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Computer Aided Hydraulic Process Design of Conventional Municipal Sewage Treatment Plant without and with Upgradation

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Abstract: *Designing a sewage treatment plant under various constraints and different criteria is becoming more and more complex, tedious and quantitative. With the advancement in the computers, an accurate, faster, and more sophisticated method of data acquisition, processing, storage and analysis has become possible with ease. There are various packages which are developed and being developed to design various engineering problems and environmental engineering field is no exception. Some of the existing software's have been developed in this area in basic, Visual Basic, C, C++, etc. and it is realized that the previous developed software have some deficits.*
Present work deals with the development of software for designing some units of conventional sewage treatment plant including some advanced treatment units in ASP.net, which is user friendly. It is one of the two flagship languages (with C#) for the .NET framework from Microsoft. Any code written in the old version will not compile under ASP.net

Keywords: *Collection Sump, Screen Chamber, Grit Chamber, Parshall flume, Sludge Process Plant.*

I. INTRODUCTION

Water supply of the community after it has been fouled is termed as wastewater due to a variety of uses. A range of chemical substances and microbial floras are exposed to water during the use of water because of which the wastewater acquires a polluting potential and becomes hazardous for health and environment. Sewage is a mixture of domestic and industrial wastes. Treatment of sewage is essential to ensure that the receiving water into which the effluent is ultimately discharged is not significantly polluted.

The objective of present project work was to design comprehensive computer design program for the design of municipal sewage treatment plant using ASP.net. The municipal sewage treatment plant designed consists of the following units, Collection Sump, Screen Chamber, Grit Chamber, Parshall flume, Primary Sedimentation Tank, Activated Sludge Process Plant, Trickling Filters, Secondary Sedimentation Tank, Stabilization Pond(aerobic) , Up flow Anaerobic Sludge Blanket (UASB) Reactor , Sludge Digestion Tank(aerobic) , Sludge Drying Beds, Chlorine Disinfection Unit. Upgraded units developed by the software are Aerated Grit Chamber, Hydro plume and UV Disinfection unit.

The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

II. OBJECTIVES

The objectives of the present study are the following:

1. To develop a comprehensive computer design program for the design of municipal sewage treatment plant using ASP.net
2. To incorporate and introduce some advanced and cost effective sewage treatment units such as aerated Grit Chamber, Hydro plume and UV Disinfection unit.
3. To validate the developed program for conventional municipal sewage treatment plant by checking the design of an existing conventional municipal sewage treatment plant.

III. DEVELOPMENT OF DESIGN TOOLS

The following are the major steps adopted to develop this software for the hydraulic process design of conventional municipal sewage treatment plant with and without up gradation.

1) **STEP 1:** Identification of design criteria and guidelines given in CPHEEO manual effective from year 1999.

2) **STEP 2:** Development of the software.

3) **STEP 3:** Verification and comparison of the accuracy of computerized design of conventional municipal sewage treatment plant by the manually designed municipal sewage plant.

IV. DESIGN OF MUNICIPAL WASTE WATER TREATMENT PLANT

1. SCREENS

The first unit of operation used at wastewater treatment plants i.e. WWTPs are screens. Screening of wastewater removes objects such as plastics, rags, paper and metals to prevent damage and clogging of piping, downstream equipments, and appurtenances

2. GRIT REMOVAL

Preliminary-treatment may include a grit or sand channel or chamber, where the velocity of the incoming wastewater or sewage is adjusted to allow the settlement of stones, sand, grit and broken glass. It is necessary to remove these particles because they may damage pumps and other equipment

3. PARSHALL FLUME

Parshall Flume is an open constricted channel which can be used both as a measuring device and also as a velocity control device. It is more commonly used for the latter purpose in grit chambers.

4. PRIMARY SEDIMENTATION TANKS

Primary Sedimentation Tanks are usually large tanks in which

- solids settle out of water by gravity
- the settle-able solids are pumped away (as sludge)
- oils float to the top and are skimmed off

a. Activated Sludge Process System

Activated Sludge Process System is a multi-chamber reactor unit that mostly makes use of aerobic microorganisms for degrading organics in wastewater and to produce a high-quality effluent. However, a constant and well-timed supply of oxygen is required for the maintenance of aerobic conditions and to the keep the active biomass suspended

b. Trickling Filter

The liquid effluent obtained from the primary settling tank is made to pass the secondary part of the system where stabilization is completed by aerobic decomposition. For this purpose, a trickling filter is used.

A trickling filter comprises of a fixed bed biological filter that mostly operates under aerobic conditions. The Pre-settled wastewater is 'trickled' or sprayed over the filter and as the water migrates through the pores of the filter, organics are degraded by the biomass covering the filter material

c. Up flow Anaerobic Sludge Blanket Reactor

The Up flow Anaerobic Sludge Blanket Reactor (UASB) is a very simple and low operation reactor and thus, has been considered to be the most attractive reactor system. Up flow Anaerobic Sludge Blanket Reactor has proven to be an effective alternative for treating wastewater.

