

## CLEAN WATER AND SANITATION IN BIOREMEDIATION TREATMENT OF SLAUGHTERHOUSE WASTE AS ENVIRONMENTALLY SAFE SOLUTIONS THAT SERVE SUSTAINABLE DEVELOPMENT

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**Abstract:** Sickness is a problem that affects one in three people. Unneeded illness and death are the outcome of this. The availability of clean drinking water has significantly improved, but inadequate sanitation is eroding these advancements. With the provision of affordable equipment and hygiene teaching, we can eliminate this unnecessary suffering and death. The use of biological treatment technology to treat slaughterhouse effluent is a highly practical and cost-effective option. Various technical approaches were examined in order to obtain the necessary quality of effluents for disposal or reuse. However, most practical procedures come with a slew of benefits and drawbacks. However, because slaughterhouse waste contains biodegradable organic matter, anaerobic digestion technology is frequently used for commercial advantage. The common approaches utilized in the treatment of wastewater in slaughterhouses, as well as their applicability, are discussed in this study. The benefits and drawbacks of various techniques were weighed. Anaerobic, facultative lakes, Additionally demonstrated to be effective were drip filters and the activated sludge method, however they needed longer start-up periods. The different tactics utilized in other wastewater treatment to create useful by-products through anaerobic digestion are also explored in this study.

**Key words:** sww, Massacres and bioremediation.

**INTRODUCTION:*****Environmental pollution problems with slaughterhouse wastewater***

Slaughterhouse effluent was classed as industrial wastewater under the food and agriculture sectors category [1]. SWW comprises a high quantity of partly soluble organic materials, resulting in a highly damaging impact that removes oxygen from rivers and pollutes groundwater. [2,3]. Due to human activities such as agricultural operations, surface water quality deterioration has become a well-studied topic [4,5]. SWW is the most polluting and detrimental to the environment, according to the EPA and different European regulations [6,7]. Due to the presence of blood, it includes significant quantities of organic matter such as BOD, COD, nitrogen, and phosphorus. Fats, lipids, proteins, suspended particles, and some natural manures are among the most significant dissolved contaminants [8,9]. According to Aniebo [10], one cow's effluent burden is comparable to the whole sewage produced by 50 persons on a daily basis. When slaughterhouse effluent is released into receiving water bodies, it has a high quantity of nitrogenous chemicals, which causes issues such as algal blooms, eutrophication, and river deoxygenation [1,11]. Groundwater contamination [12] and irrigation water pollution are both caused by untreated SWW discharge [13].

Some slaughterhouses are under the control of the Ministry of Agriculture's veterinary units. They're mainly found along riverbanks in cities and villages, with sewage being released into surrounding waterways without treatment. As a result, a suitable treatment method must be used to regulate the discharge of nitrogen and carbon contents in this effluent. The most effective way for treating slaughterhouse wastewater has been proved to be biological treatment using several methods [14-16]. Due of their substantial energy use, significant sludge output, and sensitivity to large organic loads, aerobic treatment techniques are limited [17,18]. Anaerobic treatment is efficient and economical, but requires Because of the buildup of suspended particles and floating lipids in the reactor, there is a lengthy hydraulic

retention period and a huge reactor volume resulting in reduced methanogenic activity and biomass washing [19]. To minimize sludge washing, there is a basic necessity for elevated biomass content and loss of sludge management [20].

Due to the negative consequences of pollution on the environment, Over time, the ability to treat industrial wastewater with high strength has improved. The release of raw slaughterhouse water poses a serious risk to public health and environmental hazard [21]. Although rivers have a natural cleaning potential, releasing such effluents often without first treating them might overload the receiving water body. Today, waste minimization and resource recovery must be included into wastewater management [22]. Although the volume and quantity of fresh water consumed by the various slaughterhouse industries vary, it is typically desirable to decrease wastewater formation at its source. The slaughterhouse waste water contains organic by-products that are classified as industrial organic waste and are difficult to handle owing to their high protein and fat content. Blood, punches from rumen and intestinal content removal, intestinal waste from evisceration [23], fat from butchering, and head and extremities are among the primary organic flows that SWW has shown as sticky in nature (mostly bone). Traditional wastewater and solid waste treatment procedures are comparable to modern treatment of municipal wastewater techniques, which include physical, chemical, and biological treatments, each with its own set of benefits and drawbacks.

