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A Review on Various treatment methods for wastewater containing starch

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ABSTRACT

The starch wastewater is milky white color. Both suspended and dissolved solids concentration present in starch wastewater are very high. This type of wastewater generally treated by conventional method such as sedimentation, coagulation and flocculation methods. This method gives limited purifying efficiency. In this work the treatment of starch wastewater by using solids and liquid separation with the help of gravitational settling and supernatant wastewater is treated by biologically sequential batch reactor process. Firstly analysis of quantity of wastewater, pH, TSS, TDS, BOD and COD in starch wastewater these are the operating parameters to optimize. Biochemical method and flocculation and sedimentation method are the most widely used methods for treatment of starch wastewater. Starch wastewater has high turbidity and COD, as well as a strong odor. Discharging this type of sewage could cause serious environmental pollution, so it must be treated and meet national standards before being discharged. This review paper presents investigating studies on various treatment methods for wastewater containing starch. Several methods of starch wastewater treatment in recent years, including physical method, physical-chemical process, biological method and combined process method, were reviewed. The advantages and disadvantages of these methods are analyzed, and the development and research direction of these methods are prospected. The methods ofzero liquid discharge (ZLD) treatment of wastewater containing starchdiscussed. Four common ways to treat wastewater include physical water treatment, biological water treatment, chemical treatment, and sludge treatment.

KEYWORDS- Wastewater, Starch, BOD, COD, TDS, Biological Treatment, Coagulation, Sedimentation

1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

This paper mainly through wastewater renovation project of a program of starch production enterprises and its actual operating results, the analysis of various treatment structures combined operation of the treatment plant treatment effect, the purpose is to understand the characteristics of each treatment structures in starch wastewater treatment process, for the follow-up design or improvement of starch the wastewater treatment technology has certain reference significance.Water is, literally, the source of life on earth. About 70 percent of the earth is water, but only one percent is accessible surface freshwater. The one percent surface fresh water is regularly renewed by rainfall and other means and thus available on a sustainable basis and easily considered accessible for human use. Water is the biggest crisis facing the world today. In India the crisis in terms spread and severity affects one in three people. As per an estimate in 2000, there were 7,800 cubic meters of fresh water available per person annually. It will be 5,100 cubic meters (51,00,000liters) by 2025. Even this amount is sufficient for human needs, if it were properly distributed. But, equitable distribution is not possible India, which has 16 percent of world's population, 2.45 percent of world's land area and 4 percent of the world's water resources, has already faced with grave drinking water crisis. Water is the single largest problem facing India today. Years of rapid population growth and increasing water consumption for agriculture, industry and municipalities and other areas have strained Indian fresh water resources. In many parts of our country chronic water shortages, loss of arable land, destruction of natural habitats, degradation of environment, and widespread pollution undermine public health and threaten economic and social progress. By 2050 more than 50 percent of population is expected to shift to the cities and the drinking water scarcity will be acute. In the developed world, for example, the United Kingdom must spend close to $60 billion building wastewater treatment plants over the next decade to meet the new European water quality standards. The World Bank has estimated that over the next decade between US $ 600 to 800 billion will be required to meet the total demand for fresh water, including that for sanitation, irrigation and power generation. A water short world is inherently unstable world. Now the world needs another revolution, i.e., a Blue Revolution for conservation and proper maintenance of freshwater.Wastewater treatment occurs in a treatment plant in several stages depending on the degree of treatment desired. In the first stage, the preliminary treatment processes prepare the influent wastewater for treatment in subsequent processes. Bar-screens, grit-chamber, and flow equalization tank are some of the processes included in the preliminary treatment. There is no significant removal of biodegradable organic matter expressed in terms of 5-day biochemical oxygen demand (BOD) or suspended solids by these processes. The next stage is the primary treatment process where settle able and floatable solids present in the wastewater are removed by gravity sedimentation. In some rare instances, the flotation process can be used instead of gravity sedimentation for the removal of settle able solids. The primary treatment process can remove up to 40% of the incoming BOD and 50–70% of the suspended solids. The subsequent stage is the secondary treatment process, which is needed to remove the remaining soluble and colloidal organic matter from the wastewater that was not removed during the primary treatment processes.The secondary processes invariably use aerobic biological treatment processes to remove the soluble and colloidal organic matter from the wastewater. The biological treatment process converts the soluble and colloidal organic matter into settle-able solids and micro-organisms (sludge), which are removed in the secondary settling tank leaving a clearer supernatant effluent for discharge. Thus, the settling tank following the aeration tank is an integral part of the process. In this entry, the secondary tank details are not included. These processes in combination with the primary process can remove 90% BOD (carbonaceous BOD) and suspended solids. AOP considered being tertiary treatment process which basically removes harmful organic and inorganic compounds and also serves a strong disinfectants providing upto 99.9 % disinfection.

