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Research paper

Wastewater treatment design using the Imhoff tank in a rural area, Peru

Diseño de tratamiento de aguas residuales mediante el tanque Imhoff en una zona rural, Perú

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ABSTRACT

The work shows the use of wastewater by farmers for agricultural activities, its lack of treatment generates unhealthiness problems. Under this perspective, the objective of the research was to design the wastewater treatment system in the rural area of the La Pampa neighborhood of the Auquimarca annex. It is a purposeful investigation, using the Gauge Method to analyze gravity discharges and the Triangular Weir Method to determine the flow of wastewater. The composition of the wastewater for the treatment system was verified, including: hydrogen potential, resulting in 8.4 (acidic pH < 7, and basic medium pH > 7 alkaline), as a product of the study it is recommended to implement the design of treatment, based on the Imhoff tank sizing.

Keywords: *environment, treatment design sewage water, gauging method, landfill method.*

RESUMEN

El trabajo muestra el uso de aguas residuales por campesinos para actividades agrícolas, su tratamiento nulo genera problemas de insalubridad. Bajo esta mirada el objetivo de la investigación fue diseñar el sistema de tratamiento de aguas residuales en la zona rural del barrio la Pampa del anexo de Auquimarca. Es una investigación propositiva, empleando el Método de aforo para analizar las descargas por gravedad y Método del Vertedero-Triangular para determinar el caudal del agua residual. Se verificó la composición del agua residual para el sistema de tratamiento entre ellos: potencial de hidrógeno, dando como resultado 8.4 (acido pH < 7, y medio básico pH > 7 alcalino), como producto del estudio se recomienda implementar el diseño de tratamiento, tomando como base el dimensionamiento de tanque Imhoff.

Palabras clave: medio ambiente, diseño de tratamiento aguas residuales, método de aforo, método del vertedero.

INTRODUCTION

Wastewater is a global problem; it contributes to nitrogen and phosphorus pollution. These elements act as nutrients and can suppress the proliferation of algae that can be harmful and are characterized by consuming large amounts of oxygen in aquatic ecosystems. The discharge of domestic, industrial and agricultural wastewater and the discharge of water due to excess rain and the congestion of wastewater in sewers, often without cause, cause contamination of receiving water bodies, reducing the quality of surface waters. and underground, putting the health of the population and the integrity of ecosystems at risk. "Water pollution has caused a negative impact on public health, proliferating gastrointestinal diseases" and "causing between 1 and 4 million premature deaths globally in 2019" (Fuller et al., 2022). Cited by (Farfán et al.,2022).

Peru is not immune to this reality, "rural areas are those that have fewer economic resources, which is why the discharge of wastewater is more frequent, affecting the entire ecosystem that surrounds it" (Bryan et al., 2020) , in Ecuador, "the production of wastewater is considered a problem that has been addressed in an ineffective manner due to the absence of sufficient physical infrastructure to treat it, which is why it is considered that 90% of this water is They discharge into freshwater sources without receiving treatment" Montero et al., 2020 cited by (Humanante et al., 2022).

The problem addressed is similar in many countries, the result of the research produces alternative solutions, (Gómez et al., 2022) state that, "it has been found that the reintegration or reuse of these waters is possible in hydrothermal liquefaction technology. leading to a reduction in the volume of wastewater, which is reflected as an environmental and economic advantage." Pervious concrete (PC) is considered a solution to reduce the effects of heat islands, runoff problems and concentrations of contaminants present in water. The results indicate efficiency in the absorption of total phosphorus, total ammonia, nitrate, solids totals and turbidity. Therefore, the use of CP associated with 10% $TiO2$ can add efficiency to the sanitary wastewater treatment process by maintaining good mechanical and hydraulic behavior (Melo et al., 2022).

The La Pampa neighborhood of the Auquimarca annex of the Chilca District, is in a process of population growth, this implies the need to build sewer and storm drain networks, in times of rain they suffer a significant collapse, causing the drains to overflow in homes and in the streets, generating pollution in the environment, the deterioration and wear of the pavement, as well as the non-treatment of waste water due to the lack of treatment plants in the Junín region. The problems detected are of vital importance to resolve since the lack of maintenance in sewage networks negatively influences the health of the population, in addition to affecting the environment.

