ASSESSMENT OF INDUSTRIAL WASTEWATER TREATMENT PROCESSES

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ABSTRACT

The article explores some analyses concerning industrial wastewater treatment methods, with aerobic, anaerobic, or a mixture of both ways being used in these investigations. The article tries to carefully examine the academics' as well as researchers' motivations, instruments, and results. The management of chemical industrial effluent from a structure as well as the building chemical plant alongside a rubber shoe factory is looked at. The effluent from the various facilities is dumped into the city sewage system. The wastewater discharged from the structure as well as the construction chemical plant is determined to be highly contaminated with organic chemicals, according to the results. Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD) averaged149.8mgO$_2$/l and2911.8, respectively. Phenol concentrations as high as 0.28 mg/litter were observed. With ferric chloride and lime chemically treated was successful, and the effluent had a characteristic that was within Egyptian allowed limits. Domestic wastewater is mixed with industrial wastewater at the other plant to reduce the burden i.e., organic. After mixing, the BOD and COD readings were 2614.8 and 5238.8 mgO$_2$/litter, respectively. 0.48 mg/litter is the average phenol content. As a consequence, the chemical industrial wastewater's properties determine which treatment plan to employ. Engineering development of each treatment system based on laboratory results.

KEYWORDS:*Aerobic Reactor, Aerobic, Anaerobic, Chemical Industrial Wastewater, Wastewater Treatment Plant.*

1. INTRODUCTION

For environmental impact, the chemical industry was significant. This industry's wastewaters are usually powerful as well as include dangerous substances. Inorganic alongside organic materials are frequently present in varying concentration in chemical industry wastes. It includes a low suspended solid content, a brilliant colour and matter with a high biological oxygen demand, toxic compounds, bases and acids. Numerous chemical components are toxic, mutagenic, carcinogenic, or only partly biodegradable. Many treatment unit operations suffer from the usage of petroleum hydrocarbons, emulsifiers, and surfactants, which are used in the chemical sector. The best method for cleansing highly contaminated and dangerous industrial effluent was to treat it at the cause. In terms of environmental impacts, the chemical industry is significant (1).

This industry's wastewaters are usually rich in organic and inorganic contaminants, and they may also include radioactive pollutants. Organic and inorganic particles in varying quantities are typical in chemical industry wastewaters. Many chemical industrial chemicals are toxic, mutagenic, carcinogenic, or virtually non-biodegradable. Pre-treatment is required to produce an equal effluent because these wastes differ in general characteristics from residential sewage. The practise of wastewater treatment in the chemical industry is marked by significant unpredictability, stringent effluent permits, plus severe working circumstances (2). The art of wastewater treatment in the chemical industry is defined by significant unpredictability, stringent effluent permits, and severe operating circumstances.

1. Aerobic and Anaerobic Wastewater Treatment:

The word "aerobic" refers to the presence of oxygen (air), but "anaerobic" refers to the absence of air (oxygen). As a consequence, aerobic treatment procedures take place in the presence of air and use microorganisms (also known as aerobes) that absorb organic pollutants by converting them to carbon dioxide, water, and biomass utilizing molecular/free oxygen. Anaerobic treatment methods, on the other hand, are carried out by microorganisms (also known as anaerobes) that do not need air (molecular/free oxygen) to absorb organic pollutants in the absence of air (and therefore molecular/free oxygen). Methane and carbon dioxide gas, as well as biomass, are the end products of organic digestion in anaerobic treatment.

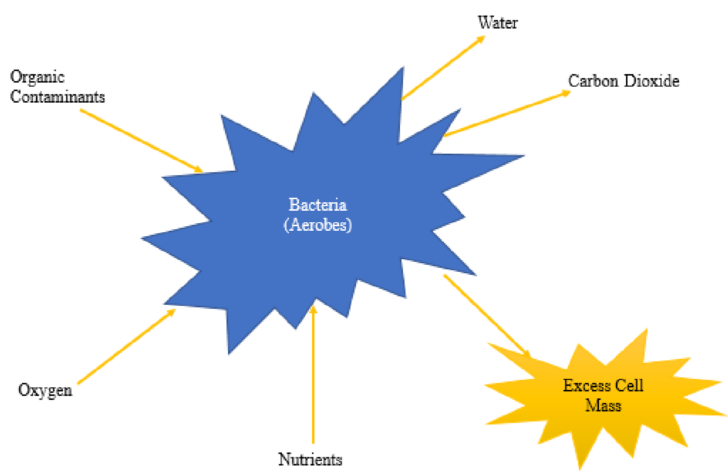

Fig. 1: In Bacteria (Aerobic Process)