1.2 STARCH WASTEWATER INDUSTRY

Starch industry inclusive of corn, potato, wheat, agricultural-food such as rice, all are raw material productions of starch or starch deep processed product (-amylose, glucose, starch derivative etc.) industry. In the process of production, water requirement is very large. Wastewater discharge is also large, and waste water contains much starch, protein, carbohydrate and the organic high concentrated organic wastewaters such as fat, the dissolved oxygen in water. All of this is consumed. Starch is polyhydroxylated natural high molecular compound, widely exists in plant roots, stems and fruits, food, medicine, chemical, papermaking, textile and other industrial sectors of the main raw material. The main raw material crop starch production is the corn, potato and wheat. Produce a lot of high concentrations of acidic organic wastewater in starch processing process, its content with the production fluctuation and change from time to time, which is mainly soluble starch and a small amount of protein, no general toxicity. The validity of this combined with the actual situation of project of a starch processing enterprises sewage treatment transformation analysis of wastewater treatment technology of starch industry. A starch factory is a large enterprise of corn starch, the crystallization of glucose, corn by-products and production in one, with the expansion of enterprise scale and production scale, the original sewage station has been unable to meet the need of production, in order to enterprise rapid development, enterprise decided to expand the sewage treatment station.

2. LITERATURE REVIEW

2.1 Wastewater

"Wastewater" Definition

The term "wastewater" refers any water that has been used or polluted, and contains waste products. Wastewater is approximately 99% water; only 1% is a mixture of suspended and dissolved organic solids, detergent, and cleaning chemicals. "Sewage" is one kind of wastewater. It includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers. Sewage treatment, or municipal wastewater treatment, is the process of removing contaminants from wastewater and household sewage. It includes physical, chemical, and biological processes to remove organic, inorganic and biological contaminants.The typical composition of municipal wastewater (after pretreatment) most often treated in CWs contains suspended solids, organic matter, and in some instances, nutrients (especially total nitrogen) and heavy metals, as shown in Table 2.1 **(Tchobanoglous&Burton, 1991**). Domestic sewage wastewater typically contains 200 mg of suspended solids, 200 mg biochemical oxygen demands, 35 mg nitrogen, and 7 mg phosphorus per liter**(Volodymyr, Sirajuddin, & Viktor, 2007).**

2.2 Wastewater Reuse and Reclamation

During the last century, the increasing demands for freshwater coupled with environmental concerns about the discharge of wastewater into ecosystems and the high cost and technology requirements of wastewater treatment have spurred processes in water reclamation and reuse. Early development stems from the land application for the disposal of wastewater, following the admonition of Sir Edwin Chadwick—"the rain to the river and the sewage to the soil" **(National Research Council of the National Academies, 1996, p. 17).** Such land disposal schemes were widely adopted by large cities in Europe and the United States in the 1900s.With the development of sewerage systems, domestic wastewater was firstly considered to be reused by farms. California was the pioneer in wastewater reuse and has the most comprehensive regulations pertaining to the public health aspects of reuse. By 1910, 35 California communities were using sewer water for irrigation (Recycled Water Task Force, 2003). In 1918, the California State Board of Public Health promulgated the initial Regulation Governing Use of Sewage for Irrigation Purpose, pertaining to irrigation of crops with sewage effluents. In 1929, the city of Pomona, California, initiated a project using reclaimed wastewater for the domestic irrigation of lawns and gardens **(Ongerth& Harmon, 1959)**. In 1965, the Santee, California recreational lakes, supplied with reused wastewater, were opened for swimming.Today, as more advanced technologies are applied for water reclamation, the quality of reclaimed water can exceed conventional drinking water quality based on most conventional parameters. Water reclamation or water purification processes could technically provide water of almost any quality desired **(Asano, 1998).**

