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Prediction of Wastewater Treatment Plant Using Genetic Algorithm

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Abstract:- A prediction of the wastewater treatment plant (WWTP) using a genetic algorithm based on historical data. In Iran, the majority of treated wastewater is used in agriculture. As a result, using waste water with poor quality attributes might be hazardous to one's health. The effectiveness of the neural network model in predicting performance was investigated in this study. To find relationships in the data, exploratory data analysis was employed and evaluated at a dependency level. The neural network models' proper architecture was identified through a series of training and testing stages. The ANN-based models were discovered to be a useful and reliable tool for predicting WWTP performance. The activated sludge methodwill be considered as a replacement for the semi-mechanical treatment system.

Keywords:- *Wastewater, ANN, Neuralnetwork, Geneticalgorithm.*

I. INTRODUCTION

The process of transforming waste water into water that can be discharged back into the environment is known as waste water treatment. Wastewater treatment is one of the most frequent ways of pollution control in the United States, according to the US EPA. The goal of wastewater treatment is to speed up the natural purification processes.

Bathing, washing, using the toilet, and rainwaterrunoff all contribute to the formation of wastewater. Wastewater is simply used water that has been contaminated by home, industrial, and commercialactivities. According to the Safe Drinking Foundation, some waste waters are more difficult to treat than others. Industrial effluent, for example, can be difficult to treat due to its high strength. On the other hand, dealing with domestic waste water is quite simple.

Given that not all trash makes it to wastewater treatment plants, there are a variety of ways in which wastewater can cause environmental issues. Combined sewer systems (CSS) collect residential sewage in the same pipes as storm water runoff in many cities, particularly older ones. Following severe rains, street gutters gathermore water than the system can contain, and a mixture of raw sewage and storm water is released directly into the environment, resulting in a combined sewer overflow (CSO).

If waste water is not adequately handled, it can havea severe influence on the environment and human health. Damage to fish and mammal populations, oxygen depletion, beach closures, and other limits on recreational water usage are only a few of the consequences. The goal of waste water treatment is to remove as many suspended solids as possible before releasing the effluent into the environment.

The amount of dissolved oxygen (DO) consumed by biological organisms when they degrade organic substances in water is measured by the biochemical oxygen demand (BOD). The amount of oxygen consumed when a water sample is chemically oxidized is known as the chemical oxygen demand (COD). Low concentrations of BOD and COD can create eutrophication and destroy aquatic life, lowering the DO of lakes and rivers. Water with high COD/BOD levels can be produced by municipal wastewater discharge and industrial activities, necessitating thorough treatment before discharge to protect the health of rivers.

Biological approaches, such as adding microorganisms and creating favorable circumstances for the organic matter to break down quickly, are widely used to treat BOD. Return activated sludge (RAS) is a bacterium source often used in sewage treatment plants to remove organics in the water. To forecast the influence of changesin the parameters of an anaerobic B-2 system on its performance, an artificial neural network was employed, and the weights of the artificial neural network were optimized using a parallel multi-population genetically algorithm. These researchers' findings revealed that combining these methodologies can provide a useful tool for anticipating changes in anaerobic system performance. The researchers also found that these techniques can beexpanded to other treatment systems due to their adaptations to various environmental circumstances. A genetic algorithm and an artificial neural network were used. Apart from oxygen, water will most likely be the most important resource for interplanetary space flight. All living things require water to survive. Most long-duration space journeys will require some form of water purification and recycling in the future. The application of genetic algorithms to the optimization of waste water treatment design is the subject of this research article The Activated Sludge Model no.1 of the International Association on Water Pollution Research and Control (IAWRC), as well asthe mathematical solution to the model, will be reviewed first. The four-stage Bardenpho procedure is then described as the design that will be optimized in this situation. Finally, the genetic algorithm

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is investigated, with future research objectives taken into account.

II. MATERIALS AND METHODS

Perkandabad waste water treatment facility No. 1 (Figure 1), which is located on the southern bank of the seasonal river, is one of Mashhad's most important municipal wastewater treatment plants. This treatment facility has a nominal capacity of 15200 cubic metres per day, and it serves a population of 100000 people. The raw wastewater istreated by passing through the waste collecting unit, aeration lagoons, sedimentation ponds, execution pond, and disinfection unit in this treatment plant, which uses an aerated lagoon with complete mixing. The design of this treatment facility is based on surface water discharge since effluent from the Perkandabad No.1 treatment plant is discharged into the river at specific periods of the year.