5. Secondary Sedimentation Tank

With the majority of the suspended material removed from the sewage, the liquid portion flows over a weir at the surface of the secondary settling tank

6. Stabilization Pond

A relatively shallow body of water contained in an earthen basin of certain shape which is designed to treat wastewater is called stabilization pond. The ponds have become a popular means of treatment of wastewater for small areas, communities and industries that produce organic wastes.

7. Aerobic Digestion

Aerobic sludge digestion stabilizes the organic matter in the sludge and commonly used at small plants. The process involves aeration of sludge for an extended period in open tanks.

8. Sludge Drying Beds

Sludge drying beds are still used extensively in small- to medium – size plants for dewatering digested sludge. It is the oldest method of sludge dewatering. These are typical sand beds having a layer of coarse sand 15-25 cm in depth and supported on a graded gravel bed that incorporates selected files or perforated pipe under rains.

9. **Chlorine Contact Tanks**

Disinfection by chlorine is not an instantaneous and can take several minutes or even several hours depending on various factors such as pH, ammonia concentration etc.

V. ADVANCED MUNICIPAL WASTE WATER TREATMENT UNITS

1. **Hydro plume – High Rate Secondary Clarifier**

Hydro plume is a new techno-economically sound solution for solids-liquid separation in water and wastewater treatment systems while achieving substantial savings in capital and recurring costs over conventional clarifiers. Hydro plume is an effective hydraulic energy dissipating, solids contact and sludge recirculation type high rate secondary clarifier, which requires minimum hydraulic retention time (1 – 1.5 hours) and saves minimum of 25 – 30% foot print area

2. **Aerated Grit Chamber**

In aerated grit chambers, the wastewater is made to flow in a spiral pattern for the removal of grit. Air is introduced in the grit chamber along one side which causes a perpendicular spiral velocity pattern to flow through the tank. Heavier particles are accelerated and diverge from the streamlines and are dropped to the bottom of the tank whereas lighter organic particles are suspended and eventually carried out of the tank.

3. **Ultraviolet Radiation**

Special lamps like mercury vapor lamps produce ultraviolet radiation. The disinfection reaction from the radiation occurs on the thin film surfaces of water where micro-organisms can be exposed to the radiation reaction. With wastewater, lethal action cannot be exerted through more than a few centimeters, which limits its application to wastewater of high quality and with low solids contents and minimal turbidity.

VI. THE COMPUTER SOFTWARE

The software Asp.net is used to hydraulically design the treatment units viz. Collection Sump, Screen Chamber, Grit Chamber, Parshall flume, Primary Sedimentation Tank, Activated Sludge Process Plant, Trickling Filters, Secondary Sedimentation Tank, Stabilization Ponds(aerobic), Up flow Anaerobic Sludge Blanket (UASB) Reactor, Sludge Digestion Tank(aerobic), Sludge Drying Beds, Chlorine Disinfection Unit.

The above software is also used to hydraulically design the advanced water treatment units viz. Aerated Grit Chamber, Hydro plume and UV Disinfection unit.

VII. VALIDATION OF SOFTWARE

The hydraulic design of conventional municipal waste water treatment plant using developed software is validated by comparing with the manually hydraulic design of Vellore Sewage Treatment Plant (Capacity26.52 MLD) , Lucknow Sewage Treatment Plant (Capacity 345MLD) , Kabitkedi Sewage Treatment Plant (Capacity 78MLD) Indore

VIII. RESULT & DISCUSSION

In most of the developing countries like India, it is of great importance to maintain the quality of surface water sources, where access to safe drinking water is not guaranteed for a majority of the population. Sewage Treatment Plants (STPs) are supposed to make

B. The municipal sewage compatible for disposal into the environment (surface and underground water bodies or land),
C. To minimize the environmental and health impacts of the sewage, and
D. To make the sewage fit for recycling and reuse (agricultural and aqua cultural uses and municipal and industrial uses).

Hence it is very much essential to have well designed sewage treatment plant as well as organized sewage water collection system. The process of designing of Sewage Treatment Plants is a time consuming process and hence development of software with the help of computers will reduce the effort required to design the Sewage Treatment Plants.

IX. CONCLUSION

E. Present software is developed in latest version of ASP.net programming language. It is more interactive, easier to understand and user friendly. The present software can be used to hydraulically design the treatment units viz. Collection Sump, Screen Chamber, Grit Chamber, Parshall flume, Primary Sedimentation Tank, Activated Sludge Process Plant, Trickling Filters, Secondary Sedimentation Tank, Stabilization Ponds(aerobic), Up flow Anaerobic Sludge Blanket (UASB) Reactor, Sludge Digestion Tank(aerobic), Sludge Drying Beds, Chlorine Disinfection Unit.

F. The present software can also be used to hydraulically design the advanced water treatment units viz. Aerated Grit Chamber, Hydro plume and UV Disinfection unit.

G. This software is coded according to formulae and design criteria given in manual on sewage treatment (CPHEEO)

H. Efficient engineering judgment is required during the use of this software and interpretation of results.

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