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DISSOLVED GAS ANALYSIS OF MINERAL OIL FOR POWER TRANSFORMER FAULT DIAGNOSIS USING SOFT COMPUTING TECHNIQUES

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Abstract: This paper reviews the use of Soft Computing Techniques for dissolved gas analysis (DGA) of mineral oil for power transformer fault diagnosis (PTFD). Various FLtechniques for PTFD have been developed to reduce operating costs, enhance operational reliability, and improve power and services supplied to customers. These techniques enable researchers to analyse fault phenomena and diagnose transformer faults, and these approaches have evolved rapidly as highly effective approaches for PTFD. Our conclusion is that no single DGA technique enables detection of the full range of faults, which is needed for reliable assessment of all power transformer conditions. Therefore, the most effective PTFD technique is to combine outputs from various DGA diagnostic methods and to aggregate them into an overall evaluation.

INTRODUCTION

Force transformers are quite possibly the most costly gadgets in power frameworks. Any mix of electrical, mechanical, or warm burdens can prompt a transformer shortcoming that can be calamitous and quite often causes irreversible inside harm. Subsequently, all key force transformers in a force framework ought to be observed intently and persistently to guarantee greatest uptime. Indispensable in the beginning issue conclusion of force transformers, DGA intermittently tests and tests the protection oil of transformers to get broken up gases in the oil that structure because of decay of inside protection materials. Dependable and productive shortcoming free activity of enormous force transformers is fundamental for solid power supply. Improved methodologies encourage changes in upkeep procedures that limit hazard of untimely disappointment while amplifying pragmatic working proficiency and administration life. Investigation of the transformer's dielectric oil is the traditional and solid strategy utilized for checking the anomalies present in the transformers by utilizing the Dissolve Gas-in-oil Analysis (DGA)method. There are additionally a few issues related with an electrical transformer, for example, over-burdening, over-voltage, overheating and different components that eventually lead to a lasting disappointment. Thusly, there is a significant need of observing the boundaries related with the transformer to keep it from closing down. Consequently, there is an intense need of new advances which can screen the stockpile frameworks all the more successfully to keep them from surprising and unequivocal disappointments. In this way Genetic-Neural Computing utilizing DGA investigation is utilized to discover the issues present in the transformer.

The principle and the most significant reason for gas arrangement in the transformer is warm warming and electrical releases. It breaks down the oil into various gases like CO, CO2, C2H2, C2H4, C2H6, H2 and CH4. The cellulose and the minerals present in the transformer oil decay to deliver these gases as demonstrated in Fig. 1. The decay of cellulose produces carbon oxides, methane and some hydrogen. The pace of creation of these gases suddenly increments with the increment in temperature and volume of the material present in the oil. Beta liquid and mineral oil comprise of an assortment of hydrocarbon atoms. They disintegrate into dynamic hydrogen iotas and pieces of hydrocarbons which consolidate to frame new particles. The further reworking and disintegration of particles lead to the development of different gases like acetylene and ethylene. The centralization of these gases is investigated by the DGA canvassed in the following segment. It must be checked consistently so the irregularities in the transformer can be investigated appropriately.

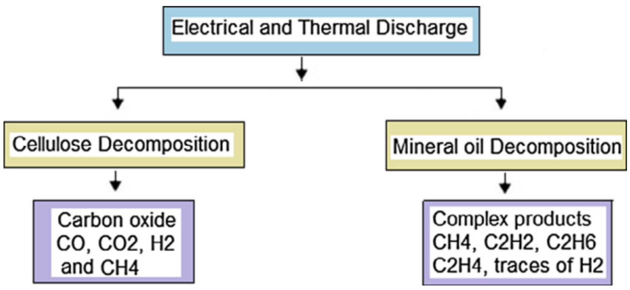

Fig. 1. Composition of the gases evolved during a normal functioning of a transformer.

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CONVENTIONAL TECHNIQUES

Disintegrated Gas-In-Oil Analysis (DGA) is quite possibly the main analytic tests performed on the transformer oil to decide the condition of the force transformer. We can likewise recognize extremely low fixation levels of the hurtful gases. This method includes the depriving of gases from transformer oil and imbuing them into a gas chromatograph. An example of the oil is taken utilizing a gas tight needle of suitable limit. This needle is fit for taking an example of the oil from the standard place of the transformer. It is put away in a dim walled in area to forestall the oxidation of gases. The following stage incorporates the extraction of gases from the example. In the last advance, the example is exposed to gas chromatography. This is utilized for isolating the various constituents of the gases from a blend.
The utilization of DGA in the transformer is generally acknowledged for examining and recognizing the deficiencies as it can analyze the debasement of the transformer and can assess its future. Furthermore, it can assess the interior circumstance of the transformer and is a vital piece of the support checking and testing framework.

