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Research paper

Development of ANN models for optimization of methane yield from floating dome digester

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Abstract

The development of methane generation is mainly based on a desirable combination of operating parameters. The essential objective of this analysis systematically analyzes the prediction of methane yield with different operating parameters. Current work is to analyse the reaction of Temperature (T), Agitation time (AT), pH, value and Substrate Loading Rate (SLR) which are all considered to be the different factors. Artificial Neural Network (ANN) is the modern method aid to solve complex issues that could not be addressed by conventional methods. In this work examine the study employ the ANN as a tool for prediction of methane from floating dome anaerobic digester with press mud. The result showed that ANN model is found the value of methane yields much closed to theoretical methane yield. It is obtained the percentage of predicted value of methane is 58% and theoretical value of methane is 62 % with the temperature of 45ºC and agitation time of 20 min, pH value of 7.2 and substrate loading rate of 120 kg.

Keywords: *Substrate loading rate, temperature, agitation time, methane.*

1. Introduction

Biological operations has been incorporated in Anaerobic digestion process, in the case loss of oxygen for crack up organic element along with that conversion CH_4 and CO_2 causes stabilization of these materials which is almost solid slag [1]. Anaerobic digestion gives appealing prospects as well as providing results to global interest as substitute energy creation, managing people, and animal community along with the safety of industrial wastes, governing environmental pollution. For reprocessing of nutrients back to the soil, Biogas technology has been efficiently utilized. Ecological shortcomings occurs due to the flaming of non-commercial fuel resources, like manure as well as agricultural slag, where these sources are utilised as fuel and not as fertilizer, because the resources like mini-nutrients, nitrogen, potassium, nutrients are actually vanished from the ecosystem [2]. It is an important technology; the improvement of computational model for anaerobic digestion applications can assist in operation and control the process of anaerobic digestion as well as enhance the methane production. Ann is [3] fit the process particularities, these models and tools have to be calibrated and modified with the biogas plants own data. They are used to predict, design and optimize the process.

Artificial neural network (ANN)

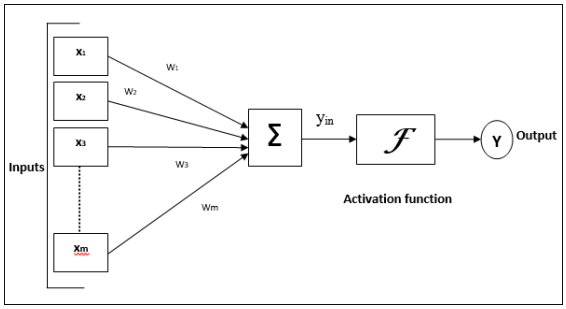

Fig. 1: ANN architecture

Fig. 1 illustrate the architecture of Artificial Neural Networks where,

Zin = a1.f1 + a2.f2 + a3.f3… an.fn

i.e., Net input Zin = $\sum_i^m a_i . f_m$

Biological neural networks (BNN) are the base from where the Artificial Neural Network (ANN) is a dynamic measuring model formed. ANNs is the abbreviation stands for "artificial neural systems," or "parallel distributed processing systems," or "connectionist systems." ANN brings in a big gathering of entities that are linked in certain format to grant transmission among entities. These entities, which are commonly known as nodes or neurons, are smooth operators which process alongside. The key basic of ANN models are supported on an information processing paradigm and the learning processes of a biological neural system, in this model offer the different methods of analysing data and make out patterns within the data in comparison with traditional mechanistic approaches. The approach of ANN model is

particularly efficient for modelling processes implicit relationship between input and output data are unknown [4]. The artificial neural network model has been successfully used for AD process for many application cases. The performance of AD mechanism can be increased by means of optimizing as well as designing is utilized in biological along with chemical mechanism. Pattern recognition system based on the autonomous efficiency of ANN is used to create a standard. Along with the analog mechanism, it manufactures fast and best solutions with minimum assumption as well as original techniques [5].

Genetic algorithms are used to enhance the forecast standard in order to get the excellent biogas yield. The study by (Rivera et al) build greater enhancing by means of genetic algorithm (GA). At the end, the outputs are correlated with deterministic standard that as more inputs which comes from the ANN standard. In order to obtain the excellent standard that optimize the bio-digester mechanisms with less flaws, many ANN standards are created and verified [6]. Artificial neural network standards stimulate the digester process with more accuracy by having a couple of covered layers in which it has twenty five neurons along with activation functions. In order to measure the interactive as well as respective effects in biochemical changing mechanisms through anaerobic digestion operations, artificial neural network has been used in the many industrial sectors [7]. The current process is an experiment done by utilizing ANN as a forecasting standard for methane yield with different factors such as substrate loading rate, pH value, temperature, agitation time. Which influence of biogas yield under an anerobic digestion using pressmud. The ANN [8] is appropriate for developing bio process standards along with ANN standards are clearly information oriented. It is one of the architecture of multi-layers uses to develop approximates linear relationship between input and output dependent variables. In the past many applications are neural network architectures oriented where the biological neuron standards are the basic manufacturing tools.

