Waste water treatment in brewery industry, Review

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Abstract - Breweries are the traditional industry in agro and sector using cost effective techniques to manufacture the best quality product. Beer is a soft drink obtained through alcoholic fermentation, using selected yeasts of the genera Saccharomyces, of wort prepared from malt cereals, mainly barley, and other amylaceous or sugar-based raw materials. Most of the solid wastes and waste waters firms industries are discharged into the soil and water bodies and thus ultimately pose a serious problem threat to human and routine functioning of ecosystem. The main characteristics of environmental concern that can be associated with brewery wastewater include Biochemical Oxygen Demand (BOD)/ Chemical Oxygen Demand (COD) concentration, TSS concentration, pH, nutrients (nitrogen and phosphorus) concentration and temperature. Water pollution is serious problem globally involving the discharge of dissolved or suspended substances into groundwater, streams, rivers and oceans. A major source of pollution in developing countries is industrial activities and this has gradually increased the problem of waste disposal. Anaerobic bacterial degradation of organic matter (i.e. in the absence of oxygen), methane gas (CH_4), carbon dioxide (CO_2) and traces of other elements are produced. Aerobic biological treatment is performed in the presence of oxygen by aerobic microorganisms (principally bacteria) that metabolize the organic matter in the wastewater, thereby producing more microorganisms and inorganic end-products (principally CO_2, NH_3 and H_2O).The overall result is a growing interest within the brewing industry in environmental pollution controls systems.

Keywords - Waste water, Breweries, Chemical Oxygen Demand, Biological Oxygen Demand, Concentration, Total Suspended Solid.

1. Introduction

Breweries are the traditional industry in agro and sector using cost effective techniques to manufacture the best quality product. During the process beer is alternatively possess through three chemical and biochemical reaction(mashing, boiling ,fermentation, and maturation) and tree solid liquid separation (wort separation ,wort clarification, and rough beer clarification) consequently the water consumption . Waste water generation and solid-liquid separation after real economic opportunities for wastes generated including ,glass ,paper, card board, plastics, wood, biological sludge, green residues and other industrial solid wastes [1].

Untreated wastes from processing factories located cities are discharged into inland water bodies resulting to stench, discoloration and a greasy oily nature of such water bodies. These wastes pose a serious threat to associated environment, including human health risks. Thus there is need to control the pollution of surface and ground water since the public health and wellbeing of the people have a direct link with the availability of adequate quantity of good quality water [2].

Brewery plants have been known to cause pollution by discharging effluent into receiving stream, ground water and soil Water consumption for breweries generally ranges from 4-8 cubic meters per cubic meter of beer produced. Production steps include malt production, wort production and beer production. Over the last century, continued population growth and industrialization have resulted in the degradation of various ecosystems on which human life relies on. In the case of ocean and river quality, such pollution is primarily caused by the discharge of in adequately treated industrial and municipal wastewater. On initial , these waste waters can contain high levels of inorganic pollutants which can be easily biodegradable, but whose impact load on the ecosystems, either in Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), or Chemical Oxygen Demand (COD), may be in the tens of thousands mg/L [3].

Anaerobic sludge digester, being one common part of the activated sludge process (an aerobic wastewater treatment process) and the up flow anaerobic sludge blanket (UASB). Reactors (joint anaerobic treatment of wastewater and sludge) are suitable for the treatment of municipal wastewater. Anaerobic sludge digesters have a long tradition primarily in industrial countries. Municipal wastewater treatment often combines anaerobic and aerobic treatment steps in order to achieve the best possible purification and hygienisation results [4].

Both aerobic and anaerobic process can be used the former involves the use of free or dissolved oxygen by microorganisms (aerobes) in the conversion of organic wastes to biomass and CO_2 while in the latter complex organic wastes are degraded into methane, CO2 and H_2O through three basic steps (hydrolysis, acidogenesis including acetogenesis and methanogenesis) in the absence of oxygen [3].

Aerobic biological processes are commonly used in the treatment of organic waste waters for achieving high degree of treatment efficiency, while in anaerobic treatment, considerable progress has been achieved in anaerobic biotechnology for waste treatment based on the concept of resource recovery and utilization while still achieving the objective of pollution control Highly polluting industrial waste water are preferably treated in an anaerobic reactor due to the high level of COD, potential for energy generation and low surplus sludge production. However in practical applications, anaerobic treatment suffers from the low growth rate of the microorganisms, a low settling rate, process instabilities and the need for post treatment of the noxious anaerobic effluent which often contains ammonium ion (NH_4^+) and hydrogen sulfide (HS^-) [3].

