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AjaySharma
Ph. D Research Scholar, Guru Kashi University, Talwandi Sabo, India

Dr. Ashutosh Pathak
Professor, Guru Kashi University, Talwandi Sabo, India

Correspondence:
AjaySharma
Ph. D Research Scholar, Guru Kashi University, Talwandi Sabo, India

A Review on Physical and Chemical Characterisation of Dairy Effluents

Ajay Sharma, Dr. Ashutosh Pathak

Abstract
Biological treatment of wastewater has been engaged successfully for numerous types of industries. Aerobic processes have been used expansively. Large production of sludge is the main problem and methods such as bio filters and membrane bioreactors are being developed to combat this occurrence. Anaerobic waste treatment has experienced noteworthy developments and is now consistent with low retention times. The UASB though a high rate anaerobic reactor is now becoming less prevalent than the EGSB reactor. New developments such as the Annam ox process are highly promising for nitrogen removal. For metal removal, processes such as bio sorption and bio surfactants combined with ultrafiltration membranes are under development. Bio surfactants have also shown promise as dispersing agents for oil spills. Wetlands can be used to reduce biological oxygen demand (BOD), total suspended solids (TSS), nutrients and heavy metals if sufficient space is available.

Keywords: wastewater, environment, solids, organic and inorganic etc

Introduction
Wastewater is a combination of water and water-carried wastes originating from households, commercial and industrial amenities and institutions. Untreated wastewater generally contains high levels of organic material, numerous pathogenic microorganisms, nutrients and toxic compounds leading to environmental pollution and health hazards. So, the waste water must be treated appropriately before final disposal, which leads to protection of the environment with public health and socioeconomic concerns. It is a mixture of sewage water, manufacturing waste effluents, agricultural drainage and hospitals facilities; it is well known that the wastewater from domestic origin contains pathogens, suspended solids, and other organic and inorganic pollutants. In order to diminish the environmental and health hazards, these contaminants and impurities need to be brought down to permissible limits for safe disposal of wastewater. Therefore, removal of the organic contaminants and pathogens from wastewater is of paramount important for its reuse in different activities (pollutants in waste water: European committee). The waste water that flows after being used for domestic, industrial, manufacturing and other purposes is known as sewage. Sewage comprises water as the main constituent, while other constituent, and include organic waste and chemical. Sewage discharge is one of the problems presently facing Rourkela and several efforts are being vigorously pursued to control it (Rakshit and Sudeep, 2010). Assessment of water and wastewater is very crucial to safeguard public health and the environment. Sewage discharges are a major source of water pollution, contributing to demand of oxygen and nutrient loading of the water bodies; promoting toxic; algal blooms and leading to a destabilized aquatic ecosystem. (Kushwah and Vajpayee, 2011) The problem is compounded in areas where wastewater treatment systems are simple and not efficient. The conventional wastewater treatment technologies as adopted in industrialized nations are expensive to build, operate and maintain especially for de-centralized communities. Research efforts are underway for the development of treatment technologies suited to these decentralized communities. (OECD, 2009) The principal objective of wastewater treatment is generally to allow human and industrial effluents to be disposed of without causing any danger to human health or damage to the natural environment which may be unacceptable. Irrigation with

wastewater is both disposal and utilization and indeed is an effective form of wastewater disposal (as in slow-rate land treatment) (N. R.M; 2010). However, some degree of treatment must normally be provided to raw municipal wastewater before it can be used for any agricultural or aquaculture purposes. The effluent quality used in agriculture has a great outcome on the operation as well as performance of the wastewater-soil-plant and also of aquaculture system. The required quality of effluent in the case of irrigation depends on the crop or crops which are to be irrigated, the soil conditions and properties and also on the system of effluent distribution adopted. (N. R.M 2010). By means of crop restriction and by selecting irrigation systems which could minimize health risk, the grade of pre-application treatment of waste water can be reduced. A analogous approach is not possible in aquaculture systems and more trust will have to be placed on controller through treatment of waste water..