2. Materials and methodology

The ANN model for anaerobic co-digestion process of press mud with cow dung produce methane is developed by using neural network. The ANN toolbox, which is a built in tool in mat lab, it is given the function and applications for modelling complex non-linear problems. It is not simply modelled in a closed form, since data fitting, pattern recognition, prediction of value. In Feed forward networks the operations are carried out in a sequence of layers. In this each layers are interconnected to each other like the first layer has a connection with input layer and subsequent layer has a connection from the last layer. The last layer will gives the model's output. Feed forward models are suitable for different kind of input to output scaling.

Fitting (fitnet) along with pattern recognition (patternnet) are the two network functions of functional forms of the feed forward model. The change in the feed forward model is the cascade forward network (cascade forwardnet) in which connections between each layers are added features.

We develop a model which utilizes trainlm functions with feed forwardnet or cascade forwardnet.

To generate a user network to be validated with trainlm,

- Fix net.trainFcn to 'trainlm'. This fix net.trainParam to trainlm's are common parameters.
- Fix net.trainParam properties to covet values.

Training and validation are the two important functions of Trainlm and verifies vectors if the network's NET. Some properties like DivideFcn property is applied to a data division operations. Whenever the performance of the model is decreased or remains same for maxfail time in every rows, Validation vectors will come in handy for terminating the training at the early stage in each row. In the end, Test vectors are come into practices to verify periodically that the network is generalizing well, which do not have any impact on training.

3. Result and discussion

In this research four working parameters is selected as the input for the ANN model which includes, temperature, agitation time, pH value and substrate loading rate and output is the fraction of CH_4 in percentage in the generated biogas from the digester.

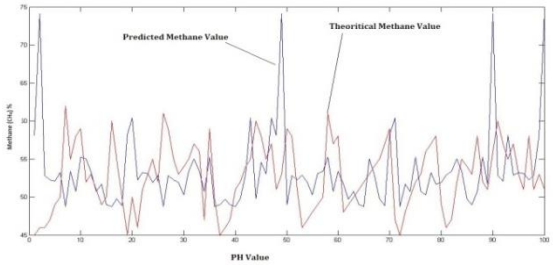

Fig. 2: Predicted value and theoretical value of pH

The Fig 2 shows the theoretical and predicted value of pH in methane yield. When the pH value is 7.2 to 7.6 at the time methane yield is increases with increases in pH 7.6 and thereafter biogas yield reduces with further increases in pH level in the digester slurry. Here predicated value of pH is slightly varied from the theoretical value of pH, since in hydrolysis process. The formation of organic acid occurred as the creativity of acidogenic microorganism in the digestion period. Therefore, the pH value decrease and then increase in the theoretical value of the digestion periods.

That is a low pH value in activated microorganisms responsible for biogas production. In this regard the pH of all the digesters was not in the range of optimal level is 6.7 to 7.4 suitable for most methanogenic bacteria to function for biogas production [9]. As it is indicated in the decrease in pH is a function of concentration of volatile fatty acids generated by the activity of methanogenic bacteria [10].

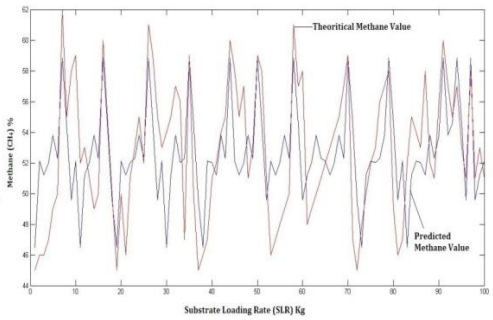

Fig. 3: Predicted value and theoretical value of substrate loading rate

Fig 3 shows the theoretical and predicted value of substrate loading rate in methe yield. When the substrate value is 100 to 120 kg at the time methane yield is inrease with increase insubstrate loading rate 120 kg and thereafter biogas yield reduces with further increases in loading rate of the digester slurry. In this figure predicted value of substrate is slighlty varied to the theritical value of loading rate. Generally methane production rate highly depends on substrate loading rate.

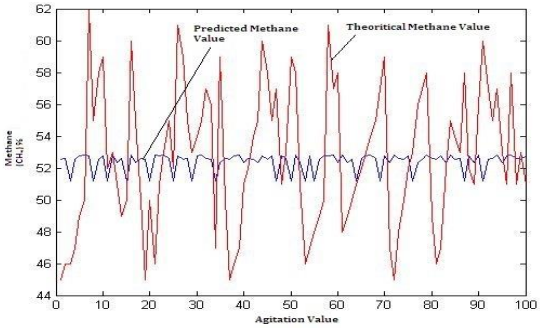

Fig. 4: Predicted value and theoretical value of agitation time

Fig 4 shows the theoretical and predicted value of agitation time value is 20 mins to 40 mins at the time methane yield is increases with increases in agitation time 20 mins and thereafter biogas yield decreases with further increases in agitation time of the digester slurry. The figure shows the predicted value of agitation time in digester slurry is slightly changed to the theoretical value in stirrer timing of the digested slurry. When the digester slurry stirred at 20 mins for digester recorded highest methane content is produce. Based on pneumatic stirrer, the slurry is flustered to distribute the slurry orderly as well as maintaining the uniform temperature throughout the digester; as a result we can prevent the slurry from scum forming, thick and caking of impurities.