Table 2.1: Contaminations Concentration in the Typical Untreated Domestic Wastewater

Parameter	Unit	Weak (Concentration)	Medium (Concentration)	Strong (Concentration)
TS	Mg/L	350	720	1200
TDS	Mg/L	250	500	850
TSS	Mg/L	100	220	350
BOD	Mg/L	110	220	400
COD	Mg/L	250	500	1000
TN	Mg/L	20	40	85
TP	Mg/L	4	8	15
Total Coliform	No/100mL	10^6-10^7	10^7 ~ 10^8	10^7 ~ 10^9

2.3 Conventional Wastewater Treatment

Conventional Wastewater Treatment Process -

The conventional wastewater treatment process consists of a series of physical, chemical and biological processes. Typically, treatment involves three stages, called primary, secondary and tertiary treatment.

Primary treatment is used to separate and remove the inorganic materials and suspended solids that would clog or damage the pipes. Primary treatment consists of screening, grit removal, and primary sedimentation. Screening and grit removal may also be called "preliminary treatment." Large debris, such as plastics, rags, branches, and cans are removed by the screens, while smaller coarse solids, such as sand and gravel, are settled by a grit chamber system. Then wastewater is moved into a quiescent basin, with a temporarily retention; the heavy solids settle to the bottom while the lighter solids, grease and oil float to the surface. The settled and floating pollutants are removed by sedimentation and skimming, with the remaining liquid then discharged to undergo secondary treatment. Typically, about 50% of total suspended solids (TSS) and 30% to 40% of BOD are removed in the primary treatment stage **(Nelson, Bishay, Van Roodselaar, Ikonomou, & Law, 2007).**

Secondary treatment removes dissolved and suspended biological matter. Typically, up to 90% of the organic matter in the wastewater can be removed through secondary treatment by a biological treatment process **(U.S. EPA, 2004b).** The two most common conventional methods used to achieve secondary treatment are attached growth processes and suspended growth processes. In attached growth (or fixed-film) processes, the bacteria, algae and microorganisms grow on a surface and form a biomass. Attached growth process units include trickling filters, biotowers, and rotating biological contactors. In suspended growth processes, the microbial growth is suspended in an aerated water mixture. The most common of this type of process is called "activated sludge." This process grows a biomass of aerobic bacteria and other microorganisms that will breakdown the organic waste.

Tertiary treatment is sometimes defined as advanced treatment; it produces a higher-quality effluent than do primary and secondary treatment in order to allow discharge into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, coral reefs, and others). The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality to the desired level. This advanced treatment can be accomplished by a variety of methods such as coagulation sedimentation, filtration, reverse osmosis, and extending secondary biological treatment to further stabilize oxygen-demanding substances or remove nutrients. As wastewater is purified to higher and higher degrees through such advanced treatment processes, the treated effluent can then be safely and appropriately reused.

Before the treated wastewater is discharged, ***a disinfection process*** is sometimes required. Water systems add disinfectants to kill pathogenic microorganisms. The purpose of disinfection in the treatment of wastewater is to substantially reduce the number of microorganisms in the water to be discharged back into the environment, and it is almost always the final step in the treatment process regardless of the level or type of treatment used.

Common methods of disinfection include chlorine, and ultraviolet light. The treated water can be discharged into a stream, river, lagoon, or wetlands, or it can be used for landscape irrigation. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

2.4 U.S. EPA Guidelines

There are no federal regulations governing reclaimed water use, but the U.S. EPA (2004b) has established guidelines to encourage states to develop their own regulations. The primary purpose of federal guidelines and state regulations is to protect human health and water quality. To reduce disease risks to acceptable levels, reclaimed water must meet certain disinfection standards by either reducing the concentrations of constituents that may affect public health and/or limiting human contact with reclaimed water.***Based on the U.S. EPA inventory***, current regulations can be divided into the following reuse categories: unrestricted urban reuse (irrigation of areas with unrestricted public access), restricted urban reuse (irrigation of areas with controllable access), agricultural reuse on food crops, agricultural reuse on non-food crops, unrestricted recreational reuse, restricted recreational reuse, environmental reuse (wetland or sustain stream flows), industrial reuse, groundwater recharge, and indirect potable reuse. Based on the study objectives, the regulations on "unrestricted urban reuse" and "agricultural reuse on food crops" should be considered in this research. Table 2.2 lists the U.S. EPA guidelines for urban reuse and agricultural reuse water quality.