Water is the basic and most fundamental resource for humans, animals and plants, all are dependent on it. The water uses are increasing with enormous rapidity; whereas the supply is static (Hockensmith, 1960). Wastewater and other low quality waters are significant in overall water resources management. By releasing fresh water resources for domestic supply and other, priority uses, reuse makes a contribution to water and energy conservation and improves quality of life. Wastewater can have positive agronomic results. Moreover, wastewater schemes when properly planned and managed, can have positive environmental and health impact, besides providing increased agricultural yields (FAO, 2003). Wastewater also present problems because of their variable composition and possible high concentration of suspended solids (Ciaccio, 1977). Pollution of water by industrial and urban development's increasing in scope and must be faced realistically through government aid to prevent community pollution. State and federal pollution control regulation agencies indicates that a decisive attack is to be made on this problem. Pollution control and treatment of polluted waters can return large quantities into use full channels (Euro Training Ltd., 2001). Sanitary engineering technology for treating wastewater to reduce its impact on water courses, pioneered in United States and England, eventually became economically socially, and politically feasible (Vesilind and Peirce, 1990). Sudan will also be faced by the two major water shortage and pollution, if serious precautions are not made, this because most of the country lies in the arid and semi-arid zones which are characterized by unpredictable rain fall and high evaporation rates. According to the 1959 Nile Water Agreement between Egypt and Sudan the country is getting only 18.5 milliard m3 as measured in Aswan, this share is nearly being exploited. The underground water resources are envisaged to be substantial but require further studies to evaluate qualities and quantities and reduce cost to an economic level (Ministry of Irrigation, 2001). On the other hand, in Khartoum-North there is average of wastewater exceeding 300 m3 /h discharged to Khartoum Refinery treatment plant. Khartoum Refinery is discharged millions of gallons of wastewater containing some toxic by-products. This polluted wastewater is treated before being discharge into outside removing most of the toxic chemicals. The polluted wastewater is treated by a very complicated and costive chemical processes before being discharge out to four very wide evaporated bonds then part of it used for irrigation and production of some useful trees like Palm trees gardens and small lake where some fishes have been adopted.

UASB Technology

For developing countries, the anaerobic treatment offers an attractive prospect. With many options available for treatment of municipal and industrial effluents, the anaerobic treatment process stands ahead because of minimum sludge formation and production of energy in the form of methane. For the past several decades the research on fundamentals of anaerobic digestion was going on and the total duration of digestion process has come down with the advancement of high rate anaerobic processes. The relative size of these high rate digesters is quite small and the space occupied is also less. Instead of flat and short reactors as used earlier, tall reactors are being applied. The loading rates for high rate anaerobic digesters are comparatively high, because of the retention of active granular settle able sludge in the reactor. The basic studies of the microbiological and biochemical aspects of anaerobic digestion have revealed many of the characteristics and nutritional requirements of individual and groups of anaerobic bacteria, while pilot and full scale engineering studies have demonstrated the operational requirements and instabilities often encountered in the process. (NATO/CCMS; 1998) Among the high rate anaerobic digestion processes, the UASB process stands ahead for its wide ranging applications for all types of wastes (BREF : UASB). The only drawback of the process is slow start-up in the absence of granular seed sludge (Bowen, 1979).

The present work is done on a laboratory scale UASB reactor treating domestic waste water in the presence of digested sludge, and experiments of the treated sludge taken every week from the pilot model were conducted to study the effects of recirculation of the same waste water.

Advantages of using UASB technique

1. Less energy requirement
2. Less biological sludge production
3. Fewer nutrients required
4. Methane production
5. Elimination of off shore gas pollution
6. Rapid response to substrate addition
7. Periods without feeding
8. Methane from sludge dewatering plants can be converted into biogas, but it can also be converted into hydrogen, which can be used in direct fuel cells. Thus another option for the powering of wastewater plants is also possible.

