An emergent accession for the optimal systematize of waste water utilization plants using artificial intelligence

Mohd Abul Hasan
Civil Engineering Department, College of Engineering, King Khalid University, P.O. Box 394, Abha 61421, Kingdom of Saudi Arabia (KSA)
E-mail: mohad@kku.edu.sa

ABSTRACT

The treatment of wastewater is an essential factor in preventing pollutants and promoting the quality of the water. The inherent complexity, influential impact and the solid waste infrastructure lead to confusion and variance in the primary clarifier for wastewater. These inconsistencies lead to variations in the purity and capacity constraints of wastewater and the existential impact of water receipt. The water treatment is a complicated task that has means of chemical, technical & biochemical influences. A credible ANN method is necessary for another waste water treatment plant to prevent the breakdown of the processes. Virtual reality seems to have become a strong solution for preventing waste management uncertainties and problems. This is not only due to high deformations but also to significant external disturbances that water systems are controlling challenges. Climate is among the most significant of such disturbances. Various environmental conditions actually include different influx frequencies and levels of substances. Water contamination has become one of the extremely serious growing conservation; sewage treatment plant identification is a key major issue here and the agencies enforce tighter requirements for the operating of wastewater software systems. This article plans to create models of achievement and prospects for the possible future guidance of recent research borders for the use of artificial intelligence in wastewater treatment plants which concurrently deal with pollutants. This study has shown us that the composite ANN provides a greater level of competence in plant prediction and systematization.

Key words: Artificial Neural Networks, climate, plant prediction, solid waste, wastewater treatment plants

INTRODUCTION

The processing of waste water has to be the most critical strategy for reducing electrolyte pollutants and promoting groundwater. The formulation of wastewater is exceedingly complicated, with influential assets and waste product and waste management systems differ widely. In addition, the managers must consider conducting access to the system for deterministic disturbances and influential heterogeneity. The sophistication of weather occurrences, the activity of anthropology and processes of treating wastewater create certain inconsistencies (St-Onge et al. 2019). In addition, considered the quantity, purity and disposal cost savings of waste water, such inconsistencies vary significantly alone. Solid wastes water treatment plants are facing growing limitations on emissions and new rules for energy consumption and conservation of resources.

Urban and industrial wastewaters responsible for various kinds of pollutants emitted into another aquatic environments. Failure to operate a plant-specific waste water infrastructure may create serious concern regarding environmental and human health issues (Mingzhi & Jinquan 2015). The advancements of a waste water treatment plant control unit are essential to achieve outstanding quality and sustain a binding transcription The Artificial Neural Networks’ involvement in effective tracking, forecasting productivity, and tracking of procedures but also factors in complex non-linear as well as multivariate systems such as environmental science, misprocessing and waste water treatment is consistently rising over recent years. A credible ANN method is necessary for another waste water treatment plant to prevent the breakdown of the processes.

ANNs consist of a weighted-connected given node (synapses strength training) from one nerve cell output to somebody’s outlet in order to estimate or guesstimate operations that really can dependence on several feeds

This is an Open Access article distributed under the terms of the Creative Commons Attribution Licence (CC BY 4.0), which permits copying, adaptation and redistribution, provided the original work is properly cited (http://creativecommons.org/licenses/by/4.0/).
(HongGui et al. 2014). In certain biological engineering, moreover, ANN is often used as an exciting instrument for its convenience in execution and that the use of evolutionary algorithms can substantially improve ANN achievement and its constraints, as in a lower education ratio and the hazard of local minimal obstruction.

A wide range of biological treatment are operated by the on-off control, a reciprocal circle or by PID analysis system in a realistic sewerage system. These traditional techniques are used for controlling wastewater treatment URMs based upon this consume voltage regulator and input con alternatively the wastewater treatment procedure. The above spatial systems will then optimise the setting pointers and for overall quality criteria (Piotrowski & Skiba 2015). The disproportionate, integrated, differentiated coefficients of these traditional control schemes have often been challenged by human expertise or the method of trials and errors. Therefore, it may take quite a long time of create the traditional selector.

For WWTP controlling certain efficiency strategies have been introduced in latest days, including such Optimized neural networks, make predictions etc. The WWTP pattern is indeed very prominent in such optimization algorithms. But the accurate scientific formula of WWTP is difficult to attain due to its extensive and incomplete information features (HongGui et al. 2014). And less on the mathematical equation, this prototype computer model would be used. The required data of a distributed system is taken mostly during virtual prototyping system in order to achieve a highest learning style productivity by eliminating prediction error.

