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Study and Design of Destroy and Treatment Bio and Chemical Waste Plant in Hospitals

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Abstract: ***There are many hospitals around of the world served the needs for several years study on waste water characterization has been performed followed by the design of sewage treatment plant. The present study involves the analysis of pH value, total solids, total suspended solids, hardness, acidity, alkalinity, chloride, chlorine, BOD, DO and heavy metals such as Iron, Copper, Zinc, Magnesium, Nickel, Chromium, Lead, Calcium, Aluminum, Silicon, Potassium. A sewage treatment plant is quite necessary to receive the domestic and commercial waste and removes the materials which pose harm for general public. Its objective is to produce an environmentally-safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (usually as farm fertilizer). A sewage treatment plant has been designed with the treatment units, a bar screen of dimension 1.7m, an aeration tank of dimension 4.5 x 4.5 x 3.7 m^3, a collection pit of diameter 4m and depth 5 m.***

Keywords: wastewater, sewage, treatment plant, environmentally, total solids, total suspended solids, hardness, acidity, alkalinity, chloride, chlorine, BOD, DO, and heavy metals such as Iron, Copper, Zinc

1. Introductions

Water is a vital needed for human life, so the availability of water becomes the most attention in various activities. Water have to follow the quality aspects, quantity, and continuity is needed for meet human needs that continue to increase, so it takes conservation efforts of water resources. Conservation of water resources is done through the protection and conservation of water resources, water preservation, and quality management and control of water pollution. Every person or business entity utilizing water resources is encouraged to conduct water preservation through water saving movement and controlling groundwater use by stakeholders by recycling liquid waste into raw water. The recycling of liquid waste into clean water needs to be carried out by large groups of water users such as hospitals, hotels, commercial and industrial areas to maintain the sustainability of water use and efforts to minimize waste disposed into the environment. Liquid waste recycling results can be utilized for agricultural irrigation or landscaping, industrial uses, groundwater replenishment, clean water supplies, and for non-potable uses such as flushing and fire water.

1.2 Biomedical Waste

Biomedical waste is defined as any waste, which is generated during the diagnosis, treatment or immunisation of human beings or animals, or in research activities pertaining thereto, or in the production or testing of biological.

1.3 Categories of Biomedical Waste

There are defined categories: Human anatomical waste, Animal waste, Microbiological and biotechnology waste, Waste sharps, Discarded medicines and cytotoxic drugs, Soiled wastes, Solid wastes, Liquid waste, Incineration ash and Chemical waste.

2. Objective

The major objective of hospital wastewater treatment plant is to treat the influent (untreated wastewater) generated by the hospitals and healthcare sectors before its direct release into natural environment. Hospital wastewater may have an adverse impact on environments and human health.

The principal objective of waste water treatment is generally to allow human and industrial effluents to be disposed of without danger to human health or unacceptable damage to the natural environment. An environmentally-safe fluid waste stream is produced. No danger to human health or unacceptable damage to the natural environment is expected. Sewage includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers. Sewage also includes liquid waste from industry and commerce.

The objectives of the study are:

1) Physical, chemical and biological characterization of the domestic waste water from hospital of KGH, Visakhapatnam.
2) Comparison with the prescribed standard
3) Design of the sewage treatment plant.

3. Literature Review

3.1 Physical characteristic of waste water

Odour: It depends on the substances which arouse human receptor cells on coming in contact with them. Pure water doesn't produce odour or taste sensations. Thus waste water which contains toxic substances has pungent smell which makes it easy to distinguish. Odour is recognized as a quality factor affecting acceptability of drinking water.

Taste: The sense of taste result mainly from chemical stimulation of sensory nerve endings in tongue. Fundamental sensations of taste are, by convention more than by research evidence, salt, sweet, bitter, and sour. The rating involves the following steps: a) dilution series including random blanks is prepared b) initial tasting of about half the sample by taking water into mouth and holding it for several seconds and discharging it without swallowing. c) Forming an initial judgment on the rating scale d) a final rating made for the sample e) rinsing mouth with taste and odour free water f) resting.