There is a need to improve health in the neighborhood, it is necessary to expand and improve sewage networks, as well as the provision of treatment systems, in order to reduce the contamination of wastewater, which is used to irrigate crops, generating contamination in them and reducing the increase in diseases. bacteriological in the study area.

Everything stated allows us to propose the following objective. Design the wastewater treatment system in the La Pampa neighborhood of the Annex of Auquimarca, this design of a treatment system can improve the quality of wastewater in the La Pampa neighborhood of the Annex of Auquimarca, in this way avoiding contamination of the environment and the health of the inhabitants and its proper use in agriculture.

MATERIAL AND METHODS

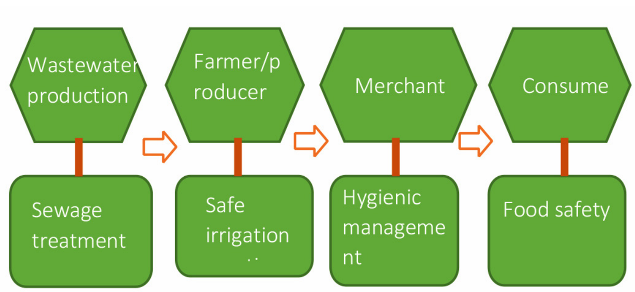
Wastewater

The term wastewater is used to refer to the varied content of liquids and dense remains that come from the supply system of a city that has undergone changes due to the action of various routines in activities carried out by domestic workers, industries, businesses., farmers, ranchers, etc. The residual water at the time of discharge is impossible to be used, as it is dumped into various receiving bodies, but with the lack of preliminary treatment it causes changes in both the terrestrial and aquatic environment, even harming human health. "Man has used water not only for his consumption but also, over time, for his activity and well-being, converting used water into a vehicle or vector for waste. This is where the name "wastewater" arises" (Trapote, 2011) cited by (Palacios, 2023). "Water pollution has become a global problem where toxic substances of organic and inorganic origin impact public health and the sustainability of ecosystems" (Contreras and Bejarano, 2022).

Form of wastewater collection

The collection of wastewaters will have a provision for the rejection of agricultural irrigation and green areas such as parks and gardens. "Wastewater collected in communities and municipalities must be conveyed, ultimately, to receiving water bodies or to the land itself." It adds what contaminant content the wastewater has and at what level they should be eliminated in order to protect the environment" (Palacios,2023). The reuse of wastewater requires the adoption of measures to protect public health. The main purpose of the treatment of wastewater for the purposes of reuse or regeneration of water is the considerable reduction of pathogenic microorganisms, in addition to the elimination of bad odors or other substances that could have a negative effect on the practice of its use. In the case of agricultural irrigation, suspended solids that can clog the nozzles of sprinklers and drippers. According to the WHO and UNICEF, the study on Management of Internal Processes and Environmental Management in Wastewater Treatment Plants is not exempt from control problems to mitigate the problem of environmental pollution and damage to health, with risk in the presence of viruses and bacteria (Pérez et al.,2022).

Fig 1. Wastewater uses for agriculture



Source: self-made
Imhoff tank design

The Imhoff tank is a primary treatment unit whose purpose is the removal of suspended solids, for communities of up to 5,000 inhabitants. The Imhoff Tank offers an advantage for the treatment of domestic wastewater, since it integrates the sedimentation of water and the digestion of settled sludge in the same unit, for this reason it is also called double-chamber tanks (Mucha, 2020), he adds "This alternative is suitable if there are not large areas of land to be able to build a domestic wastewater treatment system, the Imhoff Tank must be installed away from the population, due to the bad odors it produces. "Imhoff tanks have a very simple operation and do not require mechanical parts, however, for their correct use it is necessary that the wastewater go through the preliminary treatment processes of screening and sand removal" (Leyva,2022).

Imhoff tank parameters

A parameter is a component of a system, it allows you to divide it and access its evaluation of any component such as performance, extension or condition that leads to its measurement. "The design parameters determine the basic elements for the progress of the hydraulic design of the Imhoff tank system in the evacuation of wastewater" (Indacochea,2023).

Table 1. Imhoff Tank Parameters

Suspended solids	Reduce 40% - 50%
Biochemical Oxygen Demand (BOD_5)	Reduce 25% - 40%
Chemical Oxygen Demand (COD)	Reduce 40% - 60%

Source: Pan American Center for Sanitary Engineering and Environmental Sciences (CEPIS), Martín and Hernández (2014).