Because of the significant levels of Pathogens, organics, and cleaning agents discovered in SWW, MPP effluents often have a high organic matter concentration and residues are partly solubilized, resulting in a polluting impact. Because the pollution loads produced from the kind and quantity of animals slaughtered vary across the meat sector, SWWs are normally measured using bulk metrics [24].

***Biological treatment to reduce this problem.***

After initial treatment, biological therapy is utilized in order to lessen the focus of Biochemical Oxygen Demand (BOD) and other

soluble chemicals [25]. When aerobic and anaerobic digestion function alone or in combination with packing materials, depending on the SWW's qualities, the biological process is utilized [26]. Biological treatment, in contrast to physical and chemical treatment, employs microorganisms to remove organic debris from effluent wastewater. According to certain studies, a biological technique that appropriately employs Up to 90% of BOD in effluent wastewater can be eliminated by aerobic or anaerobic processes. Activated sludge process, facultative lakes, anaerobic, aerobic, and drip filters are examples of biological systems [27]. Biological treatment procedures, in general, are the outcome of a population of microorganisms cooperating to break down organic waste [65].

The suggested biological treatment is anaerobic treatment, which is effective in treating high-strength wastewater such as SWW while needing less complicated equipment [28]. When anaerobic treatment is successful, when complete organic matter stabilization is not achieved by anaerobic treatment alone, anaerobic treated effluents require post-treatment to fulfill discharge constraints. Anaerobically treated effluents have more solubilized organic materials, making them more suitable for aerobic treatment. Anaerobically treated effluents include solubilized organic materials, making aerobic treatment more suitable. Because their rates are greater than those of traditional anaerobic treatment methods, aerobic treatment systems are used in wastewater treatment systems more often. Because wastewater strength is closely correlated with oxygen requirements and treatment duration, aerobic treatment is commonly used as a posttreatment for anaerobic effluents as well as for nutrient removal [29].

#### **Anaerobic therapy (AT)**

The ideal technique for treating highly concentrated industrial effluents is anaerobic digestion because, in the absence of oxygen, anaerobic bacteria break down organic molecules into CO<sub>2</sub> and CH<sub>4</sub>. Among the benefits of anaerobic systems are their high COD elimination rate, low energy needs with the possibility of resource recovery, and decreased

sludge generation. Anaerobic baffled reactors (ABRs), anaerobic digesters (AD), anaerobic filters (AF), anaerobic lagoons (AL), septic tanks (ST), and up-flow anaerobic sludge blankets (UASB) are common anaerobic systems for the treatment of meat processing effluents [30].

Anaerobic treatment, on the other hand, falls short of existing discharge limits. The high organic strength of SWW makes total stability of organic molecules difficult. As a result, after anaerobic treatment, a second treatment step is required to remove any leftover organics, nutrients, or pathogens. Anaerobic treatment, on the other hand, needs greater room and a longer residence time in order to achieve high overall treatment efficiency, lowering its economic viability. As a result, to obtain maximal efficacy in the treatment of SWW, a mix of anaerobic and aerobic therapy is required [31].

#### **Anaerobic lake (ALs)**

Anaerobic lakes (ALs) have been frequently used to treat wastewater, particularly in hotter developing nations. Climate, location, land availability, and proximity to metropolitan areas all influence the approach employed [29]. As a result, it is supplied via the bottom of the system and not manually combined. It's normally injected from the bottom of the system and isn't mechanically blended. Layer A scum layer forms frequently on the lake's surface, ensuring that the system is a common layer of scum that forms frequently on the lake's surface, ensuring that the system is cohesive of scum that frequently forms on the lake's surface, as well as ensuring that the system operates under anaerobic conditions with little heat loss. A typical anaerobic model was shown in Figure 1. According to research [32,33], The removal of atypical AL, CDO, BOD, and TSS was shown to have a removal efficacy of 96 percent, 97 percent, and 95 percent alternatively with a depth of 3-5 meters and a watery secretion duration of 5-10 days.