In order to meet the specifications of a not chronological research framework and the embodied qualities of smarter technical solutions, an intelligence procedure will be used in the development of domain experts by convolutional neural networks where treating the symptoms of efficiency in an existing manufacturing project process. For instance, a computer program identification was designed for WWTP status data for the knowledge of the computer program controller (Lai et al. 2015). To adapt the feedback signal set statements for the best functioning of the shaft oven in respond to changes, an or before template segmentation entails approach was advocated. These tools may modify the digital objective is to maximize the difficult system of management.

This research contributes to improve the water quality by comparative analysis of AI and other techniques. ANN models on nutrient elimination in a biological treatment were discussed to improve the performance. The main objective of this paper was that an AI system should be applied to a water treatment facility, a simulated test framework developed, and an internet instant checking tactic established, and that high definition artificial intelligence developed and operated for complicated applications that require continuous and intellectual surveillance, prognosis and regulate.

This paper organized with following section. Section II describes the literature review of various existing work. Section III presents the waste water types, issues and challenges. Section IV describes waste water utilization processing. Section V presented the AI techniques on waste water treatment model. Section VI proposed the research methodology. Section VII analysis the results and discussion and finally, the conclusion is stated on section VIII.

**REVIEW OF LITERATURE**

Lopez et al., (Lopez Morales & Rodríguez-Tapia 2019) Indicates that ANNs are an important AI technique and a scientific neuronal model. ANN can solve multinomial non-linear difficulties by providing an adequate classification model and a correct number of time. ANNs are also often used in methodological approaches for sewage management to eliminate pollutants.

Fan et al. (2018) explains that ANNs use slightly simpler patterns made up of many modules that include activation function linked to flight recorder systems depictions via frequency deviations linking. Every neuron receives, works and sends feedback signals to the brain, which further passes to the successive nerve cells.

Zhang et al., (Zhang 2017) Propose that ANN discovers about labeled images and gathers information interactions which could be used for modeling, forecast and optimisation. ANNs are more like a processor compared to a human mind that range from policies and requirements layered to intra multi-networks that have several informational chain reactions and layered.

Adeloye and Dau, (Adeloye & Dau 2019) That explains Selection, overlap and heterogeneity are really the primary concepts for the process of analytical governors to chromosome communities. In the GA issue set, a series of sequences of multiple criteria vectors containing various responses are portrayed. ES can replicate the judgement procedure to solve complex given the knowledge and experiences of other professionals in a given field.
Sattar et al. (2019) The AI system also covers uncommon approaches like MT, DM, algorithms for clumping, BN, PSO & SVM. This approach can then be used to resolve societal inequalities through divisions of input into subdirectories for the use of a parametric normality test for subsystems. The structure portrayal of the database can indeed be achieved by means of a pieced normal distribution to resemble a possible correlation.

Bagheri et al. (2019) Difficulties in DM are addressed through division into various subdomains and the combination of the results. Convergence is an uncontrolled data grouping approach using a certain mutual information. The proposed method organises the unclassified input images into clustered according the accumulation concept, a qualitative, different figures. BN, a Bayesian creed system, is a modeling of acyclic curves containing the associated nodes' vertices and their direction. Every module represents a random sample and the likelihood assignment distributions of dungeons.

Qiao et al. (2019) Propose the PSO, an adaptive system that resolves optimising issues by randomly finding the optimised solution via iterations. SVM is a least squares classification algorithm which creates the issue of supervised learning on either the basis of the optimum class segregation concept. For implementation in problem solving, SVMs and similarity measures have quickly evolved.

**WASTEWATER**

Liquid that condition was adversely caused by social activities is generally sewage. This assumes that perhaps a diverse variety of materials would destroy it. Although there are various pollutants, the main contamination of carbon, phosphorous is the primary focus of both the traditional electro coagulation and urban renewal processes (Kern et al. 2014). Furthermore, numerous materials steps important nodes.

**Sources and types of wastewater**

The resources are primarily comparable although the rainwater differs from community to community. A summary of nodes are equipped is included in the current example:

**Wastewater at workplace**

The far more specific type of municipal sewage is essentially the liquid used in houses or medical centers and can be additionally categorized into two parts: 1. Brown water mostly affecting individuals or individuals’ mouths and blood. 2. Carry water tainted by drinking, laundry, eating and the like. Dark gray water is not divided in the number of situations and enters the treatment plant as a blend. The fact that such activities leading to a certain characterization of particulate matter feeds in water is critical for the surgical procedure.

