Wastewater Management for Sustainable Development

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***Abstract* —in the current age of immense water and power crisis the treatment of wastewater is important from ecological consideration but also on the economic front. Various treatment methodologies are adopted based on the characteristics and condition of wastewater. Best result of removing loads shows in combining system such as up flow anaerobic sludge blanket reactor followed by activated sludge process. Biological treatment assesses the efficiency of BOD and COD load removal. However the choice of the treatment techniques is critical and complex. This article reviews the wastewater treatment techniques from economic and ecological perspectives.**

***Index Terms*— wastewater, HUASB, anaerobic process, CFSTR, FBR, PBR**

I. Introduction

Wastewater contains number of pathogenic, microorganisms and nutrients which can affect the human and the environment. For these reasons, the treatment of waste water is of utmost importance. Also, the treated water can be used as an alternative source to fresh water. The energy water nexus can be positively affected by treating wastewater and recycling it to reduce fresh water demand.

The source of wastewater is from domestic and industrial activities.

Domestic wastewater is primarialrily from human activities. It comes from washing, kitchen, laundry and houses uses. In general, it consists of 99.9% water and 0.1% solid which is 70% organic (protein, carbohydrates and fats) and 30% inorganic (grit, salt and metals). Usually, it is color is grey and turbid liquid. Real health risk represents in this kind of waste water due it is composition which contains millions per milliliter of fungi, algae, bacteria and viruses which causes many illnesses such as: typhoid, dysentery and cholera.

Industrial wastewater it is industry waste and it is composition depend upon the factory products and the chemical used during the process. Both organic and inorganic can occur in the composition of industrial wastewater. This decomposability occurs due to high amount of proteins, urea, sugar, fats, amino, and amino acid. On other the hand, mines and metal industries (such as salts of metals and acid) are added the inorganic matter. [11]

II. WASTWATER TREATMENT

Primary treatment is basically a physical treatment. The most methods used in this stage are screening, mixing, sedimentation, floatation (for oil and grease) and vacuum filtration. This primarily separates large particles, solid and grit are removed from waste water influent.

Secondary treatment involves biological removal of soluble organic matter. It divides into two categories: aerobic process and anaerobic process. Aerobic process like aerated ponds, activated sludge and trickling filter whereas anaerobic process such as high rate anaerobic and non aerated ponds.

Tertiary treatment is a pollutant specific treatment which deals with removal of specific pollutants, residual of suspended solids by granular medium filtration or screen like sand filter. Disinfection is part of tertiary treatment. Advanced treatment processes generally deal with the removal of dissolved and suspended matter remaining after biological treatment or secondary treatment when required for various water reuse applications [11].

III. LITERATURE REVIEW

Gnanapragasam et. al, 2010 in their studies, " Bio-kinetic analysis on treatment of textile dye wastewater using anaerobic batch reactor" are experimented that anaerobic digestion is the technique applied to textile dye waste water. It is applied to remove color and COD. The reactor consists of bet bottles with 5 L capacity which contains methanoglnic sludge up to half litre capacity. It is used to treat wastewater for both synthetic textile dye and starch at many mixing ratio such as 20:80, 40:60, 50:50 and 60:40 at initial concentration range of 3520 to 3144 mg/L. The working temperature of the reactor is 30˚C and at pH=7. At ratio of 30:70 of starch and textile dye wastewater the removal of COD and color will be at maximum of 81% and 87.3% [5].

Lew et. al, 2004 in their research, " UASB reactor for domestic wastewater treatment at low temperatures" are reported that, after comparing between up flow anaerobic sludge blanket(UASB) reactor and hybrid UASB with filter reactor at different working temperature at range of 10˚C to 28˚C. They investigated that when the up flow velocity was less than 0.35m/h, there was removal of chemical oxygen demand (CODt) which resulted from the biological process in the reactor. For UASB reactor the removal was 82%, and the hybrid UASB reactor was 72% at temperature of 28˚C and 20˚C. At lower temperature, UASB shows good result of COD removal than hybrid UASB reactor. 200g of sludge

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was observed in the reactors at 28˚C and the removal of COD was related only to biological degradation. When temperature decreases, they observed an accumulation of solid in the reactors with an increasing in the sludge as temperature decrease. Better performance was noticed in UASB reactor at 14˚C to 10˚C with lower TSS concentration [9].