2. Literature review

2.1. Definition of Brewing

Brewing is a water-intensive process. Wastewater, sludge and effluents are the negative products from the brewing process considerable efforts have been initiated to reduce the quantity of water used up in the production of a liter of beer by breweries, due to water scarcity and to comply with global water efficiency in beer production. Beer making requires good and clean water in large quantities. Moreover, water conservation has become a subject of vital importance, due to scarce water supply. Reducing the amount of water used in a brewery process does not only reduce the supply costs of water, but also the volume of effluent discharges. Wastewater from brewery process are discharged into waterways such as rivers, streams or lakes; discharged directly into municipal sewer system; or into municipal sewer system after the wastewater has undergone some treatment [5].

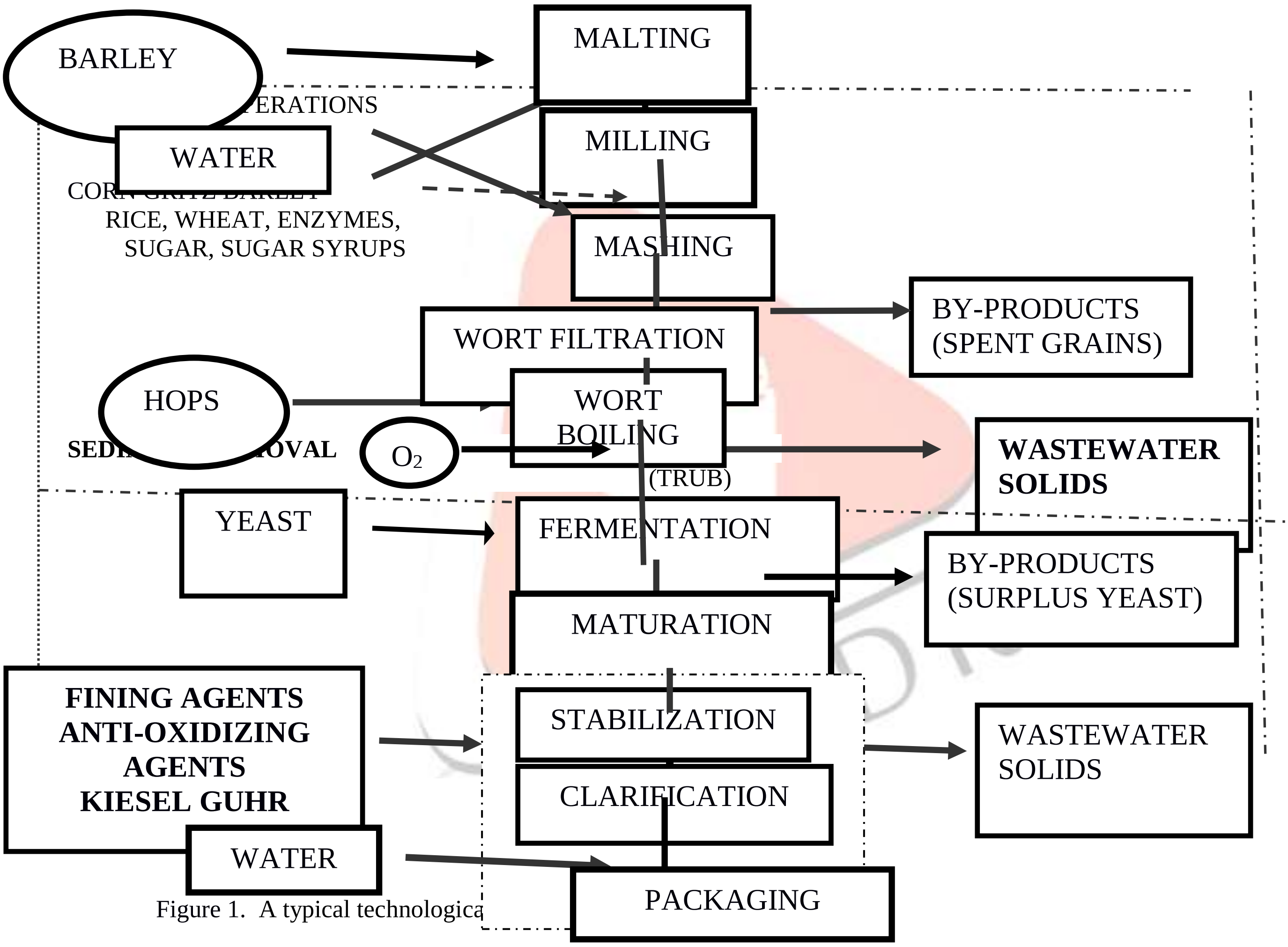

Figure 1. A typical technologica

2.2. Brewing Processes

Beer is a soft drink obtained through alcoholic fermentation, using selected yeasts of the genera Saccharomyces, of wort prepared from malt cereals, mainly barley, and other amylaceous or sugar-based raw materials, to which were added hop flowers, or their derivatives, and adequate water [6].

2.3. Brewery Effluent Composition

The quality and quantity of brewery effluent can fluctuate significantly as it depends on various different processes that take place within the brewery (raw material handling, wort preparation, fermentation, filtration, CIP, packaging. etc.). The amount of wastewater produced is related to the specific water consumption (expressed as hl water / hl beer brewed). A part of the water is disposed with the brewery by-products and a part is lost by evaporation. Organic components in brewery effluent (expressed as COD) are generally easily biodegradable as these mainly consist of sugars, soluble starch, ethanol, volatile fatty acids, etc. Brewery effluent pH levels are mostly determined by the amount and type of chemicals used at the CIP units (e. g . caustic soda, phosphoric acid, nitric acid etc). Nitrogen and phosphorous levels are mainly depending on the handling of raw material and the amount of spent yeast present in the effluent. Elevated phosphorous levels can also be the result of phosphorous containing chemicals used in the CIP unit. Table 1 summarizes some of the most relevant environmental parameters [7].

2.3.1. Brewery Wastewater