Disadvantages of UASB technique

1) Sensitive to adverse effects of low temperature
2) More susceptible to upsets due to toxic substances
3) May require alkalinity addition
4) Biological N and P removal is not possible.

Literature Review

Water and wastewater

The supply of an adequate quantity of water of suitable quality is of vital importance to food industry. Water is an integral component of the product as in soft drinks and beer, or it may come into intimate contact with product during the manufacturing process, as in the washing of butter. Water is used for washing of process equipment, for cooling purposes, for conveyance of materials, and boilers, heating and air conditioning system (Herschdoerfer, 1986). Wastewater means, domestic sewage and industrial waste discharged into drainage ditches and sewers and the entire contents emptied into the nearest water course (Vesilind and Peirce, 1990). Wastewater discharge standards in the U.K. are set and enforced on a regional basis by the water Authorities or River Boards. Discharge quality standards are established depending on the, sensitivity, of the receiving environment, it is surface water or sewage treatment works. In other countries, for example the U.S.A, discharge standard are set by a national body in accordance with limitations imposed by treatment technology (Herschdoerfer, 1986). Most industrial processes either require water or are made by the use of water for one purpose or another. As the water is being used, some of the other materials used in the industrial process may become mixed in with the water. That part of the water which is not reused by the industry is discharged as industrial wastewater treatment plant processes (Euro Training Ltd., 2001).

Wastewater Treatment

The objective of wastewater treatment is to reduce the concentration of specific pollutants to level at which the discharge of the effluent will not adversely affect the environment or pose a health threat (Vesilind and Peirce, 1990). The most appropriate wastewater treatment is that provides and secures effluents with the chemical and microbiological quality required for a certain specific use at low cost and minimal operational and maintenance requirements. Wastewater treatment plants reduce organic and suspended solids, remove wastewater chemical constituents that may be toxic to crop as well as biological constituents which are of main concern to public health in general (FAO, 2003). Industrial wastewater discharges can have numerous adverse impacts on the wastewater collection system, treatment facilities and environment. The discharges can corrode sewers, plug sewers and release toxic gases and obnoxious odors in the collection system. When this wastewater reach treatment plants they can be toxic to the biological processes, they can inhibit microorganisms from performing their intended functions, and they can accumulate to undesirable levels in the microorganisms. After industrial wastes leave the treated effluent, they can be toxic to microorganisms, aquatic life and people in the environment. Industrial wastewater treatment depends on the types of pollutants in the waste or waste stream, also the quantities and concentrations of pollutants. The frequency of generation and discharge can be once a year or once a day (Euro training Ltd., 2001). The treatment system of wastewater can be divided to:

Primary Treatment

Is a physical process, the objective of primary treatment is the removal of solids. Some BOD is removed as a consequence of the removal of decomposable solids, and also little phosphorus (P), (Vesilind and Peirce, 1990). Primary treatment for wastewater includes:

a) **Screening:** A screen in treatment plant removes materials that might damage equipment or hinder further treatment. Typical screens, consist of steel bars that about 2.5 cm a part. These screens are cleaned either manually or mechanically.
b) **Comminutor:** A circular grinder designed to grind the solids coming through the screen in to pieces about 0.3 cm or less in diameter.
c) **Grit removal:** Grit and sand can damage equipment like pumps and flow meters and must be removed.
d) **Skimming:** It is the removal of materials that will float. Settling tanks: also called sedimentation tanks or clarifiers, to settle out as much solid material as possible. The solids settle to the bottom of the tank and are removed through a pipe while the clarified liquid escapes over.
e) **The settling tank:** that immediately follows screening and grit removal is called the primary clarifier. The solids that drop to the bottom of primary clarifier are removed as raw sludge. Raw sludge generally has a powerfully unpleasant odor, is full of pathogenic organisms – and is wet, three characteristics that make its disposal difficult. It must be stabilized to retard further decomposition and dewatered for ease of disposal (Vesilind and Peirce, 1990). By the end of the primary treatment approximately 25 – 50% of the biochemical oxygen demand (BOD), 50 – 70% of the total suspended solids (SS) and 65% of the oil and grease are removed (Asano and Tchobanoglous, 1987).

