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RESEARCH ARTICLE

A Study on Optimum Design Periods of Wastewater Treatment System

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ABSTRACT

An initial task for the designer of wastewater treatment works is the selection of a time period for which the works are intended to serve. Selection of this deign period establishes the boundary conditions i.e. population to be served, quantity of waste water to be treated, degree of treatment required, funds required to finance the project, and the revenues to be generated. This makes it to proceed in the usual manner with the design of particular unit treatment process. In this chapter an attempt has been made to present briefly research overview regarding the concept of stage design period as suggested by the different research workers over the past three decades. Some local wastewater treatment plants data were also collected and evaluated with a review to meet the objective of the study.

Keywords : Wastewater Treatment Plant, Cost Analysis, Optimum Periods, Water Economics

INTRODUCTION

With the present population of over 192,826,502 according to 2016 census from non-official sources but authorized, Pakistan ranks as the seventh most populous country in the world. Movement of population from rural to urban areas and corresponding rise in the living standards has boosted the process of industrialization however this change has occurred without proper planning and careful anticipation. Cities are becoming bigger and disposal (UN-Water 2014).

Shortage of technical skill and high capital investment has primarily handicapped the industries have been reluctant in constructing treatment plants due to high initial costs that could cut their profit and lack of government restrictions. Sanitation agencies in big cities have, by and large, relied on insufficient preliminary treatment or direct disposal due to high cost of treatment where as municipal agencies in small cities and towns have not bothered about wastewater treatment (Fionn 2016).

In addition, Pakistan today faces an inexorable momentum of population growth. The population growth rate estimated to be as 2.69%according to 1998 census is much higher as compared to the other major developing countries of the world. In order to ensure that in view of the high population growth rates, financial constrains, bank mark up and the high initial investment, the wastewater treatment facilities in stages and taking into account the assimilative capacity of the recipient water bodies (Mulkerrins et al. 2003).The economy of wastewater treatment depends upon the climatic situation of any country for example technical operation of waste water treatment system and cheaper treatment system of wastewater needs the optimum environmental condition such as temperature, humidity etc.

For the analysis of financing wastewater treatment works over time, we must consider the dynamic factors involved in planning for future growth. A solution for this problem will indicate the most advantageous staging for the construction capacity of wastewater treatment works over the time period consideration. Staging will dependent on such dynamic factors as population growth, quantity of wastewater to be treated, concentration of the waste, availability and cost of borrowing monies, and opportunities to make investments in such time increment (Pasztor et al. 2008).A model for this problem must necessarily contain statements, which reflect the requirement of the situation. These requirements or constraints should indicate for each period, the funds required, the level of treatment, the quantity of waste water to be treated, and founds available.An optimum solution to the problem will indicate the capacity or size of treatment plant to be constructed in each time period; the total funds available for the program in each time period; the funds borrowed in each period; the treatment paths to be considered for each increment of capacity; the per capita service charge for each period and a schedule for investment of funds in each period (Roeleveld & van 2002).

In the Present Study, It is investigated the Feasibility of Design in Wastewater Treatment System under Local Conditions.

METHODOLOGY

It describes the procedure adopted for the development of cost models and calculates the economy of scale factors to be used for calculations of design periods for wastewater treatment facilities.
To develop cost models, assumptions are mostly same as given by Manne Model described in literature survey (Sangsawat et al. 2010). Two different courses of action for the determination of design periods are considered. These options were as follows:

I. By use of cost data of existing wastewater treatment plants located in various cities of the country.
II. By sizing of proposed wastewater treatment systems.

Waste stabilization ponds and Aerated lagoon systems were considered for this study. Other treatment systems such as Trickling Filter, Activated Sludge Process etc were not considered due to non-availability of technical data in Pakistan presently.

(I) By use of cost data of existing wastewater treatment plants

Cost data of existing wastewater treatment plants from different cities of the country will be collected, and will be used to develop the Cost Model. The pertinent design criteria and implementation cost of these plants are described

in literature survey .In Pakistan there are few domestic sewage treatment plants in operation. For our study, the data of treatment plants having same treatment system were required.

(ii) Proposed Waste Stabilization Ponds

System comprising f Anaerobic Ponds followed by series of Facultative and Maturations Ponds of different capacities will be designed to meet the National Environmental Quality standards, (NEQS) with a view to generate costly data to be used to develop Cost Models. Sixteen proposed wastewater treatment plants based on waste stabilization pond technology are sized for different populations ranging from 25,000 to 1,000,000. Wastewater flows for these treatments plants were calculated by consideration 200 M^3 of water demand (Sin & Vanrolleghem 2006).

RESULTS AND DISCUSSIONS

The development of a mathematical model for optimal design periods for wastewater treatment system for a given population growth rate is the best option for the study the treatment methods using in wastewater treatment system as well as optimum methods. It is also useful for the development for the accurate pollutant discharge results according to the environmental standards of wastewater treatment system.Studying about the specific microorganism which is used in microbiological treatment of wastewater.