Brewery wastewater is a significant waste or negative product in a brewery process. Although, substantial technological improvements have been made by breweries in South Africa to reduce wastewater generation, yet an estimated 5 to 6 L of waste effluent is generated per liter of beer produced. Wastewater is mostly water by weight with other waste materials making up a small option. At other times, large quantities of these other materials may be present that require some form of pre-treatment before discharging the wastewater into the sewage system. The brewing process usually generates large amounts of wastewater that need to be disposed of or treated in the least costly way to meet discharge regulations [5].

Brewery wastewater contains a high biochemical oxygen demand (BOD) as a result of all the organic components such as sugar, soluble starch, ethanol and volatile fatty acids used in the brewing process.

Table 1.Typical characteristics of brewery effluent [7].

Parameter	*Unit*	*Brewery Effluent Composition*	*Typical Brewery Benchmarks*
Flow	-	-	*2-8hl effluent/hl beer*
COD	*mg/l*	*2000-6000*	*0.5-3 kg COD/ hl beer*
BOD	*mg/l*	*1200-3600*	*0.2-2 kg BOD/hl beer*
TSS	*mg/l*	*200-1000*	*0.1-0.5 kg TSS/hl beer*
T	*^{O}C*	*18-40*	-
pH	-	*4.5-12*	-
Nitrogen	*mg/l*	*25-80*	-
Phosphorous	*mg/l*	*10-50*	-

Brewery wastewater has a high temperature in the range of 25 to 38°C The high pH levels of between 2 and 12 are influenced by the amount and type of chemicals used in the cleaning and sanitation processes, such as caustic soda, phosphoric acid, and nitric acid . Brewery solid waste includes spent grains, spent yeast, diatomaceous earth (DE) slurry and packaging materials [7].

2.4. Wastewater Characterization

The composition of brewing effluents can fluctuate significantly as it depends on various processes that take place within the brewery, but the amount of wastewater produced depends on the water consumption during the process. In general, water consumption per volume of produced beer attain 4.7 m^3 /m^3 but it should be pointed that the wastewater to beer ratio is often 1.2 m^3 /m^3 to 2 m^3 / m^3 less because part of the water is disposed of with by-products and lost by evaporation Organic components in brewery effluent are generally easily biodegradable and mainly consist of sugars, soluble starch, ethanol, volatile fatty acids, etc., leading to a Biological Oxygen Demand (BOD)/COD a ratio of 0.6 to 0.7. The effluent solids consist of spent grains, kieselguhr, waste yeast and "hot" trub. The pH levels are determined by the amount and the type of chemicals used at the CIP (clean in place) units (e.g. caustic soda, phosphoric acid, nitric acid). Nitrogen b and phosphorous levels are mainly depending on the handling of raw material and the amount of spent yeast present in the effluent. High phosphorous levels can also result from the chemicals used in the CIP unit. Table 1 summarizes some of the most important environmental parameters [6].