Table 2. Wastewater parameters with the LM P

Parameter	Unit	effluent Imp for discharged into bodies of water
Biochemical Oxygen Demand	Mg/L	100
Chemical Demand for Oxygen	Mg/L	200
pH	UNIT	6.5 – 8.5
Total solids in Suspension	ml/L	150
Temperature	°C	<35
Fats and oils	Mg/L	twenty
Settleable solids	Mg/L	twenty

Source: Ministry of the Environment DS N° 003-2010

Table 3. Parameters of wastewater in the Chemical Laboratory - UNCP

Tests	Results
Hydrogen Potential (PH)	8.4
	1200μ/cm
Electric conductivity	
Turbidity	358.0 NTU
Temperature	16.0°C
Total Suspended Solids	296.0 mg/l
Dissolved oxygen	0.0 m/l
Biochemical Demand for Oxygen (BOD 5)	366.0 m/l
Chemical Oxygen Demand (COD)	813.0 m/l

Source: UNCP Chemical Analysis Laboratory Results

Table 4. Parameters carried out in the Chemistry laboratory - UNCP

Sample	Total coliforms	Fecal coliforms
	nmp/100ml	nmp/100ml
	24 hrs / 37°c	24 hrs / 37°c
Residual water	$2.4 x 10^7$	$9.3 x 10^7$

Source: UNCP Chemical Analysis Laboratory Results

Solution against water leaks

According to Álvarez and Arias (2022). "The applications of filtration processes are very extensive, found in many areas of human activity, both in domestic and industrial life." The current situation of the land where this study will be projected has the presence of a water table - water for the design of our treatment system, the measures to be taken for its present solution are: The water will be evacuated by means of motor pumps, conducted through pipes or sleeves towards the Mantaro River in order to obtain a stable soil for the construction of the proposed system.

Surface drainage system

It is proposed for the purposes of avoiding areas and adequate evacuation of surface runoff into a river "sustainable drainage systems involve managing stormwater as close as possible to its source, reducing runoff, firstly, through infiltration and, when That is not possible, through retention, temporarily storing said water and later discharging it in a controlled manner" (Hidalgo et al., 2022).
Waterproofing System

Evidence of the presence of water in the land planned for construction, after its extraction, a waterproofing system is proposed for the treatment system as proposed, a waterproofing screen composed of cement injections is recommended. The permeability in this stratum will project a value close to 10-5 cm/s. That is, they are materials that can be waterproofed with the use of cement commonly used for conventional construction (Portland type MS) but it is also advisable to add clays (bentonite). To make this treatment effective, the type of cement must be much more ground.

Waterproof Screen

To prepare the design of the waterproofing screen, the results of the permeability tests will have to be considered, in addition to laboratory and field tests, all of this with the purpose of guaranteeing the good operability of the system under construction. The construction of an injection screen is based on the assumption that, during this work, a cylindrical affectation volume is formed around the construction, which represents the injection screen. Impermeable bentonite-cement screens, also called soft, plastic or self-hardening mud , constitute barriers to the passage of groundwater of similar construction to that of diaphragm walls (Cañizo et al ., 1976).

Use of geosynthetics

The use of geosynthetics for the waterproofing of the structure allows the creation of an impermeable barrier in soils susceptible to destabilization, in structures with water circulation in which the waterproof function prevails. Used for buried structures, they are installed inside the soil, crossing the failure surface and capable of resisting bending and shear forces. "The geosynthetics industry incorporates a high degree of polymers as the main manufacturing material, in order to ensure correct deformation and resistance to the stresses that its product will face" (Norambuena et al., 2009).

Geosynthetics dlt drain twenty . The same as the previous geosynthetics, but with the particularity that its resistance is 400 Kn/m2, El DREN 20 is a nodular drainage sheet, used as a drainage layer and waterproofing protection in tunnels and deep constructions.

Geotextile of bentonite . Formed by two geotextiles sewn together and encapsulating bentonite, this geosynthetic is an innovative and highly waterproofing product. Bentonite is a clay material of volcanic origin that expands when it comes into contact with water. Its main function is to waterproof underground extensions.

Wastewater treatment

In a wastewater treatment system, physical, chemical and biological procedures occur. Its consideration in the biochemical changes where the processes that occur in the environment (river, lake, soil, etc.) occur, in an examined manner within the tank or reactor at higher speed.