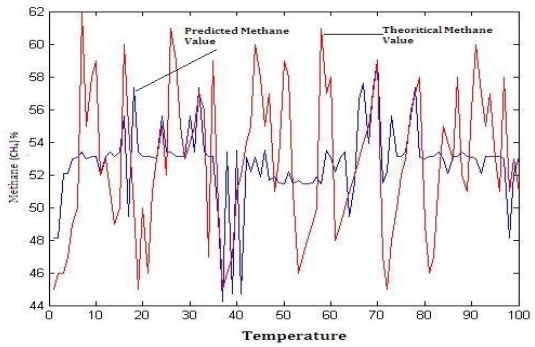

Fig. 5: Predicted value and theoretical value of temperature

The Fig 5 shows the theoritical and predicated value of temperature in methane yield. When the digester temperature is 40 to 50 ºC at the methane content is increases with increasing in temperature of the slurry 45ºC, and thereafter biogas yield decreases with further increases in diegster temperatre of the digetser slurry. The predicted value of temperature slurry close the theoritical value of the digester slurry temperature. Here digester slurry obtained 45ºC is the diegster temperature, this thermophilic type temperature kills the pathogenic bacteria that may develop during the process due to high temperature of operation.since, these atribute the methanogenic bacteria are very senstive to temperature and enhance the activity of the bacteria to improve the gas yield. Hence the temperature improes the biogas yield as well as the efficiency of the anaerobic diegster.

4. Conclusion

Optimizaton of production of biogas from the digester of anerobicbiogas digester is studied. Artifical Neural Network (ANN) is used to generate a model that uses feed forward network (FFN) with one hidden layers for the diaganosis and the sigmoid activation functions composed most of the factors in methane production from ananerobic digester. It is compared and found out that it suited perfectly with measured value and predicted value of methane contant. This study development of the use of ANN and FFN as better performing tools for optimizing the methane content from different factors. Future studies on complete optimization and simulation of biogas operating parameters on continous monitoring of the ananerobic diegster and resulting metane and corbondioxide production studied are recommended.

References

[1] Angeli SD, Turchetti L, Monteleone G & Lemonidou AA, "Catalyst development for steam reforming of methane and model biogas at low temperature", *Applied Catalysis B: Environmental*, Vol.181, (2016), pp.34-46.

[2] Bora BJ & Saha UK, "Experimental evaluation of a rice bran biodiesel–biogas run dual fuel diesel engine at varying compression ratios", *Renewable energy*, Vol.87, (2016), pp.782-790.

[3] Collet P, Flottes E, Favre A, Raynal L, Pierre H, Capela S & Peregrina C, "Techno-economic and Life Cycle Assessment of methane production via biogas upgrading and power to gas technology", *Applied energy*, Vol.192, (2017), pp.282-295.

[4] Hagos K, Zong J, Li D, Liu C & Lu X, "Anaerobic co-digestion process for biogas production: Progress, challenges and perspectives", *Renewable and Sustainable Energy Reviews*, Vol.76, (2017), pp.1485-1496.

[5] Kiesel A & Iris L, "Miscanthus as biogas substrate–Cutting tolerance and potential for anaerobic digestion", *Gcb Bioenergy*, Vol.9, No.1, (2017), pp.153-167.

[6] Sathish S & Vivekanandan S, "Experimental investigation on biogas production using industrial waste (press mud) to generate renewable energy", *Int. J. Innov. Res. Sci. Eng. Technol*, Vol.4, No.2, (2015), pp.388-392.

[7] Sathish S & Vivekanandan S, "Parametric optimization for floating drum anaerobic bio-digester using Response Surface Methodology and Artificial Neural Network", *Alexandria Engineering Journal*, Vol.55, No.4, (2016), pp.3297-3307.

[8] Sathish S, Chandrasekaran M & Parthiban A, "Effect of Co-Digestion Agricultural-Industrial Residues: Various Slurry Temperatures", *International Journal of Ambient Energy*, (2017)

[9] Xia ZM, Li XS, Chen ZY, Li G, Yan KF, Xu CG, Lv QN & Cai J, "Hydrate-based CO_2 capture and CH_4 purification from simulated biogas with synergic additives based on gas solvent", *Applied Energy*, Vol.162, (2016), pp.1153-1159.

[10] Zou S, Wang X, Chen Y, Wan H & Feng Y, "Enhancement of biogas production in anaerobic co-digestion by ultrasonic pretreatment", *Energy Conversion and Management*, Vol.112, (2016), pp.226-235.