2.4.1. Wastewater Treatment

Waste water treatment can involve physical, chemical or biological processes or combinations of these processes depending on the required outflow standards. A generalized layout of a waste water treatment plant. The first stage of waste water treatment takes place in the preliminary treatment plant where material such as oils, fats, grease, grit, rags and large solids are removed. These processes are described in greater detail in the preliminary treatment manual [8].

Primary settlement is sometimes used prior to biological treatment. Radial or horizontal flow tanks are normally employed to reduce the velocity of flow of the waste water such that a proportion of suspended matter settles out. Biological treatment of waste water takes place in fixed media or suspended growth reactors using activated sludge, bio - filtration, rotating biological contactors, constructed wetlands or variants of these processes. Nitrification/ denitrification and biological phosphorus removal can be incorporated at this stage and will reduce nutrient concentrations in the outflow. Chemical treatment is used to improve the settling abilities of suspended solids prior to a solids removal stage or to adjust the properties or components of waste water prior to biological treatment (e. g. pH adjustment, reduction of heavy metals or nutrient adjustment). It may also be used for precipitating phosphorus in conjunction with biological phosphorus [8].

2.4.2. Discharge Requirements

The effluent discharge limit a brewery has to comply with depends on local environmental legislation. It is obvious that in case of discharging to a municipal sewer discharge limits are less stringent than when the effluent is to be discharged into a sensitive receiving surface water body (river, Lake, Sea, etc). Removal of organic compounds (COD chemical oxygen demand) from the wastewater is important to avoid anaerobic conditions in the receiving waters. Nutrients like nitrogen (N) and phosphorous (P) should be removed to avoid algae bloom disturbing the receiving waters ecosystem [6]. Phorus treatment, Secondary settlement separates the sludge solids from the outflow of the biological stage. Operation; and Tertiary treatment refers to processes which are used to further reduce parameter values below the standards set out in national regulations. The term is often used in reference to nutrient removal. Sludge treatment can be a significant part of a waste water treatment plant and involves the stabilization and/or thickening and dewatering of sludge prior to reuse or disposal [8].

2.5. Treatment Processes

Different environmental and socio-economic criteria can be considered when deciding on a wastewater treatment plant for a brewery industry. The aim is to select a process that is flexible enough to cope with large fluctuations in organic load and characteristics of such waste waters, while keeping capital and operating costs as low as possible. Because organic matter concentration in brewery effluent is significant, a high input of energy for aeration is required. Another factor is the amount of waste sludge generated from aerobic metabolism, which also needs to be handled and disposed of. Both increase the cost of operation of the treatment system. Therefore, anaerobic processes are preferred for the purpose of brewery waste waters pre-treatment because energy is saved and sludge disposal costs are minimized [6].

2.6. Wastewater Treatment Options

Sewage treatment options may be classified into groups of processes according to the function they perform and their complexity:
Preliminary: - this includes simple processes such as screening (usually by bar screens) and grit removal (through constant velocity channels) to remove the gross solid pollution.

I. Primary: usually plain sedimentation; simple settlement of the solid material in sewage can reduce the polluting load by significant amounts.

II. Secondary: for further treatment and removal of common pollutants, usually by a biological process.

III. Tertiary: usually for removal of specific pollutants e.g. nitrogen or phosphorous, or specific industrial pollutants [9].

2.6.1. Biological Effluent Treatment Systems

Among biological treatment systems one can distinguish between anaerobic (without oxygen) and aerobic (with air/oxygen supply) processes. Anaerobic treatment is characterized by biological conversion of organic compounds (COD) into biogas (mainly methane 70-85 vol% and carbon dioxide 15-30 vol% with traces of hydrogen sulphide). During aerobic treatment (air) oxygen is supplied to oxidize the COD into carbon dioxide and water. Both biological processes produce new biological biomass (biosolids). The overall basic reactions are:

Anaerobic: $COD + H_2O \longrightarrow CH_4 + CO_2$ + anaerobic biomass

Aerobic: $COD + O_2 \longrightarrow CO_2 + H_2O$ + aerobic biomass (6).