Table 2.2: U.S. EPA Guidelines for Water Reuse

Reuse types	Treatment	Reclaimed water quality	Setback distance	Monitoring
Urban reuse (landscape irrigation, vehicle washing, fire protection, commercial air conditioners, etc.)	Secondary Filtration Disinfection	pH=6-9, BOD≤10mg /L, ≤2 NTU, No detectable fecal coli/100mL, 1 mg/L CL2 residual(minimum)	50 feet to potable water wells	pH: weekly, BOD: weekly, Turbidity: continuous, Coliform: daily, Cl2 residualcontinuous
Agricultural reuse on food crop	Secondary Disinfection	pH=6-9, BOD ≤30mg/L, TSS ≤30mg/L, < 200 fecal coli/100ml, 1mg/L CL2 residual(minimum)	300 feet to potable water wells 100 feet to areas accessible to the public (if spray irrigation)	pH: weekly, BOD: weekly, TSS: daily, Coliform: daily, Cl2 residualcontinuous
Agricultural reuse nonfood crop	Secondary Filtration Disinfection	pH=6-9, BOD≤10mg /L, ≤2 NTU, No detectable fecal coli/100mL, 1 mg/L CL2 residual(minimum)	50 ft (15 m) to potable water wells	pH: weekly, BOD: weekly, Turbidity: continuous, Coliform: daily, Cl2 residualcontinuous

2.5 Overview of the Literature Review related to wastewater starch technology

[1] Corn starch industry wastewater pollution and treatment processes- A review

NeogiShubhaneel1 ,DeyApurba , ChaterjeePradip Kumar (2018), Corn starch industry contributes almost 12% of starch production. Maize starch, produced worldwide, contributes huge amount of acidic effluent (pH 3-5) containing high Chemical oxygen demand (COD) (10000- 30000 mg/L), biological oxygen demand (BOD) (4000-8000 mg/L), nitrogenous pollutant (400-900 mg/L) and other pollutants. Conventional methods of anaerobic digestion and nitrification-denitrification process are widely being used to treat starch industry effluent. The anaerobic digestion requires neutral pH operation thus increases operational cost. Similarly, nitrification and denitrification processes are lengthy processes consuming high operational cost and require secondary treatment for generated excess sludge. Several technologies like low pH methanogenesis, anaerobic ammonium oxidation, and sludge pyrolysis are the newer concept found to be very promising. But it still require evaluation for effective removal of waste from corn starch industry effluent; as well as a matter of extensive research itself because of the non-confirmative bacterial characteristic, occurrence, growth factor, culture and isolation possibilities, which are still to be explored. This paper reviews the newer possibilities to treat effluent under low pH and possibilities for effective anaerobic removal of nitrogenous pollutants and incorporation on zero discharge close loop technology in corn starch wastewater treatment. Corn starch contributes 12% of total starch production and growing at 5.5% rate annually. Thus corn starch industry, now a days is an area of concern in term of global pollution contribution and control. The technologies available for treating starch industry waste water are not specific to the type and character of its huge amount of wastewater with high load, low pH and degradable solids. There is also lack of focus on reutilization of treated effluent and ensuring zero discharge in terms of water and waste sludge. Thus vigorous research emphasis is required on low pH bioreactor operation for carbonaceous effluent treatment along with nitrogenous pollutant removal by low cost denitrification with modification of available nitrification-denitrification or by anammox process. Introduction of secondary filtration-reverse osmosis to ensure generating reusable potable water is also a research gap that is present with today's available technology. Corn starch wastewater treatment thus leaves a wide area of opportunity for technological development in order to design cost efficient treatment system.