**Figure 1: Anaerobic lake for wastewater treatment[29]**

However, this system has drawbacks, such as odor creation and reliance on weather and odor, and to collect biogas and trap odor, an artificial floating cover is often utilized, as illustrated in Figure 2.

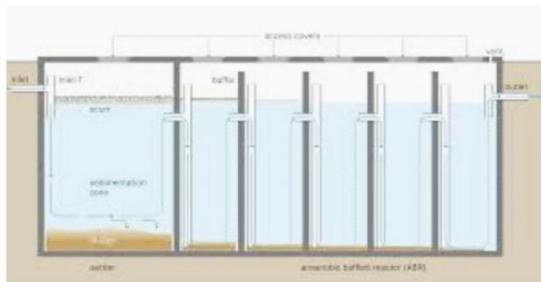


**Figure (2): Anaerobic lake with cover[32]**

Furthermore, The synthetic covering has to be long-lasting and able to endure temperature changes as well as the accumulation of ice and snow. ALs are frequently used to treat SWW because of their simplicity and inexpensive operating and maintenance expenses, especially in underdeveloped nations [32].

### **Anaerobic filters**

Because the system has a decreased danger of leaching the static biomass, anaerobic filters are often operated in the upper flow mode, as indicated in Figure 3.



**Figure 3: Anaerobic filter for wastewater treatment[33]**

The filter must be submerged in water medium by at least 0.3 meters to achieve an equal flow regime. The most critical design parameter that influences filter effectiveness is hydraulic retention time (HRT). The optimum filter for bacteria growth should have a wide surface area and tiny holes to minimize clogging. The increased surface area assures enhanced interaction between the organic materials and the related biomass, which finally breaks down. Per cubic meter of reactor volume, the material should ideally cover an area of 90 to 300 square meters. Filter content sizes typically range from 12 to 55 mm in diameter. Depending on local availability, common items include mud, broken stone or brick, pumice, and specifically shaped plastic pieces. The systems are used to treat solid waste in a secondary process that results in significant solids removal and biogas production. A fixed bed bioreactor is often paired to a filter chamber in these systems, which run in series. The large and medium dispersed particles in the SWW are retained inside the filter chambers, where the active biomass connected to the filter surface destroys the organic matter particles [33]. At medium and thermophilic temperatures, the performance of SWW-treated anaerobic upward-flow filters (UAFs) was examined. The COD removal effectiveness in the moderately hydrophilic condition was 90%, but only 72% in the thermophilic state at an organic loading rate (OLR) of 9 g/L/day. [33], on the other hand, investigated a mean treatment (35 °C) of SWW with a high organic loading rate of 10.05 kg/m<sup>3</sup> day and HRT for 12 h. With normal methane production ranging from 46 to 56 percent, the system achieved a COD removal rate of 79 percent, experiment with it [34]. Several experts have looked at the impact of substrate properties and microorganisms found in sludge and supporting media on atrial fibrillation. In 1-day HRT, the maximal COD and TN elimination efficiency were 80 and 90 percent, respectively. The primary drawback of the anaerobic barrier reactor is that it requires comparatively higher temperatures for optimal performance, however this is not a problem in tropical areas.



from 1,820 to 12,790 mg/L, and the study was run in 24-hour HRT for 90 days. In a related event, Chavez and his colleagues [44], [45] found a 95% BOD removal effectiveness of UASB in slaughterhouse waste treatment at an appropriate OLR of 31,000 mg/L in 3.5 and 4.5 h HRT under medium loading conditions. Miranda worked on a large-scale 800m<sup>3</sup> UASB reactor that treated SWW with COD concentrations ranging from 1400 to 3600 mg/L and oil and grease content ranging from 413 to 645 mg/L. According to their findings, it has a COD removal effectiveness of 70-92 percent and a 27-58 percent oil and grease removal efficiency. Furthermore, after a 10-hour HRT and altering the COD content in the UASB reactor from 3000 to 4800 mg/L, study [46] found an ideal COD removal efficiency of 90%. [47] Examine the output of a UASB reactor treating SWW at ambient conditions after solids separation. With regard to OLRs, improved COD removal efficiency have been documented. The system has a high COD elimination effectiveness of 90% with an effective oxygen content of 3,437 mg/L. While UASB reactors have been shown to be successful in treating SWW, current water quality criteria for water body discharge necessitate an additional treatment phase. However, the lack of a sludge cleaning mechanism results in a high flow velocity upwards, slowing the growth of methanogenic bacteria.