2.6.2. Physical Methods

Among the first treatment methods used are physical unit operations, in which physical forces are applied to remove contaminants. Physical methods remove coarse solid matter, rather than dissolved pollutants. It may be a passive process, such as sedimentation to allow suspended pollutants to settle out or float to the top naturally. In general, these methods have yielded little success; most often resulting in incomplete contaminant removal and/or separation. For example, sedimentation has been found to be unsatisfactory even with the addition of coagulants and other additives [10].

2.6.3. Chemical Methods

Different chemicals can be added to the brewery wastewater to alter the water chemistry. Chemical pretreatment may involve pH adjustment or coagulation and flocculation. The acidity or alkalinity of wastewater affects both wastewater treatment and the environment. Low pH indicates increasing acidity while a high pH indicates increasing alkalinity. The pH of wastewater needs to remain between 6 and 9 to protect organisms. Waste CO_2 may be used to neutralize caustic effluents from clean-in-places (CIP) systems and bottle washers. The waste CO_2 can also be used as a cheap acidifying agent for decreasing the pH of alkaline waste waters before the anaerobic reactor, thus replacing the conventionally used acids. Neutralization with H_2SO_4 and HCl acids is usually not recommended because of their corrosive nature and sulfate and chloride discharge limitations, which may add to the cost of effluent treatment operations [10].

Coagulation and flocculation are physicochemical processes commonly used for the removal of colloidal material or color from water and wastewater. In water and wastewater treatment, coagulation implies the step where particles are destabilized by a coagulant, and this may include the formation of small aggregates by Brownian motion (perikinetic coagulation). On the other hand, the subsequent process in which larger aggregates (flocks) are formed by the action of shear is then known as flocculation. After small particles have formed larger aggregates, colloidal material can then be more easily removed by physical separation processes such as sedimentation, flotation, and filtration [10].

2.6.4. Biological Treatment of Waste waters

The biology of waste water treatment is based on the consumption of organic matter by micro- organisms which include bacteria, viruses, algae and protozoa. An operator's job is to regulate these micro-organisms so that they perform in an efficient and economical way. Therefore, knowledge of their metabolism is necessary in order to control the process effectively. Bacteria are the most populous of the micro- organisms used in waste water treatment; these single-celled organisms directly break down the polluting matter in waste water. For aerobic bacteria, oxygen is required in breaking down the substrate. Anaerobic bacteria operate in the absence of oxygen [8].

Facultative micro-organisms have the ability to operate aerobically or anaerobically. Anaerobic bacteria thrive in the absence of oxygen and, in urban waste water treatment plants, are most often encountered under septic conditions where oxygen is not available or has become depleted, for example in long sewers or in sludge storage tanks. Foul odors are associated with generally septic conditions. Anaerobic processes are most commonly used for the pretreatment of high strength industrial wastes and for the digestion of sludge's. Higher life forms in the waste water treatment food chain include protozoa and rotifers [8].

2.6.5. Inhibition

The performance of the waste water treatment plant is dependent upon the activity of micro-organisms and their metabolism which can be dramatically affected by the presence of toxic material in the raw waste water. The extent to which inhibition may cause a problem in waste water treatment plant depends, to a large extent. On the constituents of the waste water undergoing treatment. Many materials such as organic and inorganic solvents, heavy metals and biocides can inhibit the biological activity in the treatment [8].

2.6.6. Anaerobic Treatment Systems

The applicability of anaerobic treatment for municipal sewage (mixed sludge and wastewater) depends strongly on the temperature of the sewage. The activity of mesophilic anaerobic bacteria is at its optimum at 35°C. At lower temperatures, bacterial activity decreases, which results in lower treatment performances. According to the present technology development combined anaerobic sewage treatment is feasible without heating at sewage temperatures above 15°C. Speaking of this type of technology, in addition to appropriate sewage temperatures, a further precondition for effective anaerobic treatment are the organic loading and nutrient content of the wastewater. A comparison of investment and operation costs of different treatment systems shows that, given a high availability of land and thus low land costs, and not considering smell, environmental and climatic effects, pond systems at first appear to be the more economical solution [4].

