Abstract

A wastewater treatment plant (WWTP) is a crucial infrastructure that requires careful planning and the selection of cost-effective treatment technologies for successful implementation. Urban planners often necessitate available data or published information for evaluation of costs of WWTPs for various capacities and technologies, as well as the land area and energy requirements for operation. Municipal authorities, tenderers, contractors, and other stakeholders aim to select appropriate WWTP technologies that balance economic and fiscal considerations targeting to award of the job.

It has been noticed through detailed survey of literature that most of the researches in the relevant area were undertaken in connection with cost functions and indices for the construction and operation of WWTPs, primarily aiming for rapid cost estimation and commercial comparisons among various conventional technologies. These studies typically utilize cost data collected from sources for technologies such as continuously mixed activated sludge, oxidation ditches, and aerated lagoons.

In response to this gap, our research initiative aims to develop cost functions and 3-D cost response maps for rapid estimation of WWTP costs using MBR, MBBR, and SBR technologies, without reliance on historical or collected data.

In the present investigation an effort has been endeavoured for development of cost functions for WWTP with recent MBR, MBBR and SBR technologies with due consideration of cost of land acquisition. The approach is based on engineering design and cost estimation rather than use of historic and available cost database from elsewhere. The study includes detail process design, estimation of bill of quantities and cost estimation as per published schedule of rates are the base for development of the cost functions as well as cost response maps and sensitivity study for the cost functions developed. This approach is envisaged to be appropriate and reliable for cost comparison among MBR, MBBR and SBR technologies with reference to planning for installation of WWTP. Research in this new domain will surely add value to the set of tools available for selection of technology to be used for a WWTP, particularly for decision makers and bidders.

The study involved designing and estimating using a developed model, followed by optimization through regression techniques, with the following objectives:

a) Develop cost functions for wastewater treatment plants (WWTPs) employing MBR, MBBR, and SBR technologies, based on an inlet BOD load of 250 g/m^3, a standard practice in municipal sectors.

b) Create 3-D cost response maps to estimate the costs of WWTPs using MBR, MBBR, and SBR technologies at varying capacities and inlet BOD loads. This aimed to analyze cost variations relative to deviations from the standard inlet BOD load.

c) Perform sensitivity analysis on the developed cost functions for WWTPs utilizing MBR, MBBR, and SBR technologies, specifically focusing on an inlet BOD load of 250 g/m^3.

Cost functions developed for capacity wise three different groups of WWTPs with MBR, MBBR & SBR technologies may be used for accurate forecast level cost estimation as applicable in India.

3-D cost response maps have been developed with applicable engineering design criteria and do not include any historic reference. These maps will predict overall cost inclusive of capital, operation and maintenance expenditure for WWTPs with MBR technology within the specified ranges of capacity and inlet BOD.

Sensitivity analysis has also been carried out and validated to facilitate world-wide use of cost functions developed for BOD removal at inlet BOD load of 250 g / m^3.