The triggered sludge technique was utilized in batch laboratory studies. Plexiglas laboratory columns with a capacity of two litres were utilized. Enabled sludge from a residential sewage treatment plant was added to the wastewater. Aeration was turned off every day to allow till a substantial amount of adapted sludge was produced. Several experiments were carried out to evaluate the impact of the aeration cycle upon the activated sludge. A pre-treated wastewater was administered to a separate column with a predetermined volume of sludge (2.8–3.8 g/l) transferred to it. The researchers looked at prison terms ranging from one hour to full one day. After 1 hour of settling, the treated wastewater was characterised (3).

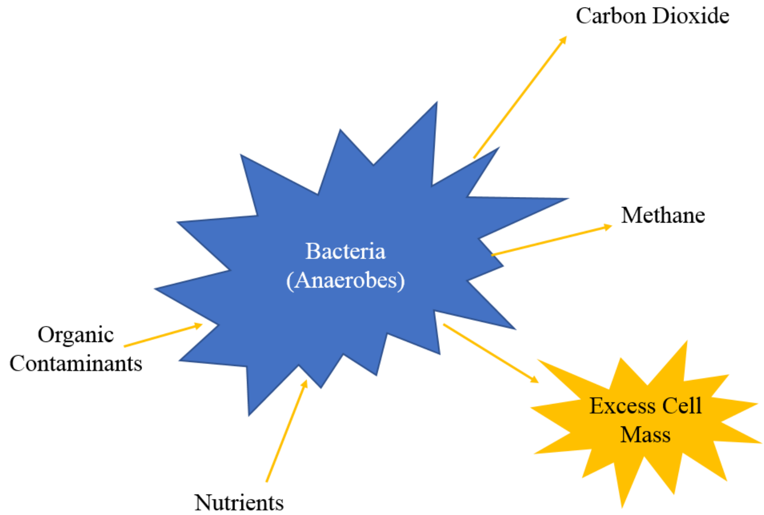

Fig. 2: In Bacteria (Anaerobic Process)

Aerobic treatment methods, such as the conventional activated sludge (CAS) process, are frequently used to treat low-strength wastewater (less than 999.8 mg COD/L), such as municipal wastewater. Fig. 1 depicts the aerobic unit, which comprised of a bio-film reactor accompanied by a sedimentation tank. Due to the high aeration needs, the CAS process is energy expensive, and it also produces a considerable quantity of sludge (about 0.38 gram dry weight/gm COD detached) that must be treated then disposed of. As a result, the cost of operating plus maintaining a CAS system is extremely significant. Anaerobic procedures (Fig. 2) for residential wastewater treatment was a potentially more cost-effective alternative, particularly in sub-tropical and tropical regions. In the past several decades, anaerobic wastewater treatment has grown increasingly common. These techniques are essential because they have beneficial effects, such as eliminating more organic loading, generating less sludge and removing more pathogens, producing methane gas, and consuming less energy (4).

2. LITERATURE REVIEW

Mahdi *et al.* performed a hybrid anaerobic-aerobic system for textile wastewater treatment in 2007. Textile manufacturing requires a large quantity of water throughout the production process. The water is mainly utilized in the textile industry's dyeing and finishing processes. The textile industry wastewater is the most polluting of all industrial sectors, both in terms of volume generated and effluent composition. In their study, a continuous operation of a mixed anaerobic-aerobic reactor was utilized to remediate effluent from textiles. Cosmo ball is used as a microorganism growth medium in an anaerobic reactor. In the nitrification and denitrification processes, the effects of pH, dissolved oxygen, and organic changes were studied. The findings indicated a removal efficiency of about 84.618 percent ammonia nitrogen and approximately 98.88 percent Volatile Suspended Solid (VSS) (5).