Process that arises in a domestic wastewater treatment system, starting from pretreatment, primary and secondary treatments, then detailing the tertiary treatments. According to (Mera et al., 2022). The primary treatment consists of a physical process that involves the sedimentation of particles, with the aim of removing grease and sand; and a chemical process is intended to correct the pH of the wastewater; The secondary treatment is a biological process that seeks to reduce the organic loads of the effluents by carrying out the degradation of the organic compounds of the first stage. In the tertiary treatment, they add disinfection and nutrient control, achieving the possibility that these waters are used for agricultural purposes, irrigation in green areas, firefighting systems, among others.

Imhoff Tank

"The Imhoff tank offers advantages for the treatment of domestic wastewater, since it integrates the sedimentation of water and the digestion of settled sludge in the same unit, for which reason it is also called double-chamber tanks" (Leyva,2022). The typical Imhoff tank is rectangular in shape and is divided into three compartments: sedimentation chamber, sludge digestion chamber, and scum accumulation and ventilation area. The Imhoff tank removes 40% to 50% of suspended solids and reduces BOD by 25 to 40%. The sludge accumulated in the Imhoff tank digester is periodically extracted and taken to drying beds (Jabo, 2017).

Likewise, Vela (2018) maintains that "the typical Imhoff tank is rectangular in shape and is divided into three compartments: Sedimentation chamber, Sludge digestion chamber, and Ventilation and cream accumulation area."

- Sedimentation chamber

The behavior for the upper chamber in the tank that receives the black water was sized in order to give an estimated retention time, in relation to the average flow of the black water, the depth in the chamber has a pair of converging slabs where it has a angle of 50° to 60° in reference to the horizontal so that the solid settles and slides into the digestion compartment through the slot, at the entrance it varies from 0.15 to 0.20 m. so that the digestion gas does not enter the sedimentation chamber, inducing turbulence and solid transport to the upper zone. The chamber has a baffle at its inlet for the purpose of uniform distribution to the tributary, which will in turn establish a cream outlet in the tributary.

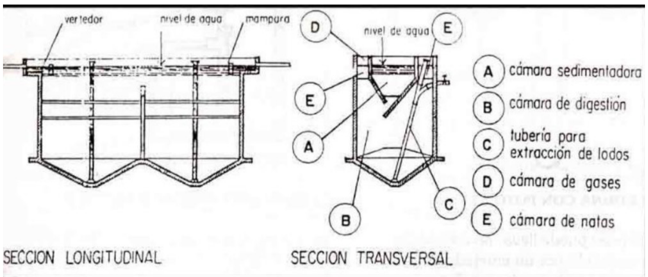
- Digestion chamber:

The interior compartment for the sedimentable solid tank has anaerobic digestion, the compartment will be sized to accumulate sludge during the course of assimilation in relation to the temperature. The depth in the chamber does not have to exceed 50 centimeters, and the digested sludge is removed in the troughs in the middle by a 20-centimeter tube. The diameter, using the hydrostatic head, for this purpose the discharge line is located in a dimension of 1.80 meters to 2.0 meters below the water level of the sedimentation chamber. The pipeline must be equipped by the cleaning line formed in a pressurized water line to fluidize the sludge at the beginning for its extraction operations if relevant. The ascending gases and particles, which are inevitably produced in the digestion process, are diverted towards the cream chamber or ventilation area (Pan American Health Organization, 2005).

- Cream chamber or sludge digestion:

During the digestion, certain solids rise, creating cream and fat that are released into the atmosphere through the chamber. Its minimum width in the chamber will supposedly be 1.0 meter.