The simplest anaerobic systems are so called lagoons and CSTR reactors (Continuous Stirred Tank Reactors). As these reactors have no special sludge retention system the sludge retention time is equal to the hydraulic retention time. As a result the suspended biomass concentration is very dilute and consequently biological treatment capacity is limited. These systems are mainly applied as sludge digesters and hardly suitable for treating waste water:-

- The anaerobic contact process is a CSTR with an external separation unit to return a part of the sludge. Mixing is done by means of mechanical agitators or biogas blowers. Because of the flocculent and dilute nature of the anaerobic sludge these systems operate at relatively low volumetric loading rates and are less suitable for low concentrated industrial effluents like brewery effluent. Anaerobic filters (AF) use carrier material for sludge retention on which biomass is supposed to grow. As fixation to the carrier is often limited, suspended flocculent sludge still largely contributes to the capacity of such reactors [7].

Advantage of Anaerobic Wastewater Treatment:

Generally speaking, joint anaerobic treatment of sludge and wastewater is attractive (given sufficient sewage temperature) due to the following advantages:-

- Low investment and maintenance costs:-
    - ✓ No primary clarifier required
    - ✓ No sludge digester required (stabilization of suspended organic matter in anaerobic reactor).
    - ✓ Low land requirements.
    - ✓ Local production of construction material, mechanical plant components, spare parts
- Low demand for process energy (no energy consuming aerators): thus a considerable reduction of CO_2 emissions due to low consumption of fossil energy and simultaneous surplus energy production.
- Reduction of CH_4 emissions from uncontrolled disposal/decomposition of wastewater due to the collection of the gas formed during the process.
- Low sludge production and high sludge quality (the sludge, if not loaded with pathogens or heavy metals, can readily be applied to agricultural land [4].

The main disadvantages of these treatment systems are:-

- ➢ Lower treatment efficiencies (about 5- 10% less than in activated sludge processes if no post-treatment is installed)
- ➢ H_2S content in the gas can lead to problems with bad smell and corrosion No nutrients (N, P) are removed without post treatment
- ➢ Compared to pond systems, a rather poor pathogen removal if no post- treatment is installed
- ➢ Compared to pond systems, a high demand for operational know-how
- ➢ Economically not feasible for sewage temperatures below 15 °C. Anaerobic treatment alone will usually be insufficient to meet the officially required effluent discharge standards: If legislation demands compliance with the standards, the treatment systems need to be combined with a post-treatment installation (4).

2.6.7. Aerobic Treatment Systems

Aerobic biological treatment is performed in the presence of oxygen by aerobic microorganisms (principally bacteria) that metabolize the organic matter in the wastewater, thereby producing more microorganisms and inorganic end-products (principally CO_2, NH_3 and H_2O). Aerobic treatment utilizes biological treatment processes, in which microorganisms convert non-settle-able solids to settle-able solids. Sedimentation typically follows; allowing the settle-able solids to settle and separate out. Three options include:-

I. Activated sludge process: In the activated sludge process, the wastewater flows into an aerated and agitated tank that is primed with activated sludge. This complex mixture containing bacteria, fungi, protozoans, and other microorganisms is collectively referred to as the biomass. In this process, the suspension of aerobic microorganisms in the aeration tank is mixed vigorously by aeration devices, which also supply oxygen to the biological suspension [10].

II. Attached growth (biofilm) process: The second type of aerobic biological treatment system is called “attached growth (biofilm) process” and deals with microorganisms that are fixed in place on a solid surface. This “attached growth type” aerobic biological treatment process creates an environment that supports the growth of microorganisms that prefer to remain attached to a solid material [10].

III. Trickling filter process: In the trickling filter process, the wastewater is sprayed over the surface of a bed of rough solids (such as gravel, rock, or plastic) and is allowed to “trickle down” through the microorganism-covered media [10].

Similar as to anaerobic reactor systems aerobic reactor systems can be classified in the way these reactors arrange biomass retention and ensure a good contact between the aerobic biomass and the wastewater. Aerobic lagoons have no special sludge retention system and not commonly used for the treatment of brewery effluent as these systems do require large areas of land. As lagoons tend to accumulate solid over the years, the lagoons require to be emptied after a period of time. Aerobic fixed-bed and moving-bed reactors use carrier material for biomass to grow on [7].

These systems do not retain inlet suspended solids and are therefore mostly used as pre- treatment. Like with anaerobic filters, aerobic fixed bed reactors are susceptible for clogging due to solids in the wastewater or growth of biomass. Furthermore if no forced aeration is applied these systems are known to cause possible odor emissions due to insufficient oxidation. Moving bed reactors often have a relatively high energy-consumption and sludge production [7].