[2] Starch wastewater treatment technology

TongboCai, Hua Lin, Zhaojun Liu, Kaiwei Chen, Yi Lin, Yuan Xi , Kong Chhuond (2019), Several methods of starch wastewater treatment in recent years, including physical method, physical-chemical process, biological method and combined process method, were reviewed. The advantages and disadvantages of these methods are analyzed, and the development and research direction of these methods are prospected. Starch is an important industrial raw material, widely used in food, chemical, textile, medicine and other industries. In the process of starch production, waste water discharge is very large, each production of 1t of starch will produce 10~20 m3In the wastewater, COD concentration is between 5000 and 50000 mg/L, BOD concentration is between 3000 and 30000 mg/L, and SS concentration is between 1000 and 5000 mg/L. These wastewater mainly contains dissolved starch, a small amount of protein, organic acid, dust, minerals and a small amount of oil and fat, easy to corrupt fermentation, make the water black and smelly, discharge into rivers will consume dissolved oxygen in the water, promote algae and aquatic plant reproduction.. When the amount of waste water is large, the river will suffer from serious hypoxia, anaerobic corruption and odorous smell, and aquatic animals may suffocate and die, thus posing a threat to human living environment.

[3] Tiezheng Tong et al. The creator in this paper have surveyed three film based innovations – ED/EDR, thermolytic FO, and MD – as three arising ZLD advances to additional concentrate the feedwater after the RO stage. Notwithstanding, contrasted with the specialized development of RO and MVC brackish water concentrators, these advancements are less settled. More pilot or field studies are attractive to approve their enormous scope execution and suitability in seeking after ZLD. Particularly, their energy utilization and cost should be additionally assessed to make an immediate correlation with MVC saline solution concentrators. For MD and thermolytic FO, their capacity of saddling poor quality energy will essentially diminish the great energy interest, activity cost, and GHG impression of ZLD. Moreover, the natural effects of ZLD should be better perceived. A daily existence cycle appraisal investigation of the energy interest and GHG discharge will give extra experiences into the money saving advantage adjusting of ZLD. Alongside propels in working on the energy and cost efficiencies of ZLD innovations, especially by joining layer based cycles, ZLD might turn out to be more attainable and reasonable later on.

[4] M. Cheryan et al. The creator has assessed about the wide scope of enterprises experiencing oil and oil contamination. Modern squanders might be lower in volume, however contain a lot higher grouping of contaminations .Industries like steel, aluminum, food, material, calfskin, petrochemical and metal ®nishing are some that report undeniable degrees of oil and oil in their effluents. Accordingly the utilization of UF and MF to treat oil±water emulsions is surely going to increment later on, particularly in applications where the worth of the recuperated materials is high, e.g., reusing watery cleaners and machining coolants. Layers could likewise be valuable in a half and half framework when it is joined with regular substance treatment frameworks to think mucks. . This survey of the creator depicts a few contextual investigations of these applications, and examines the potential entanglements and capability of in applying layers to the treatment of slick squanders.

[5] ValentinaColla et al. The creators in this paper did the exploration about the water reuse and office the executives ideas for the primary circuits in various steel plants of steel industry through salt end strategies. This review concerned two water circuits having a place with two coordinated steelworks where high salts fixations led to pertinent issues. In the main circuit, the high chloride and carbonate focus in the cooling water of the hot strip plant can influence the nature of the strips, because of the salt testimonies on the strip surfaces, and causes erosion of gear. In the subsequent circuit, the high substance of chlorides and fluorides in the process waters of a Blast Furnace gas cleaning framework causes erosion of different parts. . In the two cases the creator completed the tests to survey the likelihood to apply Reverse Osmosis execution and to assess the security of its subjective presentation to the saline water. The tests showed that pre-medicines are really required for colloids expulsion, and, subsequently, to ensure Reverse Osmosis layers: in the primary circuit, ultrafiltration, and in the second circuit customary coagulationflocculation-sedimentation framework followed by sand filtration have been carried out. . Results showed that, through Reverse Osmosis framework, most salts, like chlorides, fluorides, calcium, sulfates, and so forth can be taken out and different boundaries, like electrical conductivity, alkalinity and Total Dissolved Solids significantly diminished. Appropriately critical outcomes have been accomplished, like new water utilization and water released decline, and the line administration life improvement, because of the decrease of consumption issues. The monetary reasonability at modern scale was additionally assessed and their execution came about plausible.