Gapariková *et al.* investigated how to create an optimal system based on a combination of anaerobic and aerobic technologies. Following operational practices, it may be managed advantageously for the organic waste removal alongside suspended particles, as well as nutrient removal under optimum circumstances. When compared to a small WWTP that functioned on aerobic standards, energy consumption fell by approximately 24.8 percent to 39.8 percent. The AS-ANA comb's operation revealed a 39.8 percent decrease in actual sludge production. The WWTP's frequent start–up is not creating any major problems owing to good servicing. The AS-ANA comb's process revealed numerous problems, leading in a decrease in care quality. In some instances, this is related to the buildup of materials that shouldn't go into WWTPs (grease, gasoline, solvents, washing chemicals) (6).

Florante *et al.* did a preliminary research which was performed concerning the effectiveness of removal of organic besides nitrogen. The researchers utilized a synthetic wastewater with high nitrogen content. The objective of the study is to assess the performance of the anaerobic as well as the aerobic reactors in removing COD alongside nitrogen from wastewater high in nutrient. Moreover, it shows the results of start-up tests performed upon artificial wastewater with separate reactor configurations: aerobic and anaerobic was tracked by calculating the concentration of biomass characterized by mixture of liquor volatile solid, which was fed continuously to the two reactors (MLVS) (7).

Bashaar *et al.* described laboratory size were used to categorize and treat wastewater from Jordanian mills, respectively. The lowest frequently mentioned in the literature for P: N: C ratios of 0.8:4.8: 99.8 for aerobic therapy and 249.8:4.8:0.8 for anaerobic treatment in the literature. This is owing to the wastewaters' weak biomass yield coefficient as well as relatively low removal efficiency. It is found that anaerobic treatment conducted upon olive mill effluent with a P: N: COD ratio of approximately 1.69:4.9: 899.9 was capable of removing more than 79.9 percent of COD. The biomass yield was 0.059 kilogram VSS per kilogram of COD decomposed, according to the data (8).

Bury *et al.* used dynamic simulation to maintain as well as the control of treatment plant in the chemical industry by the virtue of the change in rate of flow besides strength. The main aim of this study was to evaluate the use of alternative wastewater treatment technologies in the chemical sector. Preliminary results showed that after a dozen days, an aerobic reactor with a hydraulic retention time (HRT) of five hours produced a 97 percent decrease in COD, whereas an anaerobic reactor with the same hydraulic retention period obtained a 34 percent reduction in COD after two weeks. A COD: N: P ratio of approximately 169.8:4.8:1.48 was competent to achieve more than 74.8 percent COD removal for extended aeration aerobic treatment of pulp and paper mill effluent. The biomass approximately 0.308-kilogram of COD decomposed. Nutrients were not added to any of these wastewaters (9).

Hu *et al.* suggested a technique for identifying the optimum disposal strategy for chemical industrial wastewater based upon biodegradability as well as the pollutants' molecular size. Waste reduction is the first and most important stage in the chemical industry's manufacturing process to avoid waste creation. The chemical oxygen demand (COD) was monitored to monitor the elimination of organic contaminants until a steady state condition was reached. COD and nitrogen tests, were also carried out using different feed concentrations on nitrogen elimination. Founded upon actual biomass yield coefficient as well as the removal efficiency, a simple formula is used to estimate nutritional needs (10).

Research Question:

1. What is the role of Industrial Wastewater Treatment Processes?

3. METHODOLOGY

3.1 Design:

The efficiency of the system was investigated using a laboratory scale combined anaerobic-aerobic reactor.

3.1.1 Anaerobic Reactor:

The transparent PVC anaerobic reactor has a 29.8 cm diameter, 29.8 cm height, and a total working volume of 17.8 litre with supporting particles to keep micro-organism in the system immobilised, as well as an over-all 1.8-liters sludge which is active from a palm oil mill are gathered as well as nourished in reactors from Hulu Langat, Malaysia. The support material had a total surface area of 192.558 m^2. Chemical treatment with lime and ferric chloride was effective, and the effluent had a characteristic that was within Egyptian allowed limits.