An inquiry into anaerobic digestion was carried out in order to uncover essential ideas and operational characteristics related with total upstream anaerobic sludge reactors, such as technology used and issues pertinent to the studies. The research includes significant information on the COD removal and biogas generation efficiency of UASB reactors that treat slaughterhouse and slaughterhouse-related wastewater. The effects of OLR and HRT on system efficiency, which is likely one of the most critical elements in digesting abattoir and other organic waste, have gotten a lot of attention. [48] reported a 30-62 percent COD removal effectiveness in a laboratory size investigation of anaerobic digestion of slaughterhouse effluent. The effectiveness of COD removal and biogas production was poor, as can be shown.

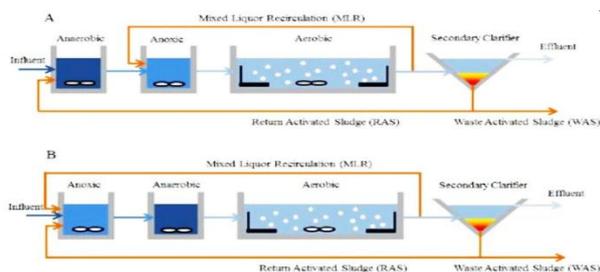
Hypothermia and HRT might be to blame. Similarly, on a laboratory scale, [49], [50] investigated anaerobic digestion of slaughterhouse effluent. The regimens, however, have been reported to be characterized by longer HRT therapy and lower biogas generation. An experimental scale investigation, on the other hand, revealed a high efficiency in removing COD [51,52]. On the other hand, [49] discovered a very low specific production of methane (SMP), which might be ascribed to the effluent's reduced COD (COD = 7049.07- 306.42 mg/L).

With excellent success, the UASB reactor has treated a variety of industrial organic effluents, both high- and low-strength household wastewater. However, the systems had a lengthy HRT, despite the fact that they had a low HRT removal efficiency and a high COD removal efficiency in the experiments [53] and [54], and the effective COD content was extremely low compared to other wastes. As a result, the UASB reactor must be modified to treat high-strength wastewater with a higher OLR and shorter HRT while also complying with strict environmental laws.

#### *Hangin and attached growth process*

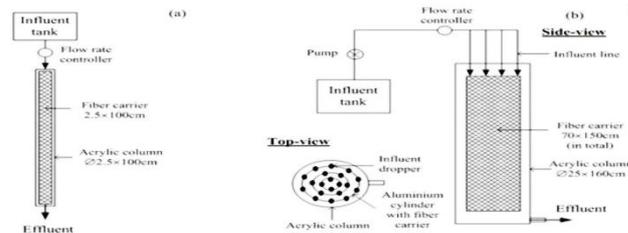
Industrial organic effluents, Waste passes through and around free-floating microorganisms in suspended growth environments, such as activated sludge processes (Figure 6a, b), as well as aerated lakes and aerobic digesters, aggregating in biological flocks that settle out of the sewage. Anaerobic system performance, including that of low- and high-strength systems, is significantly impacted by COD, total N, and total P as well as operating parameters including HRT, SRT, dissolved oxygen (DO), activated sludge return (RAS), and mixed fluid recycling flow rate (MLR) (Figure 6a). Sludge's detrimental effects on bacterial development, which prefers to exist in alternating anaerobic and aerobic environments because of bacterial population competition for organic substrates, are a cause for worry. The process that is anoxic, anoxic, and aerobic in reverse (Figure 6b) is intended to increase bacteria's performance by exposing them to aerobic conditions, thereby

overcoming the disadvantages of anaerobic, anoxic, and aerobic processes.