**Wastewater manufacturing**

During power generation such as manufacture, purification or cooling, industrial waste waters are water contaminated. Distinguishing formulation of industrial effluent versus wastewater discharges, it is heavily dependent on the quality of industrial dump. Each source thus possesses its own features. Although a charging device releases high concentrations of COD into another water, some have toxic elements percentages. The neural network model with genetic approach is studied in (Park et al. 2019). The mixture will vary considerably day by day if another supply chain is arranged in clusters. The implementation of control systems generated voltage is complicated by these unknowable.

**City wastewater (municipal)**

Municipal waste water applies to public water that represents a blend of polluted water from household and also from industry.

**Wastewater farming**

Energy used on agriculture is livestock wastewater. Poses, fertilisers, chemicals etc. are common toxins. Only agriculture raw sewage from diffraction gratings, such as living projects supported, is of concern to processing plants. Polluted water does not normally gather on the soil or in the aquatic environment directly.

**Water intrusion**

Water for intrusion is a particular kind of discharge. It could also be contended in a strict sense that it is not groundwater. Information warfare seawater that penetrates the drainage system (normally aquifers).
Water surface
Earth’s crust waste is industrial wastewater sewage from roads, car parks and other adjoining sealed materials. Furthermore, gasoline, metal, road corrosion, etc. will pollute it. Because when WWTP is connecting to a treated wastewater, the influential effect on the facility grows markedly, it’ll become important for the water source and also the care provided.

WASTEWATER UTILIZATION PLANTS
Physical, chemical and biological cleansing procedures are used in these industries. The microbial ritual cleansing comprising carbon, nitrogenous compounds and in main generator is then performed following different mechanical chlorination steps. The final therapy is accompanied by the selective removal of the awakened locks from the water by subsidence. The final cleansing stage is desirable and is only used when the reliability of the waste water is especially strict.

The underlying structure of a conventional water source is shown in Figure 1. The following paragraphs explain the appropriate phases as well as the interventions options (Kern et al. 2014).

AI TECHNIQUES FOR WASTE WATER UTILIZATION PLANTS
In combination with other AI methods, the Hybrid AI method provides an inference engine to circumvent some more of the biggest drawbacks of specialised systems. The consulting system depends on consulting human experts upon this accumulation of expertise, however when scientific technology remains essential, it cannot synthesise apply experiences in a changing situation. The smart Computer program blends knowledge from specialist information.

Figure 2 shows a description of both the hybrid AI management system for the imaginary waste water treatment plant. From either the simulation environment con- spammed by the optimization technique, the skills necessary data were constructed for the computer program. The computer program then learned from the institution of experts the patterns of control. The professional system produces an Influence the value in the air compressor then takes the valued to the computer program to produce the recycled raw sewage percentage.

Figure 1 | Layout of a typical wastewater utilization plant.

Figure 2 | A hybrid AI system applied to the control of a Waste water utilization plant.
the raw sewage recycling rate cannot release serious problem, except for when the BOD intensity is high in the air vessel, the expertise process delivers a further significance level for the BOD before the vital solution is satisfied during the process.

The Waste water utilization plant consists of static screens, pumping station, anaerobic lagoons, aerated lagoon, sedimentation and chlorination tanks shown in below Figure 3.

**The Class Hierarchy of the waste water utilization plants**

One of the benefits is that a superclass for a feature is declared and the sub-classes possess the characteristic of the superclass. Many legacies cause subclasses to be superclassed in any quantity. On the other hand, the subclass inherit several inheritances of all the attributes and methods of its kin. Liquids are defined by flow quantitative and qualitative qualities at a water treatment facility (Alver et al. 2015).

The entity model is shown In Figure 4 illustrates the classification of the group. In the raw sewage plant and sewer processing plant, there are two types of fluids which flow as persistent channels. Two sections of the waste-water treatment have to be linked between the tubes and the pump. The pump is thus a subclass of components and the pipe is a subset of the connection. The regulator can regulate the energy and flow rate. Membrane separation is discussed in (Asghari et al. 2018). The devices can monitor from the WWTP that the monitoring or command software needs. In this design, no consideration was given to the signal delay from the detector to the device.