3.1.2 Aerobic Reactor:

The clear PVC aerobic reactor has a diameter of 19.8 cm, a height of 47.8 cm, and a total working capacity of 8.9 litres. The aerobic reactor received a total of 1 litre of sewage sludge from the Indah Water Konsortium (IWK). Because the aerobic reactor's primary purpose was polishing solely, acclimatisation of the aerobic sludge was not as essential as it was for the anaerobic reactor. A tiny bubble diffuser provided the air, and a flow gauge maintained the flow at 5.8 mg/l/min. They arrived to the conclusion that the combined anaerobic-aerobic system could manage high-strength textile effluent. Ammonia nitrogen, BOD, COD, and VSS removal rates were 84.618 percent, 63.638 percent, 59.8 percent, and 98.88 percent, respectively. COD, BOD, as well as the Ammonia nitrogen concentrations in the final effluent were found to be 108.748 mg/litter, 13.168 mg/litter, and 1.108 mg/litter, respectively.

pH as well as the DO is shown to contain very minimal impacts upon the nitrification process, with just 2.8 percent of pH alterations happening for each 9.8 percent decrease in nitrogen. The denitrification rate was 0.058 mg NO_3/VSS when the COD/NO_3 ratio was 27.8 percent, and this rate would decrease as the dissolved oxygen content increases. The factory of building and construction chemicals, as well as the factory of plastic shoes, were examined. The effluent from the two facilities is dumped into the municipal sewage system. The wastewater released from construction chemicals plant as well as the structure were determined to be highly contaminated with organic compounds. COD and BOD averaged 2911.8 and 149.8 mgO_2/l, respectively. Phenol concentrations as high as 0.28 mg/l were observed.

3.2 Sample:

Aerobic biological therapy was carried out utilizing a rotating biological contactor as well as an activated sludge. The geometry of the instrumentation is shown below (Fig. 3):

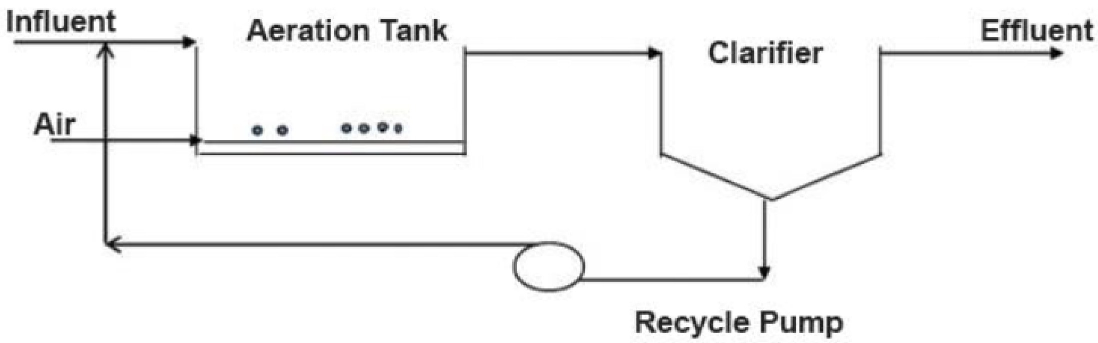

Fig. 3: System for Activated Sludge Processing in the Past

According to their results, chemical industrial wastewater properties, define the suitable treatment method. The use of household sewage in the factory to dilute chemical industrial pollutants effectively lowers the concentration and toxicity of the contaminants, improving the efficacy of biological treatment. The researchers utilized a simulated sewage with high nitrogen levels. Preliminary findings revealed that after 10.8 days, an aerobic reactor with a HRT (hydraulic retention period) of five hours achieved a 97.8 percent reduction in COD, while an anaerobic reactor with the equivalent hydraulic retention period (HRT) achieved a 33.8 percent reduction in COD after 2 weeks.

It also displays the outcomes of start-up experiments conducted upon simulated wastewater using two distinct reactor configurations: the anaerobic as well as the aerobic. Starting experiment was conducted utilizing a 3.8-liter flask anaerobic reactor as well as a 4.8-liter acrylic aerobic reactor with activated sludge as an inoculum source controlled the concentration of biomass signified by mixture of liquor volatile solid, which was fed constantly to the two reactors (MLVS) was measured to track the reduction of organic pollutants until a steady state condition was attained.