3.2 Chemical characteristic of waste water

Chemical characteristics of water state the presence of metals their treatment, the determination of inorganic non-metallic constituents and the determination of organic constituents. Here goes a brief description of all the experiments we have performed.

3.3 Biological characteristic of waste water:

Water quality has a key role in deciding the abundance, species composition, stability, productivity and physiological condition of indigenous populations of aquatic communities. Their existence is an expression of the quality of the water. Biological methods used for evaluating water quality include the collection, counting and identification of aquatic organisms. Most microorganisms known to microbiologists can be found in domestic wastewater like Bacteria, Protozoa, Viruses, and Algae.

4. Hospital Sewage Design

4.1 Main Factors for Design

Hospitals generate on average 750 L of wastewater by bed and a day. These effluents are loaded with pathogenic microorganisms, pharmaceutical partially metabolised, radioactive elements and other toxic chemical substances. The dosage of pollutants of hospital origin shows that certain substances, such as anti-tumor agents, antibiotics and organohalogen compounds, leave mostly wastewater treatment plants. By leaving the wastewater treatment plants, these chemical compounds can provoke the pollution of the natural environment by entailing a biological imbalance. In case the environmental conditions allowing the degradation of these substances are not gathered, they can exercise negative effects on the receiving waters and the living species. In countries that do not experience epidemics of enteric disease and that are not endemic for intestinal helminthiasis, it is acceptable to discharge the sewage of health-care establishments to municipal sewers without pretreatment, provided that the following requirements are need:

1) The municipal sewers are connected to efficiently operated sewage treatment plants that ensure at least 95% removal of bacteria;
2) The sludge resulting from sewage treatment is subjected to anaerobic digestion, leaving no more than one helminthes egg per litre in the digested sludge;
3) The waste management system of the health-care establishment maintains high standards, ensuring the absence of significant quantities of toxic chemicals, pharmaceuticals, radionuclides, cytotoxic drugs and antibiotics in the discharged sewage;
4) Excreta from patients being treated with cytotoxic drugs may be collected separately and adequately treated.

In normal circumstances, the usual secondary bacteriological treatment of sewage, properly applied, complemented by anaerobic digestion of sludge, can be considered as sufficient. During outbreaks of enteric disease, however, or during critical periods (usually in summer time because of warm weather and in autumn because of reduced river water flow), effluent disinfection by chlorine dioxide (ClO_2) or by any other efficient process is recommended. If the final effluent is discharged into coastal waters close to shellfish habitats, disinfection of the effluent will be required throughout the year. To stop the phenomenon of excess load in the process of the wastewater treatment plant, it seems important to consider upstream treatments to hospital wastewater before their discharge in the municipal sewage system. The maintenance on the mechanical parts should be easy. Biological treatment systems are used, sludge disposal should be infrequent-once or twice per annum. Finally, the designer should make sure that the plant or facilities are in keeping with the surroundings. Therefore, the facilities for small wastewater treatment ought to be not only environmentally sound but also human friendly. There are great varieties of systems that combine suspended growth processes and attached growth processes. Among the latter several random media filters have been tested. Some experiences have been developed combining anaerobic and aerobic zones in separate zones in the so-called baffled reactors and employing an air-lift system for recirculation. There is considerably less experience with integrated systems allowing the co-existence of anaerobic and aerobic populations inside the same reactor without physical separation. In the system, attached-growth microorganisms in a biofilm on the surface of plastic biomedia modules, which were vertically moved repeatedly into and out of the bulk fluid, were employed to remove pollutants from wastewater, in terms of chemical oxygen demand. The fixed film system has been proven to remove nutrients efficiently from wastewater. The purpose of this paper was to summarize the long-term performance experience of integrated anaerobic-aerobic fixed film bioreactor system for hospital wastewater treatment. The removal efficiency of pollutants and significant removal of pathogenic bacteria were analyzed.