2.6.8. Anaerobic Pre-Treatment with Aerobic Post-Treatment

A few new technologies have appeared in the field of biological wastewater treatment during the last few years. Combined anaerobic and aerobic wastewater treatment can be considered one of them. Such an integrated system appears to be one of the possible ways for treatment of wastewater from small sources. One of the possibilities to underline the advantages and fight back the disadvantages of both (anaerobic and aerobic) technologies is to combine them into one integrated system with anaerobic pre-treatment and aerobic post-treatment [11].

That technology should have the following characteristics:- high efficiency for the removal of organic matter as well as for the nutrients, low specific energy requirements, a relatively short detention time (due to the relatively small volume of the tanks), biogas production, low specific production of excess sludge[10].

Comparing parameter	**Anaerobic processes**	**Aerobic processes**
Energy consumption	Low	High
Construction	Simple	Complex
Biomass production	Low	High
Nutrition demand	Low	High
Reaction speed	Low	High
Nutrient removal	Minimal	Very good
Starting period	Long	Short

Table 2. Comparison of anaerobic and aerobic processes [11].

2.7. Sewage Sludge Digester

Anaerobic treatment of sludge from aerobic wastewater treatment with long retention times has a very long history in some of the central European countries but has improved considerably: These anaerobic systems can be built and operated on various scales in size with a high degree of technical sophistication and automation, but sometimes are technically quite simple as well [4].

Anaerobic sewage sludge treatment offers several substantial advantages: - Reduction of sludge volumes, Stabilization of the sludge, Production of biogas to be used as process energy, Valuable nutrients are retained; Anaerobic sludge can be preserved and easier dewatered. In anaerobic digestion of sewage sludge is presently a routine process implemented in combination with the aerobic activated sludge process, which is the standard technology for municipal wastewater treatment here. Sewage sludge is the total solid material that results from sedimentation and bacterial activity and growth during aerobic wastewater treatment. The floating and sinking layers formed before, during and after a treatment of the wastewater are normally all fed to the sludge digester [4].

2.8. Brewery Waste management

In the brewery industry, brewing and packaging are the operations that give rise to waste. Water and wastewater management constitutes a practical problem for the food and beverage industry including the brewing industry. Wastewater management and waste disposal have become a significant cost factor and an important aspect in the running of a brewery operation [5].

Brewery managers need to view wastewater and waste disposal problems as a proof of inefficiencies in their production process rather than as inevitable by-products of production. As brewery managers strive to improve on their environmental performance due to pressures from the society, traditional pollution prevention techniques seem no longer to be cost effective. It appears that process waste-reduction is a better cost effective solution to the traditional end-of-pipe strategies. Brewery managers and accountants should endeavor to bridge communication problems in order to have access to environmental information especially on the quantities and values of wasted products at all times [5].

3. Summary, conclusion and recommendation

3.1. Summary and conclusion

Breweries are the traditional industry in afro and sector using cost effective techniques to manufacture the best quality product. The combination of anaerobic and aerobic technologies was studied. The two-stage technology is effective for the removal of organic pollution and suspended solids, while under optimal conditions even nutrient removal can be achieved. Anaerobic treatment is a widely applied method for treatment of brewery effluent. Combined anaerobic/aerobic treatment of brewery effluent has important advantages over complete aerobic treatment especially regarding: a positive energy balance, reduced (bio) sludge production and significant low space requirements. Brewery industries are small and medium enterprises but with a significant social and economic value. Therefore, their sustainability policy requires wastewater treatment systems with the best performance and the fact is that well known processes and technologies are available for such purpose. In order to meet strict constraints with respect to space, odors and minimal sludge production, considerable attention has been directed towards the anaerobic–aerobic reactors.

3.2. Recommendation

The industrial wastewater that are distributed throughout in food crops, farmland area, stream water, minerals and others are serious problems to living organisms when taken above the optimum levels. So wastewater can cause disease and affects an organisms so further research from different point of view should be conduct in future on the treatment of industrial wastewater to provide better understanding their treatment to improve health care of the organisms. From ways of waste water treatment anaerobic waste water treatment is cheaper than aerobic waste water treatment. Due to this reason recommended that use anaerobic waste water treatment rather than aerobic waste water. Higher water prices are only one factor putting pressure on industries using conventional production processes. Advanced technologies can now treat wastewater that can be recycled in the same process or different processes and locations means that recycle (reuse) the brewery waste water rather than emit it to the environment to protect the environment from pollution.

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