3.3 Instrument:

Aerobic and anaerobic reactors were employed in the studies. An air pump was utilized in the aerobic zone of 4.8 litters. A continuous anaerobic reactor, on the other hand, a 3.8-liter Erlenmeyer flask with stir bar as well as a magnetic stirrer to allow for continual stirring within the reactor. For aeration, air pumps were employed in each reactor. The biomass output was 0.058 kg VSS per kilogram of COD decomposed, according to the results. The biomass 0.308-kilogram VSS of COD decomposed.

The following conclusions were made from the experimental results: Aerobic methods take longer to aerate and produce a lot of sludge, but they are efficient at eliminating ammonium nitrogen. Anaerobic treatment methods usually offer benefit like the generation of usable biogas as well as the higher organic loading rates; however, they also have drawbacks such as a relatively larger effluent concentration and the inability to extract ammonium nitrogen. At the same HRT, the aerobic reactor decreased COD by 97.8 percent, whereas the anaerobic reactor only reduced COD by 33.8 percent. Nutrients were not added to any of these wastewaters.

Founded upon experimental biomass yield coefficient as well as the removal efficiency, is applied to estimate nutrient requirements.

3.4 Data Collection:

The active volume of the study was 1.8 L. The combination of OMW was produced as well as the maintained at 29.8±1.8^{o}C using a magnetic stirrer/hotplate for anaerobic treatment. Mixing and heating were turned off once the mixing time was completed, and the reactor is kept idle for the two hours length so that anaerobic sludge is settled. Following this, the calculated volume of supernatant is removed from the reactor besides put to a series of tests in line with. Under anaerobic circumstances, the COD of the reactor is kept close around at 15,999.8 mg/litter by diluting after the start-up phase. Sludge wastage was carried out in order to keep the Volatile Suspended Solids (VSS) content in the reactor potentially, close to 11,999.8 mg/litter.

Three days are selected as the hydraulic retention time. The pH of the reactor is 6.8 using sodium bicarbonate when required. Dissolved oxygen concentrations in paper and pulp mill effluent are retained from 1.8 to 3.8 mg/l for aerobic treatment, prolonged aeration was selected as the treatment method. The average period for hydraulic retention was 1 day. The reactor was fed three times a day with 669.8 ml each time. The MLVSS content (mixed liquid volatile suspended solids) was maintained at approximately 2499.8 mg/litter. He also discovered that the nitrogen and phosphorus contents in Jordanian olive mill effluent as well as the paper and pulp mill wastewater are sufficient, and that no extra nutrients are needed.

The COD: N: P ratio used for aerobic and anaerobic treatment of industrial wastewater should be derived using a formula that takes into consideration the removal efficiency and observed yield for the wastewater in question (40.8/EYobs:4.8:0.8). Finally, for testing, three WWTPs were constructed with the assistance of Slovak Technical University. They work on the idea of anaerobic pre-treatment and aerobic post-treatment. Plants for wastewater treatment are intended for 4.8-598.8 PE. The findings match the directive water discharge from small wastewater treatment facilities in the Slovak Republic when operating under the appropriate circumstances.

3.5 Data Analysis:

The work described here is divided into two parts: laboratory research in reactors AN-I and AN-II, and research with evaluation of a real-world WWTP, AS-ANA comb. The experiment utilized two pilot-scale reactors with aerobic post-treatment. Reactor AN-I (shown in Fig. 1, which consists of a primary settling tank, an anaerobic baffled system, an aerobic component, and a secondary settling tank), seeded with anaerobic sludge (~200 l, SS content 17.8-21.8 g/l). Reactor AN-II was built in the same manner as AN-I, but it was powered up without being vaccinated. Both experimental plants were erected (39,998 PE) municipal wastewater treatment facility in Bratislava. From September 1999 to August 2001, pilot size tests with both reactors were performed. The underlying wastewater parameters of the influent and effluent (COD, BOD5, pH, SS, NH_4-N, NO_3-N, NO_2-N) were monitored using Standard Methods.