Fig 2. Imhoff tank and its parts



Source: Pan American Health Organization, 2005

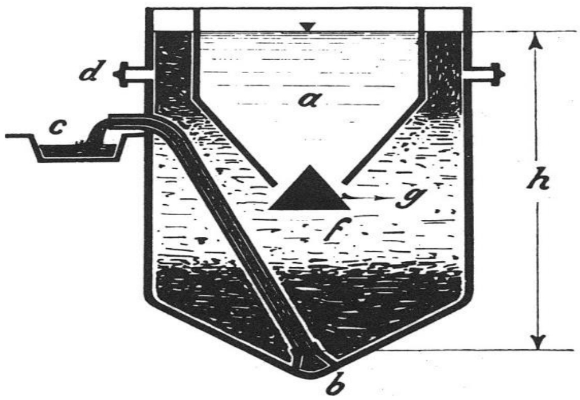
Imhoff tank process

The wastewater enters the sedimentation chamber, in which the sediments are stirred and run down the oblique walls. For the material, it begins to film the arrival inside where it circulates through the overlapping stripe, where it enters the chamber in assimilation. The overlap derives from the material removed during the assimilation, through the cream chamber or ventilation point. The winds derived from assimilation climb through the gas storms, due to the cautious walls paralyzing their progress through the sedimentation chamber. Non-controllable natural factors are represented by meteorological phenomena and variables intrinsic to local conditions, such as wind, temperature, solar radiation, precipitation and evaporation (Sánchez and Matsumoto, 2012).

Imhoff tank operation

The operation of the Imhoff Tank can be seen in the following diagram. The water passes through the sewage systems, enters from chamber a, the solid goes down gently and reaches zone f. In zone f, anaerobic reactions originate, that is, without the mediation of oxygen. The sludge is placed in the space in the lower part of zone f in which it lasts about thirty days, more or less, or until it is well assimilated and is usually isolated through the oblique conduit bc and transferred to the drying pools. of mud the water emerges through the loopholes d and goes to the subsequent part of the process. "They work through an anaerobic degradation process that removes the organic load of microorganisms in order to comply with the regulations of each country regarding its discharge parameters" (Campo, 2022). (See attached diagram)

Fig 3. Imhoff Tank Operation



Source: Pan American Health Organization, 2005

RESULTS

It started with obtaining samples of the residual water, which consists of 2 bottles (samples) with residual water to then be taken to the laboratory for the analysis of the physical, chemical and bacteriological characteristics at the study point of the Auquimarca neighborhood annex. Pampa in the District of Chilca, carrying out previous observations at the study point or area in search of elementary notes and information in preparation for its design.

The search obtained is the amount of current population, the determination of the wastewater flow in the study area, the location of the place where the wastewater final disposal area is located. The main disadvantages that wastewater causes to the population and the consequences that they cause to the environment were investigated.

Sampling Phase

A significant point is the completion of field work, which was to locate the wastewater discharge point in the Auquimarca annex of the Pampa neighborhood. It began with taking samples at the discharge point, to analyze the physical, chemical and bacteriological parameters of the wastewater, it was taken to a specialized laboratory. These were collected in transparent containers for physical and chemical analyzes such as suspended solids, BOD, COD, and a sterilized 250-millimeter glass container for bacteriological analysis.

In turn, initial flow parameters were taken (m 3 /s), the determination of the discharges was made in 5 measurement stages over a period of 24 hours a day, taking the first sample from 8:00 a.m. tomorrow and culminating the sampling phase at 4:00 in the afternoon. The coordinates and altitude of the sampling point were taken with a GPS.

Information Analysis RNE was used as a guideline, this action consisted of comparing the data obtained from field work, whether the. Water quality was between the LMP or if these data exceeded the parameters.

The results of the samples were taken and what parameters they were in, a methodology was used so that the information would help determine which technology would reduce the level of contamination, the purpose is to reach the parameters.

As mentioned above, a comparative table was constructed where the values obtained from the physicochemical and microbiological analysis of wastewater were established, in relation to the discharge of the maximum permissible limit. For which the level of contaminant removal of each technology was established, in order to test the selected alternatives which, have the advantages for greater efficiency of the technique.

Wastewater sample collection

For this process, sterilized bottles designated by the laboratory for the respective analyzes were used. The samples were extracted in the Chica District, Auquimarca Annex, La Pampa neighborhood, with reference to the side of the community bridge, the two samples were collected at 8:30 am in the respective bottles and then taken to the laboratory for the physical and chemical study. and bacteriological of the study sample.

Table 5. Materials and equipment Wastewater sampling.