**Classification tree of AI technology used in wastewater utilization plants**

ANNs are a significant aspect to artificial neural based on AI. ANNs can solve multinomial non-linear problems when they have an acceptable method and a correct amount of information. ANNs are often commonly adopted during water/wastewater treatment in methodological approaches to eliminate pollutants. ANNs are made up of

![Figure 3](http://iwaponline.com/wst/article-pdf/doi/10.2166/wst.2021.203/892342/wst2021203.pdf)

**Figure 3 |** Schematic Diagram of the Waste Water Utilization Plant.

![Figure 4](http://iwaponline.com/wst/article-pdf/doi/10.2166/wst.2021.203/892342/wst2021203.pdf)

**Figure 4 |** Class Hierarchy of the waste water utilization plants.
extremely simplistic models made up of several processing components, artificial neurons linked to security testing structures by ties between variable weight. Each node receiving, recognizes and transfers feedback information from other neurons, which are then moved on to corresponding neurotransmitters as inputs. The ANN learns from testing phase and collects the links that can be used for modeling, estimation, and enhancement among data sets. ANNs are a set of information monitoring system similar to a human brain that vary from single direction logic levels to multi input complex networks with several directional feedbacks.

The technology of AI also involves certain uncommon techniques, for example MT, DM, cluster, BN, PSO, and SVM. The MT system can be used by dividing the entry into subsites and implementing a linear, multivariate regression model to sub-domains to overcome constant class problems. The conceptual description of the set of data can also be achieved by the use of a generalized linear in part, approximating a non-linear interaction. In DM, issues are solved by splitting them into multiple sub-problems with the results. Grouping is an unattended data aggregation process using a given mutual information.

The AI technologies used in sewage treatment research can be categorised as single and mixed methods in Figure 5. The proposed method organises the highly classified function vectors in groups according to the classification concept in a statistical statistical methods. BN, a Bayesian belief system, is the design of monocylic graphs that contains associated edges’ clusters and users access. The PSO is an innovative metaheuristic algorithm which solutions combinatorial optimization problems by randomly finding a solution and by means of optimization seeking the perfect solution. SVM is a generalised linear classification algorithm that solves the issue of binary classification based on the different classes theorem. For pattern recognition tasks, SVMs and underlying structures have developed rapidly.

Wastewater reuse opportunities
As one of the highly advanced nations in the world with GDP by field, economics and social theorists, agricultural production: 8.1%; sector: 27.7%; and services: 64.2%. Central recycling systems of wastewater are probably more severe everywhere. However, person (household) and on-site disposal systems are also essential and can also be strengthened. Grey wastewater treatment solutions The choice of a method of treating wastewater relies on a wide variety of cultural factors such as use, place, climate, water availability, social values and religious viewsAs well as raising attention, it is also essential to plan city officials, to implement resource recovery laws and regulations.

Higher water needs are changing public’s curiosity in the supply of water in some regions, but the goal should always be to modify the current sewage treatment plants and build new sewage treatment plants with reusable facilities (Alver et al. 2015).

Figure 6 shows the types and levels of wastewater utilization processes. It is a great opportunity to use innovative existing technology for treating wastewater and re-use in advance to efficiently eliminate contaminants like salinity, bacterium, toxic substances and volatile substances such as Ultraviolet light, degradation, ripening lakes, fluid filtering, and electrical and chemical therapy. The waste water treatment model is differentiated in Table 1.

Figure 5 | Classification tree of AI technology used in wastewater utilization plants.
Figure 6 | Types and levels of wastewater utilization processes.