Fuchs, et. al, 2002 in these paper, " Anaerobic treatment of wastewater with high organic content using a stirred tank reactor coupled with a membrane filtration unit", are observed high anaerobic conversion was achieved when waste water of different three industries treated using cross flow membrane bio- reactors. Three industries were artificial waste water, vegetable industry waste water and animal slaughterhouse which had load of COD as following: 20, 8 and 6-8g of COD L^{-1} day^{-1} respectively. More than 90% of COD removal was achieved at stable condition. Also, there was production of methane from waste water treatment of the industries. For most complex waste water, the bioreactor is more useful for treatment with high quality [4].

Tawfika, et. al, 2007 in their paper, " Treatment of a combined dairy and domestic wastewater in an up-flow anaerobic sludge blanket (UASB) reactor followed by activated sludge (AS system)" are found out that, the treatment of dairy waste water and domestic waste water together using activated sludge system for effluent which was already treated in UASB reactor. It was operated at 24 h of hydraulic retention time and 1.9 to 4.4 kg loading of COD $/m^3$.d. The influent of UASB reactor was contained 1385 mg/L loading of COD with 69% removal and 576 mg/L loading of BOD_5 with 79% removal.

Good performance of UASB reactor indicated by the result of removing total suspended solids, volatile suspended solids, phosphorous, oil and grease and Total and faecal coliform count. This combination system, UASB reactor following by activated sludge process shows 99.6% of BOD removal, 98.9% of COD removal and 98.9% of oil and grease removal. [12]

Khan, et. al., 2008 in these studies, "Portable water from industrial wastewater" is investigated that, the using treatment effluent of textile waste water as portable water and recycled it. The treatment process included very strict procedure. First, the influent was passed through screens, then followed coagulation and flocculation. After the, it was entered the biological unit which was aeration. Then, it was filtered and sends to tertiary treatment. After analysis the treated water the result was acceptable. [2]

Igbinosa et. al., 2009 in this article, "Impact of discharge wastewater effluents on the physico-chemical qualities of a receiving watershed in a typical rural community", explored that, they spent 12 months to studying the quality of final treated effluent of sewage waste water treatment plant in rural area in South Africa. Number of parameters was done in the final effluent such as: pH, conductivity, turbidity, dissolved oxygen; total dissolved solid, salinity, COD, nitrite, nitrate and temperature. The result was high loading in COD between 7.5 to 248.5mg/L. Also, some parameters excess the standard limits like: D.O, turbidity, nitrite, nitrate and orthophosphate. These characteristics of discharge water can cause risk to the health and environment [7].

Alamdari et.al, 2007 in these studies, “Phosphate Recovery from Municipal Wastewater through Crystallization of Calcium Phosphate", found that, the agricultural and municipal waste water contains phosphate which is increase continuously. Detergents and fertilizers cause this growing of it. The study shows progress in phosphate recovery due to wide application of calcium phosphate. Also, the experiment indicates that magnesium ions enhance the removal of phosphate from 50ppm to 5.5ppm [1].

Atashi, et. al, 2010 in their research studies titled "Effect of Operational and Design Parameters on Removal Efficiency of a Pilot-Scale UASB Reactor in a Sugar Factory", investigated the effect of UASB reactor under specific condition, at temperature of 35˚C to 38˚C and pH of 7. At loading of COD between ranges of 800 – 1800 mg/L, the best hydraulic retention time (HRT) was 5hours. With high loading of COD between 1800 – 2600mg/L, the HRT was 6hours. 90% was the efficiency of COD removal and 72% for total suspended solid [3].

Hampannavar, et. al, 2010 in these studies, " Anaerobic treatment of sugar industry wastewater by Up flow anaerobic sludge blanket reactor at ambient temperature ", reported that, the treatment of sugar industry waste water using UASB reactor with seeding of non granular anaerobic sewage sludge at ambient temperature between 29˚C and 37˚C. 95 days was the success period for start up of granulations with organic loading rate of 0.5 g/L of COD and up to 16 g/L of COD. The hydraulic retention time was decreased until optimum value evaluated at 6hours. The removal of COD was at efficiency of 89.4%. Finally, the treatment of sugar waste water possible at ambient temperature and 16 g/L of COD loading [6].