3. PROPOSED METHODOLOGY

Analysis of available technologies and their limitation in application for treating starch industry effluent-

[1] The basic treatment focus for corn starch industry is upon removing carbonaceous and nitrogenous nutrient where subsequent treatment by anaerobic bioreactor and auxic-anoxic treatment proved to be efficient. The conventional anaerobic reactors were designed non-specific to starch industry and thus faces several issues when treating acidic effluent likeoperational limitation to pH 6.5-7.9, generation of huge amount of secondary waste sludge, high retention time. Similarly the most popular nitrification denitrification is also a high energy utilizing process due to recirculating design and vigorous aeration requirement to maintain dissolved oxygen (DO) level 5.6-6.0.

[2] The newly developed ANAMMOX process overcomes above problems with nitrogen removal by less sludge production and complete anoxic operation. But the issue with this technology is also numeric and severe, like start-up of reactor requires longer time as the generation time of the bacteria is reported to be 11 days. There is no reliable data on onsite development of ANAMMOX sludge. Maximum reactor start-up was carried out using sludge from pilot reactor of 10L lab reactor from the laboratory of Rotterdam, Netherlands (Xiong et al., 2013) (Bagchi et al., 2012). Though several successful operation is still continued to treat different industrial wastewater by this process, but the microbiological process of the ANAMMOX activity is still not completely understood. The biochemical pathways are mostly hypothesized (Jetten et al., 2001). Also there is no specific culture technique or biochemical identification technique are still available to identify the process onsite. All the activities reported are based on critical genetic studies based on laboratory scale tests (Backman and Hulth, 2013). There is very few successful application of this technology reported for starch industry wastewater treatment in China (Ali et al., 2013) (Ni and Zhang, 2013).

Scope for new technologies for effective treatment of starch industries-

Waste treatment is a low recovery process for any industry. So to overcome lacuna of treatment and to make the system more attractive and adaptable the treatment system must be specific according the characteristic of the effluent of concerned industry. Recent trend of industrial effluent treatment emphasizes to the possibility of carrying out methanogenesis under acidic condition. Methanogen cultivated from peat bog sludge shown to be highly active for utilization of bio-waste and gases like hydrogen and carbon dioxide (Kotsyurbenko et al., 2007). Duval and Goodwin (Duval and Goodwin, 2000) also reported that significant methanogenesis was observed under acidic pH. Several researcher investigated presence of low pH methanogen in peat bog where the pH goes down below pH 5 most of the time (Bhadra et al., 1984) (Jain and Mattiasson, 1998).

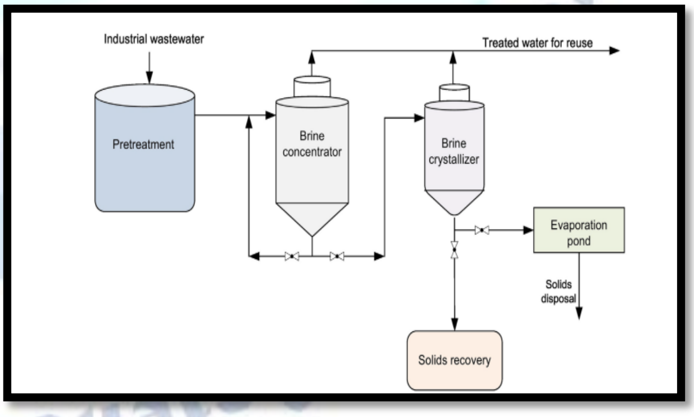
Williams and Crawford (Williams and Crawford, 1984) (Williams and Crawford, 1985) reported active methanogenic activity up to pH 3.0-4.0. Several laboratory scale optimization study was conducted by different researchers to find out optimum condition for low pH methanogenesis, where most researchers has reported an optimal range between 4.5 to 5.0 (Maestrojuan and Boone, 1991) (Patel et al., 1993) (Bräuer et al., 2006). Recent research on low pH removal of corn starch industry effluent on laboratory scale also shown promising result (Neogi et al., 2016) by removing COD up to 69.78% at pH 5. More emphasis is required to find out the possibility of removing pH under acidic condition to make the effluent treatment system more cost effective, especially for industries like corn starch, potato starch, rice starch and other food processing industries which generates acidic effluent in bulk quantity.

