ag	The area destined to biogas	0.93 m²
Vt	Total volume of the biodigester (bell + pit)	7.68 m³
Vf	Total volume of the pit	6.14 m³
Vg	Total volume of biogas	1.53 m³
L	Biodigester Length	1.65 m

Figure 5. Cross-section of the dimensioned Canadian biodigester and construction details.

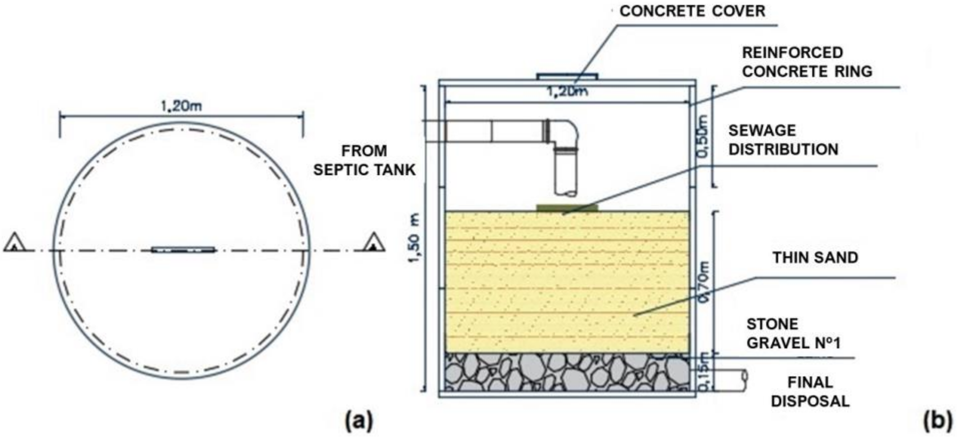


Both treatment alternatives addressed in this work require an effluent post-treatment unit. Several alternatives generally differ according to the desired ranges of organic matter removal (NBR 13969/1997; TONETTI et al., 2018). Among the complementary treatment alternatives in NBR 13969/1997 are the constructed wetlands, anaerobic filters, and sand filters. In addition, in the specific case of the biodigester, the destination of the treated sewage must be carefully evaluated, as, according to its quality, in some cases, it can be used as a biofertilizer in orchards and pastures (TONETTI et al., 2018).

The sand filter is recommended as a complementary treatment unit for the final effluent obtained from the septic tank and the Canadian biodigester. In the sand filter, the effluent passes through layers of sand followed by other filtering materials, such as gravel, resulting in polishing of the previously treated effluent, both from a physical point of view (retention of particles) and biochemical (oxidation of polluting compounds by the action of microorganisms) (ABNT, 1999; TONETTI et al., 2018). The sand filter can be constructed from concrete rings, masonry, plastic drums, water tanks, or other waterproof material. The minimum depth must be 1 m, and the system does not require complex maintenance. NBR13969/1997 recommends removing sand and other materials from the filter every four months in single-family units. Then, these materials must be placed in the sun for drying and later reuse. Figure 6 shows the cross-section and details of a sand filter designed as a complementary treatment unit in this study.

The final disposal of the effluent obtained, either by using the septic tank or by adopting the biodigester, can be carried out in water bodies, lakes, or rivers, provided that the quality of this effluent is following the classification of water bodies recommended in the resolutions of the National Council for the Environment (CONAMA) 357/2005 and 430/2011. In addition, reuse in gardens (except for irrigation of orchards and vegetables) or washing sidewalks is recommended.

Figure 6. Floor plan (a) and cut of the sand filter (b) for complementary domestic sewage treatment produced on the rural property under study.



Technical-economic comparison between the studied treatment alternatives

Chart 2 depicts the estimated cost data for implementing the two treatment systems proposed in this work. Such costs were estimated following the 2019 National Cost and Index Research System (SINAPI - Sistema Nacional de Pesquisa de Custos e Índices) for the state of São Paulo. In both cases, it was considered that the sewage would pass through a sand filter after the biological treatment alternatives were tested, at the cost of R$724.66 (Chart 2).

The final costs (Chart 2) show that the implementation of the Canadian biodigester (R$911.88) is more advantageous than the septic tank (R$ 1 314.67). The sludge must be removed from both treatment systems, following the recommendations of the pertinent norms. Due to the lack of cleaning, the accumulation of sludge in these systems can cause a drop in the efficiency of organic matter removal, bringing health risks to residents and animals on the farm and attracting insects and rodents (TONETTI et al., 2018). Table 8 depicts the results obtained in estimating energy production from biogas produced in the biodigester from the equivalences shown in Table 3. It is observed that because sewage resulting from human activities is not very concentrated, the potential production of electrical energy was marginal (Table 3). If other tailings produced on the property were sent for treatment, a greater volume of biogas could be produced, resulting in more significant LPG and electricity production rates.

Table 8. Daily production of biogas, LPG, and electricity considering the volume of waste produced in the rural property under study.

Type	Number	Biogas production (m^3 day^{-1})	LPG production (Kg day^{-1})	Electricity production (Kwh day^{-1})
Human	3	0.03	0.00	0.03
Total		0.09	0.00	0.09

Source: Adapted from BGS Equipamentos (2018).

Chart 2. Synthesis of the costs of implementing the septic tank and the biodigester and sand filter.

	SINAPI Code	***Material***	***Unit***	***Quantity***	***Unitary value (R$)***	***Total (R$)***
SEPTIC TANK	89043	Brick Masonry (9cm x19cm x19cm)	m^2	10.64	65.44	696.28
	93358	Manual ditch excavation	m^3	3.79	71.32	270.73
	36377	PVC pipe DN 100 mm	m	4.00	28.04	112.16
	41892	PVC connection (90º) DN 100 mm	uni	1.00	91.87	91.87
	003743	Conventional precast slab for floors	m^2	4.46	32.20	143.62
TOTAL			**R$ 1 314.67**			
BIODIG ESTER	3779	PVC tarp (8mm)	m^2	16.16	7.16	115.77
	93358	Manual excavation	m^3	6.14	71.32	437.90
	36377	PVC pipes DN 100 mm	m	4.00	28.04	112.16
Hydraulic chamber	89043	Brick Masonry (9cm x19cm x19cm)	m^2	3.76	65.44	246.05
TOTAL			**R$ 911.88**			
SAND FILTER	012551	Reinforced Concrete Ring DN 100 m, H=0,50m	uni	3.00	111.62	334.86
	000366	Thin sand	m^3	0.79	67.20	53.17
	04721	stone gravel Nº1	m^3	0.17	54.25	9.23
	36377	PVC pipes DN 100 mm	m	1.00	28.04	28.04
	41892	PVC connection (90º) DN 100 mm	uni	1.00	91.87	91.87
	93358	Manual ditch excavation	m^3	1.70	71.32	120.93
	88309	manpower	H	21.67	4.00	86.56
TOTAL					**R$ 724.66**	

CONCLUSIONS

The decentralized sewage treatment alternatives studied in the present work proved to be simple and low-cost technologies. From the dimensions carried out and information in the literature, it was observed that both the septic tank and the biodigester are technologies capable of improving sanitary quality in rural properties and isolated urban communities. The biodigester had a lower cost of implantation when compared to the septic tank. In addition, it is noteworthy that, in the event of inserting tailings produced by animals raised on the property to the treatment of domestic sewage in the biodigester, it would be possible to enhance the production rates of LPG and electricity, positively impacting the global economic viability of this configuration of treatment.

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