Genetic algorithm (GA) is a heuristic methodology used to discover rough answers for the issues that are hard to solveby applying the standards of transformative science to software engineering. Hereditary calculations use organically inferred procedures like legacy, change, common determination, and recombination (or hybrid). Hereditary calculations are a specific class of developmental calculations. GAs are normally executed as a PC re-enactment in which a populace of dynamic portrayals (called chromosomes) of applicant arrangements (called people) to an enhancement issue advancing towards better arrangements. Customarily, arrangements are addressed in double as series of 0s and 1s, yet various encodings
are additionally conceivable. The development begins from a populace of totally arbitrary people and occurs in ages. In every age, the wellness of the entire populace is assessed, various people are stochastically chosen from the current populace dependent on their wellness and adjusted changed or recombined to frame another populace, which gets current in the following cycle of the calculation.
Neural Network (NN) is used to predict the fault in transformer by perform training and testing.
Steps Involved in Neural Network
- Collect data
- Create the network
- Configure the network
- Initialize the weights and biases
- Train the network
- Validate the network
- Use the network

PROPOSED SYSTEM

Strange electrical or warm burdens cause protection oil to separate and delivery little amounts of gases. These broke up gases are normally hydrogen (H), methane (CH), ethylene (C2H4), ethane (C2H6), acetylene (C2H2), carbon monoxide (CO), and carbon dioxide (CO2). Each issue type produces ignitable gases. An expansion in absolute burnable gases (TCGs) that relates with an increment in gas creating rates may demonstrate the presence of one or a mix of warm, electrical, or crown issues. As referenced, the structure of these gases relies upon deficiency type. The discovery of a specific degree of gases created by an oil-filled transformer in help is regularly the most readily accessible sign of a breakdown that can make a transformer bomb when not rectified. Potential components of gas age incorporate arcing, crown release, low-energy starting, protection overheating because of extreme over-burdening, and disappointment of constrained cooling frameworks. Deficiencies in oil-filled transformers can be recognized by the gases created, and these gases are ordinary or overwhelming at different temperatures. The DGA is among the most well-known procedures utilized for on-line beginning flaw analysis since transformers don't require be de-empowered. The DGA requires routine oil examining and present day advancements for online gas observing. The vital advance in utilizing gas investigation for deficiency recognition is effectively diagnosing the flaw that created the particular gases.

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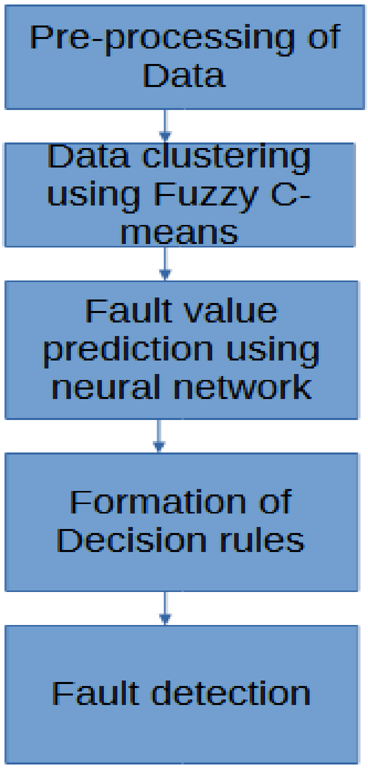

Fig. 2. Block Diagram

The proposed system is designed with a Fuzzy c-means clustering with classifier. Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. Data are bound to each cluster by means of a Membership Function, which represents the fuzzy behaviour of this algorithm. The DGA interpretations for PTFD are carried out by experts applying their experience and standard techniques, and many attempts have been made to refine the decision processes used to guide DGA reviewers when evaluating transformer conditions. Many FL applications have been proposed for PTFD in recent years. Three successive processes of the FL analysis are fuzzification, fuzzy inference, and defuzzification. Fuzzification converts crisp data into a fuzzy input membership. Fuzzy inference draws conclusions from the knowledge-based fuzzy rule set or if-then linguistic statements. Defuzzification then converts the fuzzy output back into crisp outputs.

Classification belongs to the general area of pattern recognition and machine learning.