Generally, wastewater is defined as the composition of physical, chemical and biological waste present in wastewater. Hospital sewage is a wastewater generated relatively in larger quantities from all the units of the hospitals such as emergency and first aid, operating rooms, drug treatment, ICU, chemical and biological laboratories, radiology, canteen and laundry activities etc.

The major objective of hospital wastewater treatment plant is to treat the influent (untreated wastewater) generated by the hospitals and healthcare sectors before its direct release into natural environment. Hospital wastewater may have an adverse impact on environments and human health. Therefore, proper wastewater management in each and every hospital is prerequisite.

4.2 Hospital Sewage Characteristics

Wastewater from various hospitals consists of:
1) Microbial pathogens and harmful bacteria and virus
2) Pharmaceuticals and its metabolites
3) Radioactive isotopes

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4) Hazardous chemicals, heavy metals
5) Drug residues

4.3 Hospital sewage or wastewater treatment plant process

Compact or packaged sewage treatment plant for hospitals is done in series of steps. Conventional treatment processes involved to remove impurities from the influent are listed below.

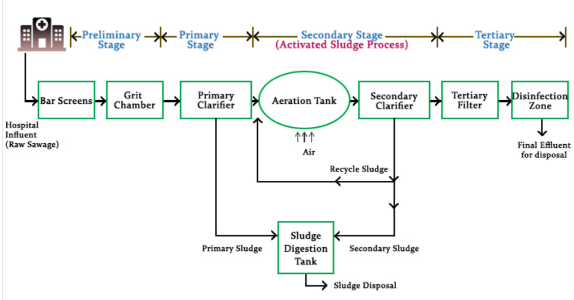

Figure: Conventional processes involved in Sewage Treatment Plant (STP) for Hospitals.

4.3.1 Preliminary Stage or Pretreatment

As a first stage, preliminary treatment process is essential in most of the sewage treatment plant (STP). It removes items such as sticks, rags and other large debris and heavy inorganic solids contained in the hotel influent through bar screens. Removal of these materials protects plant's equipments from damage. The inorganic settled is called as grit which is removed using grit chamber.

4.3.2 Primary Treatment Stage

This is the second step in sewage treatment system. Physical separation of solids and greases from wastewater is done in this stage. Now, water flows into primary filter or clarifiers for few hours to allow solid particles to settle down and lighter particles will float to the top will be skimmed off from the tank. The settled solid is called as primary sludge or primary effluent contains about 60-70% of solids. Partly treated wastewater is now subjected to next treatment level.

4.3.3 Secondary Treatment Stage

It is a biological treatment process removes dissolved inorganic materials present in soluble and colloidal form from the wastewater. Here, bacteria are used convert the colloidal and dissolved organic matter. Now the partially treated wastewater from primary tank flows into the aeration tank and air is supplied through air blower to provide oxygen for microbes. When wastewater flows into secondary clarifier, where solids settle down which is called as secondary sludge and part of it is recycled for activated sludge process and remaining is mixed with primary sludge which will be send to sludge digestion tank and then disposes off. This stage removes about 90% of inorganic solids.

4.3.4 Tertiary or Advanced Treatment Stage:

This is the last stage in most of the STP's. This stage removes the suspended solids and organic matter which was not removed in secondary treatment. The pathogenic microorganisms which were not removed during biological treatment process will get removed by the process called disinfection. Several disinfection agents can be used depending on wastewater condition (pH, clarity etc). It is achieved by means of physical or chemical disinfectants like chlorine, UV light, ozone etc. Now, disinfected wastewater is suitable for disposal or reuse. If the water is not treated adequately, the harmful contaminant in the sewage is hazardous to human health and natural environment. So, Sewage treatment Plant in hospitals is always necessary to reduce harmful impact on the environment.
Design of Sewage Treatment Plant:

4.4 Plant Design

4.4.1 Plant capacity:

Average water supply per day = 423000 lit = 0.423 mld*
Average sewage generated per day = 85% of supplied water
= 0.85*0.423=0.36 mld
= 360 kld**