Treatment of nitrogenous pollutant is a tedious job because of its highly diversified form of source starting from complex soluble and insoluble proteins, amino acids, nitrite, nitrate and ammoniacal salts (Padoley et al., 2008). Conventional effluent treatment system comprising aerobic-anoxic reactor operation is a cost effective procedure and increases overall HRT and waste sludge production. ANAMMOX process after successful application in China's corn starch industry definitely shows promising future. But for acceptable applicability confined research is required for identification and culture technique for anammox bacterial group for onsite development. Also there is an argument among researchers about its generation time, load tolerance and food to microorganism ratio (Hannides, 2014).

Zero discharge is also a principally appreciated approach for industrial manufacturing processes where reducing waste generation is the key target (Wang et al., 2015). Starch industries mostly generates huge amount of wastewater and waste biological sludge. The residue total suspended solid is a key barrier to recycle the water. The application of low cost coagulant or charcoal filtration along with reverse osmosis will prove to be an efficient and rapid technique for water reutilization and will help closing the loop (Chavalparit and Ongwandee, 2009). However, there is no sufficient data available on reutilization of wastewater internationally. Also the generated waste sludge usually dried and disposed as a cake of sent to boiler which further contribute to pollute land. Introduction to pyrolysis technology (Chen et al., 2015) (Fonts et al., 2012) using the generated methane from bioreactor will further help to generate energy efficient gas and fix the residue waste to non-leachable fixed waste which can be further used into construction material or for land filling purposes (Chen et al., 2016).

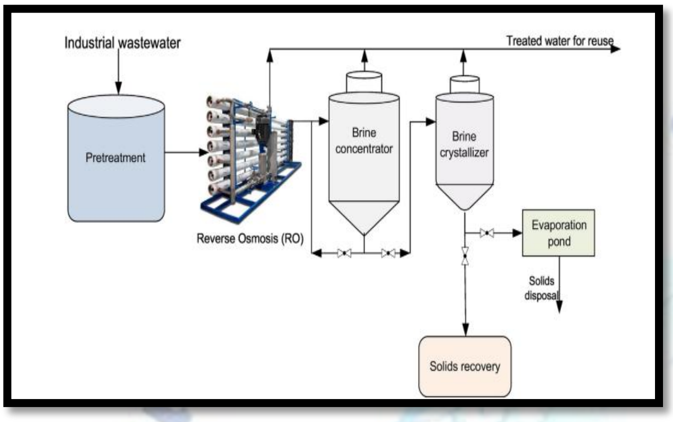
Zero Liquid Discharge-

This review also discusses Zero Liquid Discharge (ZLD) systems for starch wastewater treatment, one possible solution to concentrate disposal. ZLD disposal is the only option currently available in many inland regions where surface water, sewer, and deep well injection disposal are prohibited. A ZLD-system can produce a clean stream from industrial wastewater. Suitable for reuse in the plant and a concentrate stream that can be disposed, or further reduced to a solid. Furthermore, the prevalent technologies used for ZLD-systems and different types of components in a ZLD-system are being described in this project.



[Fig.1.1: A schematic diagram of a thermal ZLD system]

A zero liquid discharge (ZLD) can be defined as combination of techniques or facilities and system which will help the water loop of the industry to become close one for absolute recycling of permeate and converting solute (dissolved organic and in-organic compound/salts) into residue in the solid form by adopting methods like concentration and thermal evaporation. ZLD will be recognized and certified will be based on two broad parameter that is, water consumption versus waste water reused or recycled(permeate) and corresponding solids recovered (percent total dissolved/suspended solid in influent).