Secondary Treatment

The secondary treatment is the further treatment of the effluent from primary one. It involves the removal of biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes, which metabolize the organic matter in wastewater (Asano and Tchobanoglous, 1987). Common biological processes include the trickling filter and activated sludge:

The trickling filter

A trickling filter consists of a basin or tower filled with support media such as stones, plastic or wooden slates. Wastewater is applied intermittently or some time continuously over the media. Microorganisms become attached to the media and form biological layer or fixed film. Organic matter in the wastewater diffuses into the film where it is metabolized. Oxygen is normally supplied to the film by the natural flow of air either up or down through the media, depending on the relative temperatures of the wastewater and ambient air. Forced air can also be supplied by blowers but this is rarely necessary. The thickness of the bio film increases as new organisms grows. Periodically, portions of the film sloughed off the media; the sloughed material is separated from the liquid in a secondary clarifier and discharged to sludge processing. Clarified liquid from the secondary clarifier is the secondary effluent and a portion is often recycled to the bio filter to improve hydraulic distribution of the wastewater over the filter (FAO, 1985).

Activated sludge

The activated sludge process differs from trickling filtration in that the microorganisms are suspended in the liquid. An activated sludge system, as shown in the block diagram in Fig 2.1 include a tank full of waste liquid from the primary clarifier and mass of microorganism. Air bubbled into this aeration tank provides necessary oxygen for survival of the aerobic organisms. The microorganism come in contact with dissolved organic matter in the wastewater, adsorb this material, and ultimately decompose the organic material to CO2, H2O, some stable compounds, and more microorganism. When most of the organic material, that is, food for the microorganisms, has been used up, the microorganisms are separated from the liquid in a settling tank, sometimes called a secondary or final clarifier. The microorganisms remaining in the settling tank have no food available, become hungry, and are thus activated hence the term activated sludge. The clarified liquid escapes over a weir and may be discharged into the receiving water. The settled microorganisms, now called return activated sludge, are pumped back to the head of the aeration tank where

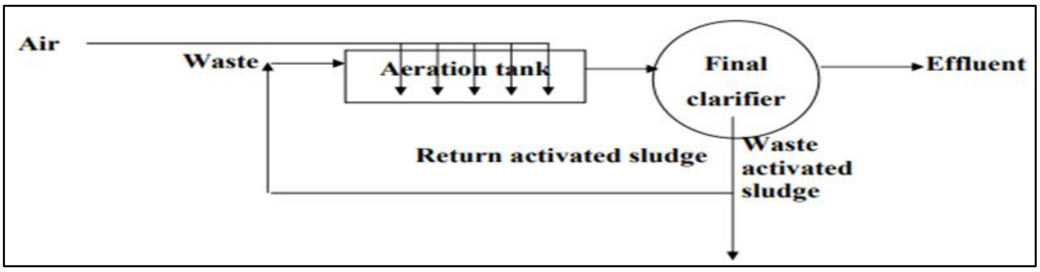

Fig. 1: Block diagram of an activated sludge system

they find more food in the organic compounds in the liquid entering the aeration tank from the primary clarifier and the process starts over again. Activated sludge treatment is a continuous process. With continuous sludge pumping and clean water discharge (Vesilind and Peirce, 1990).

Physical-chemical treatment Physical-chemical treatment processes are alternatives to biological process. In a physical-chemical plant, the main processes are chemical coagulation, carbon adsorption and filtration. Suspended solids and phosphate precipitate together in a sedimentation vessel after addition of suitable chemicals, such as alum ferric chloride or lime. The granular carbon column may serve the dual function of adsorbing organics and filtering out solids. Physical-chemical treatment is usually applied to wastes containing toxic or non-biodegradable compounds that are not amenable to biological processes (Sharif, 2000). Typical physical-chemical flow sheets are shown in Fig.