Materials	Equipment
Packaging (sterilized jars)	Gloves
Rubber boots	Photographic camera
Face mask	Helmet
Note book	

Source: self-made

a) Laboratory phase

The collected samples were taken to the laboratory, for the development of the physical, chemical and bacteriological characterization in the laboratories at the National University of Central Peru – Huancayo.

b) Physical-chemical analysis
In this analysis, the hydrogen potential (pH), electrical conductivity, turbidity, temperature, total suspended solids, diluted oxygen, biochemical oxygen demand (BOD) and chemical oxygen demand (COD) were determined.

c) Bacteriological analysis
In this analysis, the multiple tube method (NMP) was used in the analysis of total and fecal coliforms. In which culture media such as X-GAL Chromogenic Substrate (total coliforms) and Fluorogenic mug substrate (fecal coliforms) were used.

d) Determination of flow

Volumetric Method - Capacity

$$Q = \frac{V}{T}$$

Data collection was carried out on 2 days of the week, Tuesday and Wednesday, as described:

Table 6. Flow measurement day 1

Hour	Volume (gal)	Time (s)	Flow rate (lt/s)
08:00 am	55	17.84	11,670
10:00 am	55	18.16	11,465
12:00 pm	55	17.94	11,605
02:00 pm	55	16.7	12,467
04:00 pm	55	16.92	12,305
Average Flow Rate (Q 1)		11,902 lt/s	

Source: self-made

The flow measurement in 1 day of field study was carried out by taking the data at an interval of every 2 hours starting from 08:00 am to 04:00 pm, using a cylinder with a volume of 55 gallons equivalent. at 208,197 lt, in turn in each interval the 5 times it took to fill the cylinder with residual water were taken and a specific flow rate was determined in each interval, the highest flow being at 2 in the afternoon with 12,467 lt/s and lowest flow at 10 in the morning with 11,465 lt/s and to finish, an average was found for a final flow on the day of 11,902 lt/s.

Table 7. Flow measurement day 2

Hour	Volume (gal)	Time (s)	Flow rate (lt/s)
08:00 am	55	18.65	11,163
10:00 am	55	19.11	10,895
12:00 pm	55	16.86	12,349
02:00 pm	55	17.56	11,856
04:00 pm	55	18.25	11,408
Average Flow	11,534 lt/s		

Source: Own production

The flow measurement on the 2nd day was carried out by taking the data at an interval of every 2 hours starting from 08:00 am to 04:00 pm, using a cylinder with a volume of 55 gallons equivalent to 208,197 lt. In turn, in each interval, the 5 times it took to fill the cylinder with residual water were taken and a specific flow rate was determined in each interval, with the highest flow rate at 12 noon with 12,349 lt/s and the lowest flow rate 10 in the morning with 10,895 lt/s and to finish, the average was found for a final flow rate for the day of 11,534 lt/s.

Weir Method – Triangular Theoretical Flow

$$Q = \frac{8}{15}\sqrt{2g}(\text{tg}\,\frac{\theta}{2})h^{\frac{5}{2}}$$

Real Flow: It is multiplied by a discharge coefficient (Cd)

$$Q = \frac{8}{15}cd\sqrt{2g}(\text{tg}\,\frac{\theta}{2})h^{\frac{5}{2}}$$

Where the discharge coefficient values are:

Angle θ	**CD**
15°	0.52 – 0.75
30°	0.59 – 0.72
45°	0.59 – 0.69
60°	0.50 – 0.54
90°	0.50 – 0.60

For our calculation we obtained the following data in the field:

- θ = 90°
- Cd= in relation to the angle of the triangular weir
- h= For height, 5 data were taken at different times on a given day

Table 8. Measurement of triangular weir heights

Hour	Height (h) - cm
08:00 am	0.15
10:00 am	0.16
12:00 pm	0.16
02:00 pm	0.15
04:00 pm	0.14
Average heights	0.152

Source: Own production

Table 8 shows the results of the triangular spillway, the measurements were every 2 hours starting from 8 in the morning until 4 in the afternoon, we sought to determine the 5 heights to the water sheet (h) in each period of time, being the one with the highest height at 10 in the morning and at 12 noon with 16 cm respectively, while the lowest height was at 4 in the afternoon with 14 cm. Once the heights were established, an average of them was calculated in the equation of the flow.

With the average height obtained in the field, the flow calculation is determined:

Theoretical Flow:

$$Q = \frac{8}{15}\sqrt{2g}(\text{tg}\,\frac{\theta}{2})h^{\frac{5}{2}}$$

$$Q = \frac{8}{15}\sqrt{2x9.81}(\text{tg}\,\frac{90}{2})0{,}152^{\frac{5}{2}}$$

Q = 0.0213 actual flow

It is multiplied by a discharge coefficient (Cd)

$$Q = \frac{8}{15}cd\sqrt{2g}(\text{tg}\,\frac{\theta}{2})h^{\frac{5}{2}}$$

Since the spillway is triangular in shape, the angle is 90°, therefore, according to its discharge coefficient (cd) it is:
Angle θ = 90° and Cd= 0.50 - 0.60 Cd= 0.55
Q = 11,705 lt/s
The following flow rate will be used for the work:
Flow rate (q)=11.72 lt/s

Parameters evaluated in the laboratory - physical and chemical analyses.