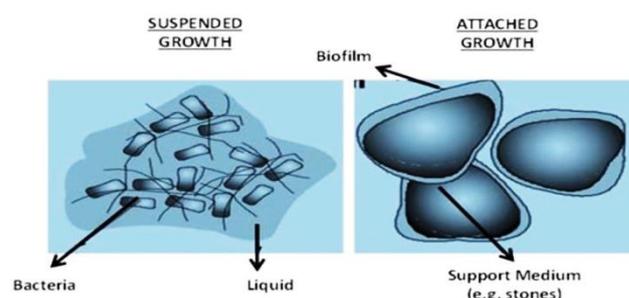
**Figure 6: The two traditional activated sludge techniques are depicted in this diagram. The diagrams are identical: (a) and (b). The main difference is that MLR sometimes returns to an aerobic state (A) and other times to a hypoxic state (B)[54]**

As clumps in growth systems, the microbial mass is kept in the reactor mixed fluid. Mechanical mixers or gas infusion suspend these masses while churning. The latter is commonly air in aerobic operations and biogas in anaerobic systems. The close connection between the substrate and biomass is facilitated by agitation. Microbes attach in biofilm systems, to the support media in a thin layer. A stationary or moving bed can be used for this. Permanent or fixed beds are often molded plastic or pebble forms, whereas moving beds may contain granular activated carbon or sand grains. While the reactor is running, these support media layers can be submerged in a mixed alcoholic beverage or exposed to air and wastewater. Suspended growth systems make up the majority of aerobic systems utilized in wastewater treatment plants. The aerated lake, oxidation trench, and batch sequencing reactor are all examples of suspended growth systems. Suspended growth biofilms, on the other hand, can occasionally be assimilated into aerobic systems. Biological wastewater treatment procedures with biomass connected to certain types of medium are known as attached growth systems (also known as fixed membrane processes). A growth system attached to a laboratory scale is shown in Figure 7a, while a growth system attached to an experimental scale is shown in Figure 7b.



**Figure (7): The associated growing system is depicted in a schematic picture. The growing system is depicted on (a) the laboratory scale and (b) the experimental scale in the diagram[55]**

These are comparable to those seen in secondary bioremediation. Ciliates, rotifers, nematodes, and a variety of other free-swimming and stalking species are examples of microorganisms. Attached growth methods are simple to run and shock robust, but they lack the flexibility of process control activated sludge technologies [54].



**Figure (8): Typical hanging and attachment growth system examples [54]**

### *Aerobic treatment*

Aerobic techniques are often utilized for further therapy and nutritional extraction following first treatment. Because the amount of oxygen required and the length of therapy are related to the SWW's strength, It works well as a post-anaerobic treatment but is ineffective as a main therapy [55].

Reduced odor creation, rapid biological growth rate, and quick temperature and loading rate adjustments are just a few of the benefits of aerobic wastewater treatment systems. Aerobic systems, on the other hand, have higher operating costs than anaerobic systems because artificial oxygenation necessitates more maintenance and energy. Aerobic unit activities for SWW

treatment include aerobic AS, SBRs, or sequencing batch reactors, and revolving biological contactors (RBCs) [56].

### ***Constructed wetlands***

Biological and physicochemical processes for the organic matter and nutrients' adsorption, biodegradation, filtration, photooxidation, and sedimentation from the interaction of plant, soil, microorganisms, and atmosphere are used in constructed wetlands (CWs) for water purification. Both horizontal and vertical subsurface flow CWs were used to investigate the efficacy of CW systems for the treatment of SWW. For numerous plant species, the results demonstrated The maximum reductions of 99, 97, 85, and 78% for BOD, COD, TSS, and TN, respectively, show a broad range of organic and nutrient removal [57]. Because of their straightforward operations, low operating and maintenance costs, and minimal environmental impact, CWs are a desirable alternative to traditional treatment methods [58].