Mahmouda, et. al, 2011 in these studies, " Use of down-flow hanging sponge (DHS) reactor as a promising post-treatment system for municipal wastewater", they explored that, the treatment of sewage waste water which discharge to irrigation system using simple process with low energy consumption. The technology used was hybrid up flow blanket reactor following by down-flow hanging sponge reactor which downstream for effluent primary sedimentation. Raw waste water was fed to both reactors continuously. Both two systems recorded good efficiency of removal BOD, COD, TSS and total nitrogen [10].

IV. COMMON REACTORS

Continuous-Flow Stirred Tank Reactor (CFSTR) is a completely mixed reactor. In such type of reactors, the flow of wastewater is continuous. The contents are dispersed throughout the tank as soon as the flow enters the reactor and their uniform concentration are maintained in the reactor operating under steady state conditions.

In a plug-flow reactor (PFR), the content of wastewater follows the principle of 'first-in-first-out' so, the particles pass through the tank in the same order or sequence in which they enter the tank and longitudinal mixing is assumed to be negligible. The concentration of a reactant varies with time and along the length of the reactor.

Completely Mixed Batch Reactor (CMBR) is a closed system where no flow is added or allowed to go out during designed reaction time. The reactants are added to the reactor when it's empty and the contents are withdrawn after the reaction period is over. In a (CMBR), it's assumed that the reaction kinetics is of first order and at a given instant of time, the reactant concentration is uniform throughout the reactor.

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Fluidized Bed Reactor (FBR) is a reactor in which the filled packing material expands and gets fluidized when the wastewater to be treated moves upward in the reactor is called an FBR. Normally, air is also introduced along with the influent flow from the inlet.

A Packed Bed Reactor (PBR) is the filled inert patch filled inert packing material for the growth of biomass is kept packed (or fixed) is called a PBR. The flow of wastewater through the reactor maybe countercurrent or cocurrent. The packing material commonly used is slag, rock or ceramic. However, the use of plastic as packing material, with various configuration and large specific area, is now more common [8].

V. RESULT AND DISCUSSION

Anaerobic process used to treat textile dye waste water in batch reactor. The efficiency was 81% of COD removal and 87.3 % of color removal at 30˚C working temperature. Different ratio of textile dye and starch waste water is used.

Up-flow anaerobic sludge blanket reactor has more efficiency comparing with hybrid UASB reactor with filter especially at low temperature. The removal of COD related to biological degradation only.

It is useful when using bioreactor for treatment of combined industrial waste water at different loading of COD. The removal of COD achieved more than 90%.

Activated sludge process used to treat downstream of an up flow anaerobic sludge blanket. Combination system used for treatment of mixed domestic and dairy waste water. This system shows high efficiency, more than 98.6% removal of BOD and 98.9% removal of COD.

It is feasible to get portable water from textile waste water but after treatment processes. First, primary treatment, then, secondary treatment (aeration) and finally the effluent passes through tertiary treatment.

Some chemicals can be used to enhance the removal of phosphate from domestic waste water. Best removal of loading can obtains when UASB reactor used under certain conditions. The hydraulic retention time related to COD loading.

UASB reactor with seeding of non granular anaerobic sewage sludge is used in sugar industry wastewater application at ambient temperature.

Combination technology used to treated municipal waste water which disposed to irrigation system. Hybrid UASB reactor followed by down flow of hanging sponge reactor. Result of some parameter shows good efficiency.

VI. CONCLUSION

Batch reactor indicates 81% removal of COD loading in textile dye waste water treatment at different ratio of inlet flow. The combination system has more efficiency than others like using UASB and AS system, more than 98.6% removal of BOD and COD loads. There is an effect of temperature on the quality of final effluent. The removal of COD and BOD depend on the biological treatment. For best quality of waste water treated effluent, the advanced treatment is required to remove some pollutant like suspended solid. Also, some chemicals can enhance the treatment such as Calcium Phosphate. In conclusions, many technologies used for treatment of waste water depend on the nature and characteristics of waste water.

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