In the second part, seven authentic WWTPs, one for 9 PE, three for 19 PE, two for 199 PE, and one for 249 PE, were chosen for evaluation. The samples were collected from WWTPs in Slovakia's north western area. The samples were collected five times from the effluent of the WWTP between August and October 2003, and they were all grab samples. The samples were tested for COD, BOD5, pH, SS, NH_4-N, NO_3-N, and PO_4-P using Standard Methods. According to the results of their study, an integrated system was developed by integrating the aerobic as well as the anaerobic technologies. Subsequent operating experience, it can be resolved that properly regulated bi-stage technique was effective for the elimination of suspended particles besides organic pollutants, as well as nutrient removal under optimum circumstances. When compared to a tiny WWTP that functioned on aerobic principles, energy consumption fell by approximately 24.8 percent to 39.8 percent.

The AS-ANA comb's operation revealed a 39.8 percent decrease in special sludge generation. The WWTP's frequent start–up is not creating any significant problems owing to good functioning. The AS-ANA comb's operation showed some problems, leading in a decrease in therapeutic efficacy. In many instances, this is due to the build-up of things that shouldn't go into WWTPs (grease, gasoline, solvents, cleaning chemicals). Fluctuations in the wastewater flow may also be a troublesome issue. The performance of chosen AS-ANA comb WWTPs may be favourably evaluated. The majority of the WWTPs evaluated were efficient at eliminating organic pollutants without the need for expert operation, which is one of the most important requirements for small wastewater treatment plants even in a temperate environment.

4. RESULTS AND DISCUSSION

The workshop produces 10.8–14.8 m^3/d of wastewater. The usual values of BOD (149.8 mgO_2/l) and COD (2911.8 mgO_2/l), (Table 1). In the average, the BOD/COD ratio was 5.8 percent. The presence of phenol was detected in the sample, with a value of 0.28 mg/litter. The grease and oil concentrations between 148.8 and 599.8 mg/litre, with a mean of 370.8 mg/litre. The gross suspended solids content averaged 199.8 mg/l. The effluent at the end of the conduit was treated chemically using activated sludge. The phosphorus as well as the nitrogen contents in the effluent were found to be inadequate.

TABLE 1: END-OF-PIPE WASTEWATER HAS MANY CHARACTERISTICS (CONSTRUCTION CHEMICALS FACTORY AND BUILDING)

Variables	Max.	Minimum	Mean	Units	Egyptian decree
Grease & Oil	599.8	148.8	370	mg/l	99
Phenols	0.2	0.05	0.09	mg/l	0.04
Organic Nitrogen	24	8	18	mgN_2/l	99
Phosphorous	29	0.7	8	mgP/l	24
Total suspended solids	518	156	199.8	mg/l	799
Biological Oxygen Demand	569	209	149.8	mgO_2/l	599
Chemical Oxygen Demand	3923	1869	2911.8	mgO_2/l	1099
pH	9.4	6.0	7.4	mg/l	6-9.4

The concentration of nitrogen and phosphorous salts was adjusted to meet the requirements. The properties of treated effluent do not reach the permissible level. The biodegradability at a very low level, as defined by the ratio of BOD to COD is 5.8 percent only, which is to blame for this outcome. On a bench scale, aluminium sulphate is carried out first to establish the optimum coagulant, ideal dose, and pH, and then a continuous approach was employed.

5. CONCLUSION

For many areas of the globe, anaerobic systems have proved to be a successful treatment technique. WSP's conventional system will certainly compete more and more with UASB methods in the future. Aerobic structures, such as ponds, trickling filters, or activated sludge plants, are also needed for post-treatment. However, it hasn't been extensively utilized in the past. Anaerobic reactors, on the other hand, were believed during variations, requiring a lengthier start-up time. This assumption originated from a lack of knowledge anaerobic treatment has now been significantly decreased due to technological advances. The usage of anaerobic procedures gradually expanded in the preceding thirty years, owing to the work of Young and McCarty in 1969. Due to significant advantages over aerobic therapy. The bench scale was essential before going on to the continuous system. The use of household sewage in the factory to dilute chemical industrial wastewaters effectively lowers the build-up and toxicity of toxins while also saving money because are utilized to provide nutrient in biological treatment systems. Spinning biological contactors are a simple to use and maintain technology that provides excellent performance.

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