Fig 1: Waste water Treatment Plant

BOD5 (BiochemicalOxygenDemandin5days), COD (Chemical Oxygen Demand), TSS (Total Suspended Solids), and pH were the parameters tested for waste water quality assessment. Meteorological data, such as average daily air temperature, sunshine duration, and daily rainfall, were also utilized. To begin modelling the neural network, the data was partitioned randomly for testing. Figure 2 depicts the input and output data, as well as the model architecture.

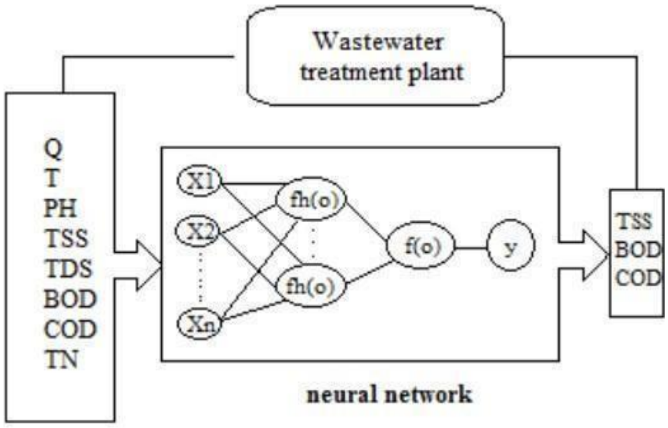

Figure 2. The architecture model of the neural network model.

Statistical indicators such as the correlation coefficient, mean square error, and root mean square error were employed during the results analysis to describe the error rate and compare the simulated parameters. The parameters affecting the treatment plant's performance were determined using quantitative and qualitative data from entering wastewater, effluent, process conditions, climatic data, and, lastly, the effluent. The concentrations of parameters in the effluent were then predicted using the determined factors and the neural network model. A genetic algorithm was utilized to optimize the neural network in order to attain higher accuracy in refinery modelling. Finally,the concentration of each of the three parameters in the effluent was predicted using the correlation coefficient R and the statistical criteria of mean relative root mean squared prediction The mean absolute percentage of relative error (rMAPE) and the root mean squared percentage of relative error (rRMSPE) were calculated with their actual values, and the model was evaluated [17].

III. RESULTS

The genetic algorithm in this work looked for the best response for 450 generations, evaluating 150 possible solutions in the search space each generation. The effluent summarizes the results of five model runs for the BOD parameter. Due to the semi-modern character of the treatment plant, the highest and minimum values of the correlation coefficient of the findings derived from the model were 0.93, 0.86, and 1.08, respectively. The average of these values was found to be a satisfactory number. It shows the TSS, BOD, and COD parameters of a waste water treatment plan's predictive outcomes. Parameter RMSEBOD0.892.3COD0.82TSS 0.83 2.07 RMSEBOD0.892.3COD0.82TSS 0.83 2.07 The number of selected neurons in the first and second hidden layers revealed that the network had failed in 16% of situations. There are two hidden layers, with an average of 16 neurons in the first layer and 11 neurons in the second layer. The network had only one hidden layer in the remaining 84 percent, with an average of 14 neurons. The optimum network structure had two hidden layers, with 15 neurons in the first layer and 2 neurons in the second layer on average. At the greatest value of the correlation coefficient, the

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network comprised only one hidden layer with 11 neurons (R). The GA-ANN model, which had a maximum correlation coefficient of 0.93 and rRMSPE and rMAPE error rates of 10% and 7%, respectively, was an effective model for predicting the concentration of the TBOD parameter and produced correct findings. . As a result, it can be used to simulate treatment plants. Parameters impacting microbe growth and activity, such as input TCOD in/TBOD in ratio, dissolved oxygen content, aeration lagoon temperature, and input TBOD load, were also prioritised in the model predictions due to biological treatment. The parameters affecting the performance of the specified treatment were determined based on the results received from the optimised artificial network model for the TBOD parameter. It shows a summary of their findings, as well as the weights assigned to each parameter. It shows a summary of the elements that are successful in forecasting the effluent's TBOD parameter, as well as the weights that are unrelated to it. Important factors to consider The importance of feature weight in predicting TBOD levels Aerator Num 0.66 TL 0.85 TAIR 0.73 Q 0.8 DO 0.88 Input pollution load TBOD 0.89 Aerator Num 0.66 TL 0.85 TAIR 0.73