Sludge disposal

Wastewater treatment processes generate significant quantities of sludge from suspended solids in the feed, biomass generated by biological operations, and precipitates from added chemicals. Some common sludge disposal operations and their functions are showed in Table 2.1. Selection of a treatment sequence for sludge depends upon the nature of the sludge, environmental factors, and ultimate disposal options. Concentration operations, such as gravity or flotation thickeners, increase the solids concentration and achieve a significant reduction in sludge volume.

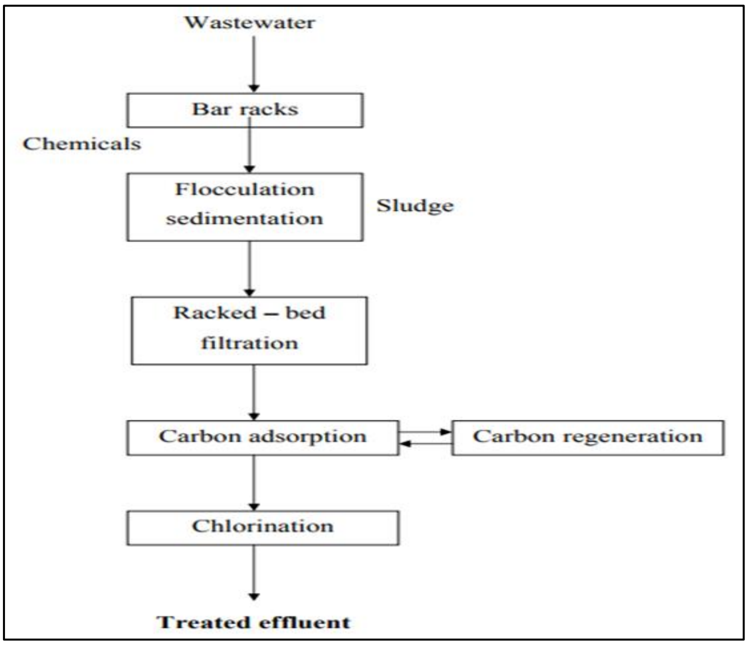

Fig. 2: Typical flow sheet for physical-chemical treatment

Study of Waste Water Quality Management in IIlawarra Coal Mines

R. N. Singh; University of Wollongong (1998) the waste auditing technique provides a powerful tool to assess periodically the efficacy of the mine wastewater treatment system. This will provide an opportunity to the mine operators to change the mining and processing conditions so that the environmental and economic goals can be achieved. This technique has been successfully applied to a mine site in the mawarra region where wastewater of dissimilar chemical characteristics could be segregated into separate streams for further treatment. Improved process of water managements systems is also proposed. Relatively simple alterations to the operation of the coal wash filtration drains are expected to reduce the periods of inefficient operation of these drains by 95%. As highlighted I this paper, often there is significant economic benefit resulting from the application of waste minimization. In addition, there is always a major benefit to the environment

Study of COD removal efficiency of AH reactor and UASB reactor Tarek

A. Elmitwali, et al (1999) investigated the treatment of sewage at a temperature of 13°C in three reactors (each 3.84 liters) a UASB and two anaerobic hybrid (AH) reactors with small sludge granules with an average diameter of 0.73 mm. The use of small sludge granules and operating the reactors at low up flow velocity (1.8 m/d) improved suspended COD removal efficiencies for the UASB reactor. Moreover, the use of sheets in the AH reactors significantly increased suspended COD removal efficiencies as compared to the UASB and reached to 87% for pre-settled sewage treatment.