[Fig.1.2: A schematic diagram of a RO incorporated ZLD system]

In a world where freshwater is an increasingly valuable resource, industrial processes threaten its availability on two fronts, unless the water is treated. Many industrial processes require water, and then reduce the availability of water for the environment or other processes, or alternately contaminate and release water that damages the local environment. Although the history of tighter regulations on wastewater discharge can be traced back to the US Government's Clean Water Act of 1972, India and China have been leading the drive for zero liquid discharge regulations in the last decade. Due to heavy contamination of numerous important rivers by industrial wastewater, both countries have created regulations that require zero liquid discharge. They identified that the best means to ensure safe water supplies for the future is to protect rivers and lakes from pollution. In Europe and North America, the drive towards zero liquid discharge has been pushed by high costs of wastewater disposal at inland facilities. These costs are driven both by regulations that limit disposal options and factors influencing the costs of disposal technologies. Tong and Elimelech suggested that, "as the severe consequences of water pollution are increasingly recognized and attract more public attention, stricter environmental regulations on wastewater discharge are expected, which will push more high-polluting industries toward ZLD."gh-polluting industries toward ZLD." Another important reason to consider zero liquid discharge is the potential for recovering resources that are present in wastewater. Some organizations target ZLD for their waste because they can sell the solids that are produced or reuse them as a part of their industrial process. For example, lithium has been found in USA oil field brines at almost the same level as South American salars.

[Fig.1.3: ZLD Water Treatment Technology]

4. CONCLUSION

The goal of a well-designed Zero Liquid Discharge (ZLD) system is to minimize the volume of liquid waste that requires treatment, while also producing a clean stream suitable for use elsewhere in the plant processes. A common ZLD approach is to concentrate (evaporate) the wastewater and then dispose of it as a liquid brine, or further crystallize the brine to a solid. The evaporated water is recovered and recycled while the brine is continually concentrated to a higher solids concentration. The effluents are desired to be treated to meet the regulatory limits. Basically the levels of COD and total suspended solids are to be reduced to acceptable values given by the Pollution Control Board and pH to neutral. Treated water can be reused for activities such as gardening, boiler feed, etc. and the removed waste is classified as organic and inorganic waste and treated accordingly. Other by-products during treatment, such as hydro carbons, lead etc. are used or sold according to the need of the industry. Other than the necessity of meeting the pollution control board norms, treating the wastewater helps in reusing tons of water within the industry and not wasting a single drop and hence it is called Zero Liquid

Discharge. The role of engineer in Zero Liquid Discharge plant is to optimize operating cost, to increase steam economy and to increase solvent recovery.

- Starch wastewater has the characteristics of high concentration and non-toxicity.
- Biochemical method and flocculation and sedimentation method are the most widely used methods for treatment of starch wastewater.
- The type, dosage and sedimentation time of coagulant were studied to improve the treatment effect of wastewater.
- We will vigorously develop clean production, resource reuse and circular economy, continue to study the recovery of useful substances in starch wastewater, and choose the combined treatment technology of wastewater treatment and resource utilization.
- For example, using coagulant to recycle suspended matter in wastewater to produce protein feed.
- At present, most of the domestic use of "anaerobic-aerobic" biochemical method.
- While degrading pollutants, the anaerobic biological treatment process can also produce recycled energy methane gas.
- However, this process has a high investment cost, covers a large area, and is easily affected by the environment.
- Moreover, for amylase factories with small production scale, methane gas has no recycling value, so this process still needs to be studied and developed.

FUTURE SCOPE

- The industries having high organic load and other refractory nature of pollutants will be requiring to adopt ZLD system.
- ZLD refers to a system which would enable and industry to recover clean water using back into industrial processes or domestic use and not subjecting to be disposed in ambient environment including use in industrial premises.
- Industries will have options to select technical system facilitating to achieve ZLD.
- Industries are liable to face closures if found violating the prescribed standards and not having installed on-line effluent monitoring devices where data will have to be available with regulatory bodies and also in public domain.
- Sectors like Pulp & Paper will immediately adopt charter which will facilitate them to reduce pollution load and maximize reduction in water usage / consumption as well as reducing in quantity of effluent disposed. However, such industries shall be subjected to regular vigilance and followed by stern action in case of their noncompliance to the existing stipulated / notified standards.

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Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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