Two characteristics (discharge and pollution load) are among the input parameters in the table above that play a crucial role in determining waste water quality. Based on the available data, it was discovered that in most situations, the flow rate exceeds the specified flow rate, and one of the possible remedies is to reduce the input flow rate.Dissolved oxygen (DO) and lagoon temperature were the most important process parameters in predicting effluent TBOD. The type of aeration system and its rate, in general, can have a direct impact on dissolved oxygen. The temperature of the lagoon and the rate of TSS precipitation are both effective. The use of a deep aeration system rather than surface aeration is one of the greatest ways to improve the performance of the treatment plant because it efficiently improves the concentration of dissolved oxygen, raises the temperature of the aeration lagoon content, and provides the appropriate mixing. Due to the open nature of the aeration lagoon system, it is practically and directly impossible to manage the effect of air temperature (TAIR) on the treatment system. The effect of air temperature on the temperature of the aeration lagoon content can be decreased by utilizing deep aerators instead of surface aerators. Surface aerators lose the most heat energy since the air is more in touch with the aeration lagoon's surface. The volume of inflow, according to the test results of this study, was the most relevant criterion in determining the quality of waste water. The inlet flow rate to the treatment plant in the following years can be determined with a good approximation based on the statistics and in the formation of the project. In the given plan, the rate of rise of TBOD and TSS input concentration for every 10 years is equal to 5%. As a result of this rising trend, the annual concentration of TBOD and TSS of waste water entering the treatment plant between 2021 and 2025 is anticipated to reach 1.005. The model was deployed in two modes to forecast the effluent quality assuming no corrective action to improve the treatment plant's performance. The network topology and weight of the features were examined in the first case scenario, which was based on the case where the model had the highest correlation coefficient. For the structure and weight of the features in this scenario, the average number of neurons in each layer and the meanweight of the features in 15 times of model execution were used. In the first scenario, putting the model concerning the TBOD parameter into practise yielded superior results, as shown in Figure 3. These concentrations in the wastewater are substantially greater than the usual TBOD value. As a result, it is critical to execute appropriate strategies to improve effluent quality as soon as feasible, as well as to ensure the efficacy of the solutions and the actual improvement of effluent quality at various phases, as predicted by the model..

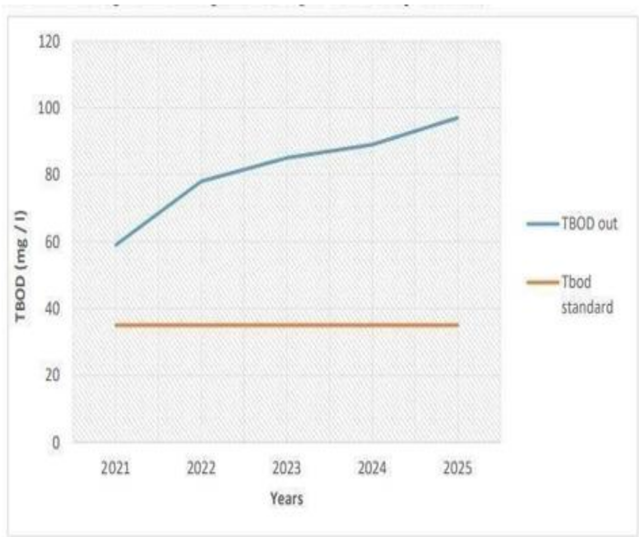

Figure 3. Predicting the average annual concentration of TBOD parameter in the effluent of the treatment plant (mg/l).

IV. CONCLUSIONS

As a result, it is critical to monitor BOD and COD in wastewater in order to prevent environmental pollution and to save the lives of aquatic animals and fish. RLT offers modern technology BOD and COD analyzers that can provide precise data in real time. According to the findings, the inlet flow rate, TCODin/TBODinratio, temperature, and load of organic matter in the incoming wastewater, as well as the amount of dissolved oxygen, temperature, and pH in lagoon content, and several active aerators, were the most important factors affecting the Mashhad treatment plant's performance. Air temperature and the quantity of sunshine hours were two climate elements that influenced performance. The neural network model was optimized using a complete search genetic search technique, and the results showed a maximum correlation coefficient of 0.89 for the TBOD parameter and corresponding rRMSPE and rMAPE for the qualitative parameter of 10% and 7%, respectively. Among process factors - dissolved oxygen concentration, lagoon content temperature, and several active aerators - the neural network model singled out important parameters in predicting the concentration of TBOD parameter in the effluent -discharge rate and a load of organic matter pollution of incoming wastewater, and from climatic conditions - air temperature. In comparison to other inlet characteristics, the inlet discharge of the examined treatment plant had a higher weight in predicting the concentration of the TBOD parameter of the effluent. As a result, in order to optimize the performance of the aforementioned treatment plant, suitable steps should be done to lower and control the incoming flow to various treatment plant units.

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