High strength sewage treatment in a UASB reactor

Nidal Mahmoud (2007): The upflow anaerobic sludge blanket (UASB) reactor is extensively used in tropical nations for sewage treatment, such as India and Brazil. The ambient temperature in these countries, ranges between 20 and 30 degree Celsius throughout the year (Aiyuk et al, 2006; Von Sperling and Chernicharo, 2005) and sewage is of low to medium strength. The present challenge in development of anaerobic technology is to alter the system to treat municipal sewage in severe situation. For example, in Jordan and Palestine sewage is has high COD concentrations greater than 1000 mg/L.

A framework for efficient waste water treatment and recycling systems

Gayathri Devi, Mekala Brian Davidson, Madar Samad and Anne-Maree (2008) Wastewater has a number of substitute uses and each substitute is connected with a set a costs from the start of treatment to the start of use. Consequently, wastewater recycling can fulfil more than one objective like: decrease the nutrients discharge to natural water bodies, save or substitute drinkable water, and fetch more land under cultivation and above all saving water for environmental purposes. In Melbourne treatment of waste water was even used for thrusting a rocket. In current experiments, the researchers have demonstrated that nitrous oxide gas could be produced under laboratory conditions from wastewater by means of a lowoxygen technique but there's a drawback in the process. Nitrous oxide is a noteworthy greenhouse gas and is more than 300 times more powerful than carbon dioxide.

Domestic waste water treatment using Fixed

Bed Biofilm and Membrane Bioreactor. Ida Medawatyi and R. Pamekas(2011) used membrane bioreactor and fixed film bed biofilm in waste water treatment for water reuse in urban housing area. Their research indicated that water treatment reuse trains have probable application for treating domestic wastewater in urban housing area for non-portable water source. They engaged treatment system using fixed bed biofilm or bio-filter system that could yield water reuse standard quality and also advised substitute technology using MBR system for possible application for treating primary treatment municipal wastewater treatment plant effluent. It was found that the water quality reuse from these operations met the standard for public and urban purposes of use according to USEPA, 2004 [12].

Membrane System for cost efficient treatment of waste water

Pawar Avinash Shivajirao (2012) recommended for membrane systems for treatment of waste water with additional technical advancement and equivalent cost reductions, making them capable of purifying waters in single step processes at reasonable costs. Around onethird for wastewater and two-thirds of the market will be for water. His result further supported the Membrane technologies for receiving superior recognition as substitutes to conventional water treatment and also for enhancing treated wastewater effluent for reuse applications that can ominously decrease operation and maintenance costs and energy use.

UASB technology for Indian dairy industry

R.Thenmozhi(2007) suggested the UASB technique for paper industry. The Indian dairy industry is said to have a growth of more than 15% and waste water is composed to exceed 150 million tons per annum. Biological wastewater treatment has been accomplished in many different ways.To overcome the drawbacks of attached and suspended growth systems Up flow Anaerobic Sludge Blanket reactors are designed. UASB is a typical hybrid type of reactor, which involves both attached and suspended growth process. This study includes the dairy industry wastewater treatment through UASB reactor by fluctuating the retention times in days for a specific organic loading rate. This has efficiently removed BOD, COD and other parameters due to its combined attached growth and suspended growth processes.

Combined Application of UV Photolysis and Ozonation with Biological Aerating Filter in Tertiary Wastewater

Treatment Zhaoqian Jing and Shiwei Cao (2012) The effluent from the secondary clarifiers of the WWTP includes many organic pollutants, most of which are difficult to be decomposed. Direct treatment along with additional biological processes cannot make acceptable performance. AOPs are usually effective in refractory pollutants elimination and can be combined with biological processes in a very low biodegradable wastewater treatment. UV and O3 oxidation was combined with Biological Aerating Filter (BAF) in tertiary treatment. The tests results indicated that though UV photolysis alone was not quite effective for COD elimination, it could improve its performance of ozonation because when UV photolysis was combined along with ozonation, COD in the wastewater secondary effluent was removed by 45%.

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