### ***Wastewater management and resource recovery in slaughterhouses***

Given the portion of the meat processing industry's waste and byproducts that may be recovered for direct reuse, such as nutrients and methane for biofuel, waste reduction and resource recovery must be included into SWW management procedures. Starting with animal farming and raw materials and concluding with waste disposal and recoverable resources, Figure 5 represents the ideal operation of a meat processing facility and supply chain [59, 60].

Meat processing businesses should work on cleaner operations because of the growing demand for green practices and interest in environmental projects. As a result, identifying and reducing waste production at the source is the greatest option, and for energy recovery and water reuse, on-site treatment is the ideal choice. As a result of, a number of procedures must be taken to adequately treat SWW effluents [61- 67].

Anaerobic digestion has emerged as a potential solution for treating low- and high-powered effluent in slaughterhouses, according to studies, despite the fact that it is a complicated and

sensitive process. pH, Temperature, loading rates and hydraulic retention time, in addition to wastewater and biomass characteristics, all play a part in an anaerobic reactor's performance.

Anaerobic digestion has emerged as a potential solution for treating low- and high-powered effluent in slaughterhouses, according to studies, despite the fact that it is a complicated and sensitive process. pH, Temperature, loading rates and hydraulic retention time, as well as wastewater and biomass parameters, all have a role in the operation of an anaerobic reactor. Anaerobic (25°C), mesophilic (25-40°C), and hot (>45°C) temperature conditions for anaerobic reactors were also determined to be appropriate for optimum substrate breakdown. The reactor's performance was shown to be more stable at mesophilic temperatures (25-40°C) in most experiments. Similarly, the pH level is normally steady between 6.5 and 7.5. The UASB reactor outperformed the other anaerobic reactors in terms of biogas output and COD removal efficiency at high OLR. Several studies have looked at the impact of connected growth medium in enhancing microbial growth concentration. However, most systems, particularly in traditional UASB reactors, were characterized by a lengthy HRT and a low OLR. Furthermore, most of the media utilized in anaerobic reactors are coupled bacteria that are naturally produced in a suspended mobile medium, leading the media to flow onto the substrate surface at a faster pace during impact pumping, resulting in insufficient interaction between microbes and media. Furthermore, because microorganisms and medium are separated, bacteria can readily fly away during wastewater discharge. Despite various research on the subject, none has evaluated the performance of a standard UASB reactor with fixed growth medium coupled to a coarse and large surface area that confines the whole sludge region of a reactor for high-strength cow slaughter wastewater (CSWW) certified by UASB. Following the review of the literature, several significant knowledge gaps were discovered, particularly in both processes, anaerobic and aerobic, as well as a several ideas and methodologies that might be helpful for next

studies. High energy needs, a large installation space, a large volume of sludge creation, as well as ineffective small and mid-sized businesses are all characteristics of aerobic processes. Similarly, bacterial development in most systems lacking oxygen necessitates a long HRT, and sludge cleans up quickly with large microbial assemblies during effluent discharge, while being temperature sensitive. As a result of the literature evaluation, certain important knowledge gaps were found, notably in aerobic and anaerobic processes, as well as a number of concepts and techniques that might be beneficial in future study. High energy needs, a large installation space, a large volume of sludge creation, and inefficient modest and middling-sized businesses are all characteristics of aerobic processes. Similarly, bacterial development in most systems lacking oxygen necessitates a long HRT, and sludge with vast microbial assemblies cleans up quickly after effluent discharge, while being temperature sensitive.

#### CONCLUSION:

Slaughterhouses discharge effluents that are high in organic matter and potentially harmful to the environment. Water quality is impacted by the release of this material into the nearby environment, rivers, and aquatic environment without sufficient treatment.

The physicochemical analysis of slaughterhouse wastewater in this study does not satisfy the permitted limit set by the National Environmental Standards and Regulation Enforcement Agency (NESREA), and is thus unfit for disposal into the environment. To avoid pollution of the environment, especially surface and ground water, it is consequently critical to implement adequate slaughterhouse wastewater treatment methods. This study demonstrates that untreated abattoir effluents created at slaughterhouse waste water pose a major environmental and health risk to the abattoir neighborhood, and that regulatory authorities should enforce stringent environmental management.

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