Table 1 | Wastewater utilization processes technology

| S.No | Type of Wastewater | Type of Wastewater Treatment | Purpose |
|------|--------------------|------------------------------|---------|
| 1.   | Domestic wastewater| SMBR                         | Elimination of chemical and mineral contaminants |
| 2.   | Dormitory and residential settlement pollutants | Dipped vacuum (VPM) + MBR | Elimination of emerging pollutants and mineral |
| 3.   | Raw sewage enabled waste plant Organized Industrial District | Chemicals and the exchange of ions To treat and increase the effluent in an OID processing plant. | Its quality of water to the recycle rate of industrial textile requirements |
| 4.   | Residential wastewater | Lagoons in anaerobic. | Elimination of chemical compounds and mineral |
| 5.   | Direct greywater from an apartment unit. | SMBR | MBR activity without fertilizer restriction and the biodegraded use of a process modeling method to examine waste water in MBR. |
| 6.   | Urban waste water. | Urban waste and traditional therapy facilities for polluted water. | 4 different facilities' improves work study |
| 7.   | Urban waste water | The ponds have been created. | To assess the efficiency of built humidity networks. Plant material in the extraction |
| 8.   | Raw sewage tanning. | AOP | COD elimination. |
| 9.   | Household wastewater. | The floodplain program was installed. | Research on changes in wastewater efficiency. |
| 10.  | Domestic waste water | Wetlands built horizontal sub-surface-flow. | To find the best degree of mechanical load for efficient of extraction. |
| 11.  | Groundwater for olive oil mill. Sunset. Sunshine | Low altitude earth processes that give, reactor of PVC. | For the factory owners to use wastewater rather than big convection tanks provide a sustainable actual option of a small land treatment process. |
| 12.  | Wastewater domestic. | The reservoirs have been created. | To measure the impact on the therapy efficiency of various filter media. |
RESEARCH METHODOLOGY

ANN’s frame is comprised of an input layer, one or more hidden layers and output layers. A set of integrated modules are made up of neurons in each layer of the network. These neurons are weight-based interacting with each other. Every neuron in the next layer is linked to all neurons. The data are displayed in the input layer in the neural network.

In the magnitude of the issue the number of hidden layers should be chosen. Usually, the examination of most of the issue requires one secret layer. The quantity of neurons in the hidden layer shall be chosen from the minimal and then increased depending on the scale of the issues, by experimentation process. A collection of input and target output values is presented for the neural network operation. Parameters of input will be selected for output influencing parameters. The back-propagation method has been widely used to model genetic challenges (Hassan et al. 2020).

The neural network output shall be shown for the specified input data by the output layer. These networks can calculate causal interactions among input and output by means of hidden layers. Figure 7 shows Architecture Of Artificial Neural Network. Basically, the back propagation is a differential lowering process for reducing the model for network error:

$$E = \sum_{j=1}^{K} \sum_{i=1}^{n} (e_i(j) - t_i(j))$$

where $e_i(j)$ and $t_i(j)$ are estimated and targeted values, respectively. ‘$n$’ is the number of output nodes, and ‘$K$’ is the number of training samples.

Weights are immediately randomized before the beginning of an ANN instruction. Weights are modified based on the replication of errors

$$\Delta W_{ij}(n) = \alpha \frac{dE}{dW_{ij}} + \beta \Delta W_{ij}(n-1)$$

where $W_{ij}(n)$ and $W_{ij}(n-1)$ In neighboring iterations, weights increase between I and J nodes, and $\alpha$ and $\beta$ are the training rate and impetus component. For the efficient training of the recurrent neural network, appropriate examination and adequate learning rate adaptation is required. Some previous contributions to ANN models on nutrient elimination in a biological treatment were cited in different literature.

Steps in designing ANN architecture:

The developed model for ANN includes ANN architecture, micros trainer treatment of groundwater, electrolysis, flotation, soil erosion and filtering, ANN preparation, evaluation of findings, validation of and application of ANN.

![Figure 7 | Architecture Of Artificial Neural Network.](image)
Figure 8 shows the flow diagram of the ANN measures used. Raw river water has been taken. Microstrainer, ozonation and coagulation, lime-dose milk, sedimentation, oxygenation and activated charcoal oxygenation were controlled. The coagitation mechanism was dominated by unrefined water sediment and electric permeability with pH-adjustment and colloidal formulation. With the help was not dosed to flocculants. Three conditions for filter scrubblings are surface tension in a system textile wastewater less than 0.2 FNU, particulate matter larger than 1μm and a filter runtime greater than 65 h.

The importance to prevent overgrowth of microbes, and for health reasons, was influenced for the three major determinants. During the filtering runs, the observations shows a gradual increase due to a pressure loss in the filter although the filter’s runtime was not limited (Asghari et al. 2018). The fast filtration water has been gathered in the setup pond using the sedimentary sludge. The loam was drained to the wastewater system and the wastewater was deposited to the wastewater reservoir.

