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A Review Paper on Industrial Waste Water Treatment Processes

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Abstract*: This paper reviewed five (5) researches on industrial wastewater treatment processes, the methods employed in these researches are aerobic, anaerobic or the combination of both methods. The paper tried to briefly discuss the motives of the researchers, their instrumentations and results. These researches include a combined anaerobic-aerobic system for treatment of textile wastewater conducted in Koradi Nagpur conducted a research on chemical industrial wastewater treatment, a preliminary study on nitrogen and organic removal efficiency of a lab-scale system using aerobic and an-aerobic reactors.*

Keywords: wastewater treatment.

I. INTRODUCTION

The chemical industry is of importance in terms of its impact on the environment. The wastewaters from this industry are generally strong and may contain toxic pollutants. Chemical industrial wastes usually contain organic and inorganic matter in varying degrees of concentration. It contains acids, bases, toxic materials, and matter high in biological oxygen demand, color, and low in suspended solids. Many materials in the chemical industry are toxic, mutagenic, carcinogenic or simply hardly biodegradable. Surfactants, emulsifiers and petroleum hydrocarbons that are being used in chemical industry reduce performance efficiency of many treatment unit operations (EPA, 1998). The best strategy to clean highly contaminated and toxic industrial wastewater is in general to treat them at the source (Peringer, 1997) and sometimes by applying onsite treatment within the production lines with recycling of treated effluent (Hu et al., 1999). Since these wastes differ from domestic sewage in general characteristics, pretreatment is required to produce an equivalent effluent (Meric et al., 1999). In chemical industry, the high variability, stringent effluent permits, and extreme operating conditions define the practice of wastewater treatment (Bury et al., 2002). Hu et al. 1999 proposed concept to select the appropriate treatment process for chemical industrial wastewater based on molecular size and biodegradability of the pollutants. Chemical industrial wastewater can be treated by some biological oxidation methods such as trickling filters, rotating biological contactor (RBC), activated sludge, or lagoons (Nemerow, and Dasgupta, 1991; Jobbagy et al., 2000). Pollutants with a molecular size larger than 10,000-20,000, can be treated by coagulation followed by sedimentation or flotation (Hu et al., 1999).Waste minimization in the production process in chemical industry is the first and most important step to avoid waste formation during the production (Carini, 1999; Alvarez et al., 2004). Because of the fluctuation in the strength and flow rate, Bury et al; 2002 applied dynamic simulation to chemical-industry wastewater treatment to manage and control the treatment plant.

Aerobic and Anaerobic Wastewater Treatment

Aerobic, as the title suggests, means in the presence of air (oxygen); while anaerobic means in the absence of air (oxygen). These two terms are directly related to the type of bacteria or microorganisms that are involved in the degradation of organic impurities in a given wastewater and the operating conditions of the bioreactor. Therefore, aerobic treatment processes take place in the presence of air and utilize those microorganisms (also called aerobes), which use molecular/free oxygen to assimilate organic impurities i.e. convert them in to carbon dioxide, water and biomass. The anaerobic treatment processes, on other hand take place in the absence of air (and thus molecular/free oxygen) by those microorganisms (also called anaerobes) which do not require air (molecular/free oxygen) to assimilate organic impurities. The final products of organic assimilation in anaerobic treatment are methane and carbon dioxide gas and biomass. Aerobic treatment systems such as the conventional activated sludge (CAS) process are widely adopted for treating low strength wastewater (< 1000 mg COD/L) like municipal wastewater. CAS process is energy intensive due to the high aeration requirement and it also produces large quantity of sludge (about 0,4 g dry weight/g COD removed) that has to be treated and disposed off. As a result, the operation and maintenance cost of a CAS system is considerably high. Anaerobic processes for domestic wastewater treatment are an alternative that is potentially more cost-effective, particularly in the sub- tropical and tropical regions where the climate is warm consistently throughout the year. Anaerobic wastewater purification processes have been increasingly used in the last few decades. These processes are important because they have positive effects: removal of higher organic loading, low sludge production and high pathogen removal, methane gas production and low energy consumption.

Water Treatment Plant Process :-

Daily Water Usage

On a typical hot summer day, Cañon City water customers use enough treated potable water to cover 31 football fields one foot deep in water! In the winter the usage drops to about 9 football fields worth a day. Before reaching the faucets of Cañon City residents, however, city water goes through an extensive treatment process.