Average sewage generated per hour=360/24=15 cum/hr
Peak factor = 3
Design flow capacity (maximum) = 13 x 3=45 cum/hr
*mld – Million liter per day
**kld – Kilo Liter per day

4.4.2 Sizing calculation for collection pit:

Retention time required = 4 h
Average design flow = 15 m3/h
Capacity of collection sump = 4 x 15=60 m^3
Assume liquid depth = 5 m
Area required for collection pits = 60/5 = 12 m^2
Let it is a circular tank
$12=\pi r^2$
r = 1.93m.
Volume of the pit provide = π/4 x 4 x 4 x5= 62.8 m^3
Thus Area of the pit provided = 12.6 m^2

4.4.3 Sizing calculation of bar screen:

Peak discharge = 45 m3/h
Average discharge = 15 m3/h
Average velocity @ average flow isn't allowed to exceed 0.8 m/sec
Average spacing between bar 20 mm
The velocity = 0.3*60=18 m/h/ m2
Cross sectional area required = flow/velocity
= 45/18 = 2.5 m2
Liquid depth required= 1 m
Velocity through screen at the peak flow = 1.6 m/sec
Clear area = 2.5/1.6 = 1.3
No. of clear spacing = 1.3/0.02 = 65
Width of channel = (65 x 20) + (67 x 6) = 1702 mm
Width of screen = 1700 mm

4.4.4 Sizing calculation of aeration tank:

Bod in the feed sewage = 100 ppm
No. of aeration tank = 2
Average flow = 360/2 = 180 kld
Total bod load to the aeration tank = 15 x 24 x 100 = 36 kgs
Let mlss = 2000 mg/l, f/m=0.15
Volume of tank required = (Q x bod load) / (fm x mlss)= (180 x 100)/0.15 x 2000= 60 m^3
Assume liquid depth = 3.5 m

Area = 60/3.5=17.143 m2
Tank size provided = 4.5 x 4.5 x 3.7
So, Volume of tank = 75 m^3

4.4.5 Check for aeration period/hydraulic retention time:

Hydraulic retention time t = 75 x 24/180 = 10 h
So, the tank retention time is more than the required time.
Sizing calculation for sludge drying beds
Maximum design flow rate = 45 m3/h, 360 kld
Total feed suspended solid = 250 ppm
Total outlet suspended solid = 50 ppm
Load to the clarifier = 250-50 = 200 ppm
Sludge generated per day = 360x 200/1000= 72 kg/day
Solid content in the feed= 3%
Specific gravity of the sludge= 1.015
Volume of sludge= ((72/0.03)/(1000x1.015))= 2.36 m^3

For Rourkela weather condition, the beds get dried out about 7 days
No. of cycles per year = 365/7
= 52 cycles

Period of each cycles = 7 days
Volume of sludge per cycle = 2.36 x 7= 16.55 m^3/cycle

Spreading a layer 1m per cycle,
Area of bed required = 16.55/1= 16.55 m^2
So area of 16.55 m2 for 2 drying beds is provided for the above system.

Hence, Sludge Drying Bed has dimensions of 4.5 m x 4.5 m x 1 m of two numbers.

5. Conclusion

Based on the results, it can be concluded that the process of recycling liquid waste was planned by Sewage Treatment Plant. Total amount of waste water treated = 0.423 mld. Dimension of the collection pit is calculated to be 4 m in diameter and 5 m depth of the cylindrical tank. A bar screen of width 1.7 m is provided. Dimension of the aeration tank is 4.5 x 4.5 x 3.7 m3Dimensions of Sludge Drying Bed are 4.5 m x 4.5 m x 1 m of two numbers. Estimated cost of initial investment for the construction of waste water recycling installation amount to Rs 30, 00, 000, - covering the cost of procurement of materials, equipment, and labor wages. The estimated operational and maintenance costs required per month amounted to Rs 50000, - which includes electricity costs, chemical purchase costs, and membrane replacement and other maintenance costs.

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