The network used was a feedback system or a feedback system multi-layer (Hassan et al. 2020). Using a backpropagation algorithm, forwarding connections are most frequently practiced. The quantitatively described three-layer neural back propagation network

\[ O_{pk} = f_1 \left[ \sum_{j=1}^{L} W_{jk} f_2 \left[ \sum_{i=1}^{N} W_{ij} x_{pi} \right] \right] \] (1)

RESULT ANALYSIS AND DISCUSSION

The pureness of waste water is based on water elements such as Ph values, biochemical oxygen supply, suspended substances, etc. For primary settlers and secondary settlers, the ideals of these elements are established. Groupings produced are then analysed and segregated as contaminated water, unadapted liquid and drinkable water (Deepashri & Kamath 2017). Tables 2 and 3 shows the waste water utility of primary and secondary settlers respectively.
Waste water utilization plants primary settler:
The consequence from the primary settler compared with the secondary settler is that the water is in a secondary inhabitant fit and unfit. As can be seen in Figure 9, clean water is 13%, 39% is unfit and 54% is contaminated. Figure 10 shows the secondary settler performances.

| S.No | Aspects | Percentage (%) |
|------|---------|----------------|
| 1.   | Fit     | 13             |
| 2.   | Unfit   | 39             |
| 3.   | Polluted| 54             |

Waste water utilization plants secondary settler:
The existence of distilled water in secondary settlers was 20%, 42% was unsuited and 48% were contaminated. There is more dirty water in the main settler than the secondary settler. This demonstrates that the water is cleaner than the primary settler in secondary settlers.

| S.No | Aspects | Percentage (%) |
|------|---------|----------------|
| 1.   | Fit     | 20             |
| 2.   | Unfit   | 42             |
| 3.   | Polluted| 48             |

Figure 9 | Waste water Utilization Plants Primary Settler.

Figure 10 | Waste water Utilization Plants secondary Settler.
Analysis of waste water utilization plants using ANN algorithm:

Table 4 shows the analysis of waste water utilization plants using ANN algorithm. As shown in Figure 11, the secondary settler generates better water than the primary settler with the ANN algorithm and less contaminated water.

In result analysis, the primary and secondary settler takes the fit, unfit and polluted result. In this, the primary settler obtains the value of 13% (fit), 39% (unfit) and 54% (polluted). The secondary settler has 20% of fit, 42% of unfit and 48% of polluted results. Overall, optimal value on the both true negative and true positive values is analyzed for primary and secondary settler, which is taken based on alpha value.

Optimal value calculation:

The test standard is $\alpha$, which is supposed to be the likelihood of a Type I error, and a process of modification is used to decrease the type I error. We perform a numerical research to test the maximum k centres that represents the value should not be serious. 100 examples have been chosen here and further measures have been considered.

In order to achieve the optimum solution, we have set $\alpha$ values and tested each condition. According to our study and as shown in Table 5, the ideal solution for the value $\alpha = 0.0001$ will be achieved, where the real positive value in comparison to other main and secondary settlers is more true. The optimal value calculation is given in Table 5 and respective graph model is given in Figure 12.

Table 4 | Analysis of waste water utilization plants using ANN algorithm

| S.No | Aspects | Primary | Secondary |
|------|---------|---------|-----------|
| 1.   | Fit     | 13      | 20        |
| 2.   | Unfit   | 39      | 42        |
| 3.   | Polluted| 54      | 48        |

![Analysis of waste water utilization plants using ANN](image)

Figure 11 | Analysis of waste water utilization plants using ANN algorithm.

Table 5 | Optimal value calculation

| Alpha value ($\alpha$) | Primary Value | Secondary Value |
|------------------------|---------------|-----------------|
|                        | True positive | True negative   | True positive | True negative   |
| 0.0004                 | 54            | 50              | 56            | 46              |
| 0.0003                 | 63            | 41              | 66            | 37              |
| 0.0002                 | 71            | 33              | 74            | 29              |
| 0.0001                 | 74            | 30              | 77            | 27              |
CONCLUSION

The control strategies used, such as intelligent machines, artificial neural and AI networks, were shown to be strong instruments, particularly when they are used for monitoring processes that are misunderstood or complicated to design using conventional control measures. Next version of waste management AI techniques will be able to provide the operators of wastewater treatment plants with online learning and support. An upgraded treatment system for waste water must use AI techniques in the design or renovation of wastewater treatment and automatically diagnose influent waste water to change its operation. A neural network must be used to determine the behavior of the inflow water for future AI systems used in wastewater treatment plants. Furthermore, the expert method must be able to adapt the microbes in the aeration tank to the influent adsorbent dose.

ACKNOWLEDGEMENTS

The authors thankfully acknowledge the Deanship of Scientific Research, King Khalid University, Abha, Kingdom of Saudi Arabia, for funding the research grant number RGP.1/174/42.