About the Plant

The Cañon City Water Treatment Plant is a conventional surface water treatment plant that diverts water from the Arkansas River to produce drinkable (potable) water, which meets or exceeds all Environmental Protection Agency (EPA) Safe Drinking Water Act and the Colorado Department of Public Health and Environment Primary Drinking Water Standards.

The water treatment plant is located on the hillside west of Cañon City. The water plant has the ability to produce up to 22 million gallons of safe drinking water every day. On average only about 3 million gallons per day are made in the winter; however during the hot summer months when there is an increased demand for lawn irrigation water produced can exceed 10 million gallons per day.

Programmable Logic Controllers

Devices known as programmable logic controllers (PLCs) that are networked together with other PLCs control the water treatment plant and the treatment processes. The PLCs track over 1,500 signals or data points to ensure optimized treatment. The computer signals and data are collected by the Supervisory Collection and Data Acquisition (SCADA) system and provide information to the Operator on shift whenever any item requires Operator intervention.

Arkansas River Diversion

The Arkansas River solely supplies Cañon City's drinking water. The Arkansas River begins as snowmelt near Leadville, Colorado at the Continental Divide. It flows south and southeast through Cañon City, to the Pueblo

Reservoir. From the reservoir, it then flows into the lower Arkansas Valley and eventually leaves the state east of Holly, Colorado. Water taken directly out of the river is **not safe to drink** due to bacterial and parasitic conditions. It would probably make a person sick from ingesting pathogenic bacteria and parasites such as Cryptosporidium and Giardia. The water to be treated is pumped out of the river and is piped underground into our raw water settling pond.

Raw Water Settling Pond

The raw water-settling pond holds the water diverted from the river for a couple of purposes. The primary purpose of the raw water-settling pond is to allow much of the sand and debris to naturally settle out of the water before it is pumped to the water treatment plant. Secondarily, the pond allows for some capacity in the event that the river water is muddy or if an accident on U.S. Highway 50 spills contaminants into the Arkansas River. The pump station on the river can be shut down and the plant can use the ponds' water for supply until the river water is clearer or safe to use again. Also, if something were to happen to the underground piping from the pump station on the river to the pond, the water in the pond can be treated until the problem is fixed. A second pump station lifts the water to the water treatment plant headworks. A backup pump station that is supplied water from the Hydraulic Ditch can be used in the event that the pump station on the river is out of service due to issues whether they are electrical or mechanical. However, this water is pumped directly to the water treatment plant headworks by-passing the settling pond thus losing the benefit of settling the heavy sand, grit, and debris.

Pre-Sedimentation

The Pre-Sedimentation Building is where the treatment process really begins. The raw water from the settling pond is lifted 240 feet up to the water treatment plant. The raw water is delivered to the headworks of the water treatment plant where the first of 5 major unit water treatment processes start the treatment to make the water safe to drink. The 5 major unit processes include chemical coagulation, flocculation, sedimentation, filtration, and disinfection (described below). There are chemicals added to the water as it enters the various treatment processes.

Step 1 Chemical Coagulation

The first chemical added is chlorine dioxide and it is an oxidant used to break down naturally occurring organic matter such as decaying leaves and other plant material. A chemical coagulant known as aluminum sulfate is used as the primary coagulant. A polymer, a long chain of synthetic organic compounds, is also added to the water as a coagulant aid to help in strengthening the primary coagulant's bonding chains. The coagulants are added at the rapid mix unit; this is a unit that creates turbulent mixing energies to help thoroughly disperse the chemical coagulants into the raw water and to begin the coagulation process. The coagulants that cause very fine particles to clump together into larger particles that can then be removed later in the treatment process by settling, skimming, draining or filtering.

Step 2 Flocculation

The coagulated water then flows to the next major unit process, the flocculation process. Flocculation is a slow stirring process that causes the small coagulated particles to form floc. The flocculation process promotes contact between the floc particles and the particulates (sediment) in the water. Generally, these contacts or collisions between particles result from gentle stirring created by a mechanical or hydraulic means of mixing. There are two sets of flocculation basins that contain mechanical mixing paddles that the water passes through to gently stir the coagulated water. The floc formed creates a surface in which the particulates in the water adsorb (adhere) to the surface of the floc thus forming larger settleable particles for ease of removal by sedimentation and filtration.