Design Period

Historically environmental technologists has been aware of the importance of judicious selection of the design period, but little or no assistance is offered to the designer in making a wise decision in this matter except in terms of generalizations. Fair and Geyer suggest that because of the nature of work involved, wastewater disposal systems at the time of their construction are made large enough to satisfy the need of the community for a reasonable number of years in future with out requiring important condition or changes.

These suggestions for evaluation of a design period revolve about the notion of economical functional utility. The designer is required to plane a system, which will meet the operational and functional requirements of the community, viz., design a plant , which will produce the require degree of treatment. Simultaneously he has the responsibility for producing this system at the least cost to the community. The technologist's implicit charge therefore is to produce a system, which will offer the desired function at a minimum Cost (Svensktvatten 2015). Lynn et al. were the pioneer to develop linear programming, and employed to search for that combination of unit processes that would remove a given amount of BOD most economically .he applied analysis techniques to stage development in waste water systems. He described, financing the development of a waste treatment system over time required, for each time increment, consideration of population growth, treatment requirement, availability and cost of borrowed funds, and other investment opportunities.Steel, indicates that economy in design is related to its length of life, first cost, ease and cost of increasing capacity and the possibility of obsolescence.

Economic and financial analysis of wastewater treatment system

It is generally agreed that economic and financial analysis are a fundamental part of science & technological analysis and are, in fact, so closely associated that from a practical point of view analysis with out this consideration is meaningless. However economic are not an integral part of analysis but if included at all, are separate a price tagging review of alternative engineering plans. If economics is to play the important role that it should cost and efficiency as well as technical consideration should be an inherent part of design. It has been with this approach in mind that a system analysis of the cost and efficacies of municipal sewage treatment is being attempted, by directly relating the cost and efficiency of individual units. It is theoretically possible to develop the most economical; design of a

treatment plant for given conditions of quantity, strength, land costs, power cost, labour cost and effluent requirement, etc. this does not infer plant design by computer; while from an economic point of view there is only one solution to a given problem. There are many practical considerations other than cost, which influence the final design decision. While these consideration many outweigh the purely economic factor, there is nevertheless an important need to be able to eliminate as many variables from the analysis as possible (WHO 2011).

Cost and Sewerage Plant Efficiency

A first attempt to directly relate costs and efficiencies in the applied environmental field was the study of economics of sewage treatment by Sehroepfer based on observations and statistics gathered on a nation-wide basis in U.S.A. he analyzed both construction and operation costs of treatment in terms of Suspended Solids and BOD reductions. The study carried out before the development of high rate tricking filters and the acceptance of nation-wide standard of operating efficiency, showed widespread variation in both cost and efficiencies. Its use as a design tool was implied but not seriously recommended.

In the early 1960 the Harvard Water Recourse Group investigated the problem of selecting the design capacity for a wastewater treatment plant. A preliminary mathematically model was developed which would select an optimum plant size given, a population growth rate, a benefit function describing the value of the availability of treated water, a linear cost capacity relationship for wastewater, an interest rate and an economic time horizon. In the above study, optimality was defined as the maximum of the net benefits, that is the benefits derived from availability of treated water as reflected by per capita consumption less the investment required for construction of the facility (WSP 2010). In short, this study also presents a detailed literature survey regarding modeling of design period by different Environmental Engineers: Fair and Geyer (1954), Steel (1960), Harvarad water resources groups (1963), Lynnet al (1964), and importance of economic and financial analysis of wastewater treatment systems has also been discussed (Romanski et al. 1997).

Research work on modeling of wastewater treatment facilities over time, has been discussed. The modeling of stage design period by different research workers: Walte.R.Lynne`s (1964), "Wastewater treatment facilities over time Model, Manne Model (1961) and Thomas (1969) Time Capacity Expansion Model has been reviewed (Romanski et al. 1997).

CONCLUSION

As well as, Pakistan is a developing country and has not municipal wastewater treatment system as needed (Only one percent facility available in Pakistan), so it requires skill to check the operation and establishment of municipal wastewater treatment systems.The decrease in initial sage will help the industries and municipalities to develop their wastewater treatment systems. The development in waste water treatment system in line with the available existing assimilative capacities also help in improving the overall environmental condition of the natural receiving water bodies.The study will be used to develop the optimum periods for wastewater treatment system. By using the concept of design of wastewater treatment system in stages, initial construction cost of the treatment system will be decreased. In addition to that municipal wastewater treatment plants should working for long time as 7 to 10 years if research work conduct on it.Determination of this initial design capacity calls for the exercise of skill in the interpretation of social economic trends, as well as the use of sound judgment in the analysis of past experience for the purpose of predicting future requirement. They also suggest that for the selection of a design period, consideration must be given to following factors:(a) ease of extension, (b) location, (c) useful life of components, obsolescence, wear and tear, (d) interest rate for borrowed funds, (e) inflationary trends during the life of bonds and, (f) performance of the works prior to maturity.

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