Table 9. Parameters performed in the wastewater laboratory

essays	Methods	Results
Hydrogen Potential (PH)	MS – 4500 – H + – B – Electrometric	8.4
Electric conductivity	M.S. – 2510 – B – Laboratory method	1200 µs/cm
Turbidity	MS – 2130 – B – Nephelometric	358 NTU
Temperature	MS – 2550 – B – Laboratory method	16°C
Total Suspended Solids	MS – 2540 – D – Dried at 103°C – 105°C	296 mg/l
Dissolved oxygen	MS – 4500 – 0 2 – G– Oximeter Membrane Electrode Method	0.0 mg/l
Biochemical Oxygen Demand (BOD_5)	MS – 5210 – B rod 5 days – Respirometer	366 mg/l
Chemical Demand for Oxygen (COD)	MS – 4500 – 0 2 – G- Oximeter Membrane Electrode Method	813 mg/l

Source: UNCP Chemical Analysis Laboratory Results

DISCUSSION

The study aims to design a waste treatment system in Auquimarca-Pampa using the Imhoff tank to reduce water pollution caused by desalination. It focuses on agricultural areas contaminated by soil and used for human and animal consumption. The design of the treatment plant will improve the quality of excess water and reduce environmental pollution. Similar studies such as Arocutipa agree that the treatment plant reduces water pollution caused by the discharge of excess water directly to the body's receptor. Both investigations are supported by theories of waste treatment, which include primary treatments that prepare excess water, remove contaminants, reduce turbidity and reunify the water, and secondary treatments that include continuous biochemical and aerobiological treatment.

Analysis and recommendation. The treatment design is based on the Imhoff dimension and the RNE OS 090 "Plant for wastewater treatment" standard. Currently, there is no plant to treat these rivers as farmers use them to irrigate crops, which poses health risks. Physical, chemical and bacterial characterization will be carried out to determine if the water is treated and suitable for its intended use. To evaluate the effectiveness of the system, examination and testing in the laboratory is recommended. The program will monitor the treatment process and detail operation and maintenance procedures.

Costs of this and other alternatives

The budget for the implementation of the design, from planning to completion is S/. 100,000 soles, the budget must be assumed by the Regional Government with allocation to the budget for the execution of municipal works.

CONCLUSIONS

The design of the treatment system is through the Imhoff tank, allowing the pollution of wastewater from the La Pampa neighborhood to be reduced. In accordance with the provisions of Standard OS 090 "Wastewater Treatment Plant" of the National Building Regulations.

The wastewater flow rate was determined using two methods, the first using the gauging method and the second using a triangular weir. For the first method, it was determined by measuring the flow rate for two days, obtaining an average of 11.72 lt/ s. For the second method, a flow rate was determined according to the average of hourly variations, obtaining an average of 11,705 lt/s. Having both data using the developed methods, an average final flow rate of 11.72 lt/s was obtained in the Pampa neighborhood.

The estimated future population, taking into account the current population of the neighborhood and not knowing the real population of this neighborhood due to

lack of information from the institutions in charge of specifying it through specific censuses, the alternative is taken to find the current population with a proportional mathematical model, which allows us to get closer to the size of the population, this information was used to estimate the future population applying the geometric method with a growth rate of 1.6%. In a design period of 20 years, it is 724 inhabitants.

The composition of the wastewater for the treatment system was verified, including: hydrogen potential, resulting in 8.4 (being acidic pH <7, and in a basic medium and when pH >7 is alkaline), For our study our PH results It is alkaline, as for the electrical conductivity of the waste water, it varies from 1200 µs/cm, the turbidity determined was 358.0 NTU. The Temperature according to evaluation is 16.0 °C, complying with the Maximum Permissible Limits (LMP), the total suspended solids reached a value of 296.0 mg/l. the dissolved oxygen value is 0.0 mg/l. The biochemical oxygen demand (BOD 5) is 366 mg/l. As established in the laboratory with a 94 ml sample in its analysis using the standardized method (MS), chemical oxygen demand (COD) gave a value of 813.0 mg/l.

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