Step 3 Sedimentation

The flocculated water then flows to the next major unit process, the sedimentation process. The purpose of the sedimentation process is to remove suspended solids (particles) that are denser (heavier) than water and to reduce the particulate load on the filters. Sedimentation is accomplished by decreasing the velocity of the water being treated below the point where it can transport settleable suspended material, thus allowing gravitational forces to remove particles held in suspension. When water is almost still in sedimentation basins, settleable solids will move toward the

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bottom of the basin. This process of sedimentation removes almost ninety percent of the solids in the water. The clearer water on the surface is collected in the launder tubes that direct the water to the filter gallery to remove the remaining ten percent of solids.

Step 4 Disinfection

The settled water then flows from the Pre-Sedimentation Building to the Filtration Facility. Before arriving at the Filtration Facility chlorine is added to the water at the pre-chlorination point to begin the disinfection process. The disinfection process is designed to kill or inactivate most microorganisms in water, including essentially all pathogenic organisms whether they are from bacteria, viruses or intestinal parasites. Pathogenic organisms are the microscopic **bugs** in the water that can cause waterborne diseases such as gastroenteritis, typhoid, dysentery, cholera, and giardiasis.

Step 5 Filtration

The chlorinated settled water then flows into the Filtration Facility and onto the filters for the last of the major unit processes used to treat the drinking water. Filtration is the process of passing water through material such as a bed of coal, sand, or other granular substance to remove particulate impurities that were not removed during the sedimentation process. The water treatment plant uses rapid rate multi-media gravity filter beds. The filters are comprised of a top layer of anthracite, a middle layer of filter sand and then a bottom layer of garnet sand and one an underdrain system that collects the filtered water. The water enters on top of the filter media and passes down through the filter beds by gravity. The different materials work like a giant strainer and trap remaining particulates. When the filters start to get packed full of particles, the operators clean them using a procedure called **backwashing**. Potable water is run backwards through the filters releasing the entrapped particulates that are collected in drain troughs. The backwash water is sent to the Backwash Recovery Pond and, after a settling process, the backwash water is returned to the raw water settling pond for re-use.

Chlorine & Fluoride

The water that is collected from the bottom of the filters is then considered potable. Before the water leaves the clearwells under the water treatment plant chlorine is added a second time for post-disinfection. The additional chlorine ensures that the water remains safe to drink even at the furthest reaches of the distribution system. In addition to the chlorine, fluoride is added to our drinking water at the plant. When fluoridated water is drank during the years of tooth development, the fluoride strengthens teeth and prevents tooth decay. The United States Public Health Service has determined the optimum concentration for fluoride in United States water to be in the range of 0.7 to 1.2 parts per million. Dissolved fluoride-containing minerals are measured year-round in the water of the Arkansas River. The natural fluoride content of the river water averages .4 part per million. The water treatment plants enough fluoride to raise that level to .9 parts per million. The fluoride level is measured daily at the water treatment plant and monthly at the tap to make sure it is sufficient to meet the concentration recommended by United States Public Health Service (USPHS).

The Process Laboratory

The water treatment plant has a process laboratory to ensure that the water treatment processes are optimized and that the water is safe to drink. The water is tested daily for numerous parameters by our water plant operators and by continuous on-line monitoring by process instrumentation. Some of the water quality parameters monitored and tested for are chlorine, turbidity, alkalinity, hardness, dissolved oxygen, conductivity, and pH. Values for parameters of the treated water change with the time of year. Current values can be obtained by contacting the Water Treatment Plant.

II. CONCLUSION

Anaerobic systems prove to be an excellent treatment technology for many areas of the world. In future the traditional system of WSP shall definitely compete more and more with UASB systems. Post-treatment still requires aerobic systems, which e.g. can be ponds, trickling filters or activated sludge plants. The bigger the plants, the more economical it might combine these technologies. Anaerobic biological treatment is well understood and used frequently as anaerobic digesters to treat complex organic solid wastes such as primary and secondary wastewater sludges. However, it has not been used much in the past to treat low strength organic wastewaters from industrial and domestic applications. Aerobic processes were preferred for treatment of these wastewater streams because they are easy to operate and can tolerate process fluctuations.

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