DATA availability statement

All relevant data are available from an online repository or repositories.

REFERENCES

Adeloye, A. J. & Dau, Q. V. 2019 Hedging as an adaptive measure for climate chang induced water shortage at the Pong reservoir in the Indus Basin Beas River, India. Sci. Total Environ. 687, 554–566.

Alver, A., Baştürk, E., Kiliç, A. & Karataş, M. 2015 Use of advance oxidation process to improve the biodegradability of olive oil mill effluents. Process Saf. Environ. Protect. 98, 319–324.

Asghari, M., Dashi, A., Rezakazemi, M., Jokar, E. & Halakoei, H. 2018 Application of neural networks in membrane separation. Rev. Chem. Engg. https://doi.org/10.1515/revce-2018-0011.

Bagheri, M., Akbari, A. & Mirbagheri, S. A. 2019 Advanced control of membrane fouling in filtration systems using artificial intelligence and machine learning techniques: a critical review. Process Saf. Environ. Prot 229–252.

Deepashri, K. S. & Kamath, A. 2017 Survey on techniques of data mining and its applications. Int. J. Emerg. Res. Manage. Technol. 6 (2). ISSN 2278-9359.

Fan, M., Hu, J., Cao, R., Ruan, W. & Wei, X. 2018 A review on experimental design for pollutants removal in water treatment with the aid of artificial intelligence. Chemosphere 200, 330–343.

Hassan, M. R., Fikry, R. M. & Yakout, S. M. 2020 Artificial neural network approach modeling for sorption of cobalt from aqueous solution using modified maghemite nanoparticles. Int. J. Environ. Eng. 146 (4).

HongGui, H., HuHai, Q. & JunFei, Q. 2014 Nonlinear multi objective model-predictive control scheme for wastewater treatment process. J. Process Contributing 24, 47–59.
Kern, P., Wolf, C., Gaida, D., Bongards, M. & McLoone, S. 2014 COD and NH4-N estimation in the inflow of Wastewater Treatment Plants using Machine Learning Techniques, in: Automation Science and Engineering (CASE). In: 2014 IEEE International Conference on. IEEE, pp. 812–817.

Lai, G. Y., Liu, Z., Zhang, Y., Chen, X. & Chen, C. L. P. 2015 Robust adaptive fuzzy control of nonlinear systems with unknown and time-Varying saturation. Asian J. Control 17 (3), 791–805.

Lopez Morales, C. A. & Rodriguez-Tapia, L. 2019 On the economic analysis of wastewater treatment and reuse for designing strategies for water sustainability: lessons from the Mexico Valley Basin. Resour. Conserv. Recycl. 140, 1–12.

Mingzhi, Y. & Jinquan, X. 2015 A sensor-software based on a genetic algorithm-based neural fuzzy system for modeling and simulating a wastewater treatment process. Appl. Softw. Comput. 27, 1–10.

Park, K.-m., Shin, D. & Chi, S.-d. 2019 Variable chromosome genetic algorithm for structure learning in neural networks to imitate human brain. Appl. Sci. 9 (15), 3176. https://doi.org/10.3390/app9153176.

Piotrowski, R. & Skiba, A. 2015 Nonlinear fuzzy control system for dissolved oxygen with aeration system in sequencing batch reactor. Inf. Technol. Control 44 (2), 182–195.

Qiao, Y., Zhang, S. W., Wu, N. Q., Wang, X., Li, Z. W., Zhou, M. C. & Qu, T. 2019 Data-driven approach to optimal control of ACC systems and layout design in large rooms with thermal comfort consideration by using PSO. J. Clean. Prod. 236, 117578.

Sattar, A. A., Elhakeem, M., Rezaie-Balf, M., Gharabaghi, B. & Bonakdari, H. 2019 Artificial intelligence models for prediction of the aeration efficiency of the stepped weir. Flow Meas. Instrum. 65, 78–89.

St-Onge, X. F., Cameron, J., Saleh, S. & Scheme, E. J. 2019 A symmetrical component feature extraction method for fault detection in induction machines. IEEE Trans. Ind. Electron. 66, 7281–7289.

Zhang, X. P. S. 2017 To the victor Go the spoils: AI in financial markets IEEE signal process. Mag. 54, 176–176.

Received 29 March 2021; accepted in revised form 14 May 2021. Available online 25 May 2021