- Soft labelling
- Interpretability
- Limited data, available expertise

The benefits of fluffy is to improve the precision of grouping under commotion, Compute the centroid for each bunch, for each point, figure its coefficients of being in the bunches, the portion of information focuses to groups isn't "hard "

Assuming THEN (Prediction) rules, where each standard is of the structure:

Assuming <some_conditions_are_satisfied>,

<its_belong_to_certain_class>

In our framework, we have examined the individual convergence of the gases and the estimation of the Total Dissolved Combustible Gas (TDCG), which is estimated in parts per million (ppm) utilizing the Key gas strategy. In this strategy, four level measures have been created to order the issues and dangers associated with the working of the transformer characterized by the IEEE standard C57.104. The four conditions are:

1. On the off chance that TDCG is under 720 ppm, the transformer is working in a protected state.

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2. On the off chance that TDCG lies in the reach 721–1920 ppm, it is working in a marginally strayed condition. Further examination is required if any individual gas is discovered to be surpassing its predetermined level.

3. In the event that TDCG lies in the reach 1921–4630 ppm, it demonstrates that deterioration is of undeniable level. In such a situation, quick move ought to be made and any gas surpassing its ordinary focus ought to be examined immediately.

4. On the off chance that TDCG is more prominent than 4630 ppm, it proposes that there is over the top disintegration of cellulose and oil. The transformer will fizzle in the event that it is permitted to work further.

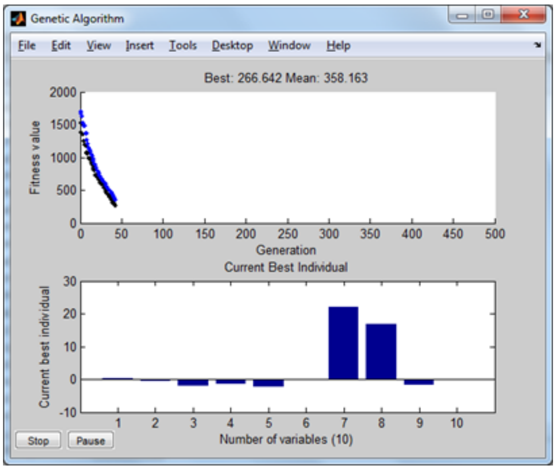

Fig.3 GA Clustering with NN

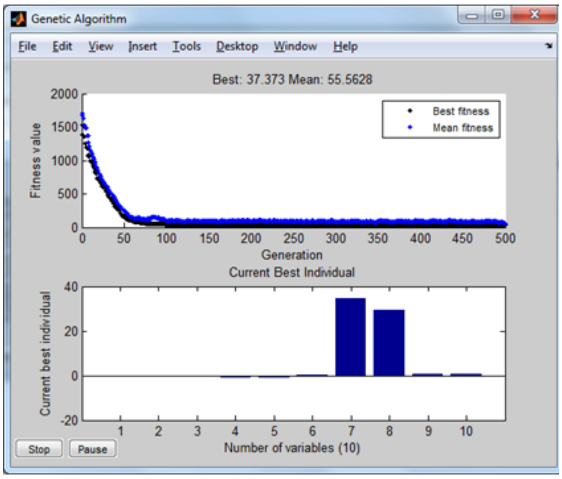

Fig.4 Final condition: after 500 iterations in GA

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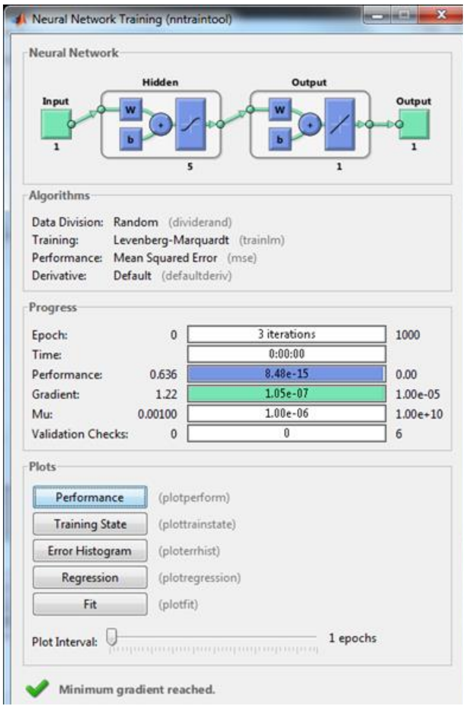

Fig.5 Training tool of neural network

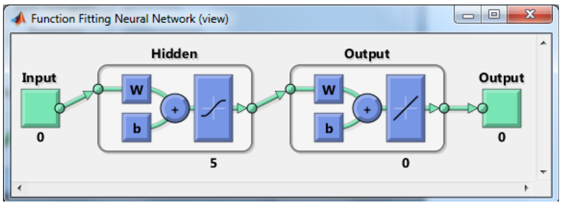

Fig.6 Process layers of neural network

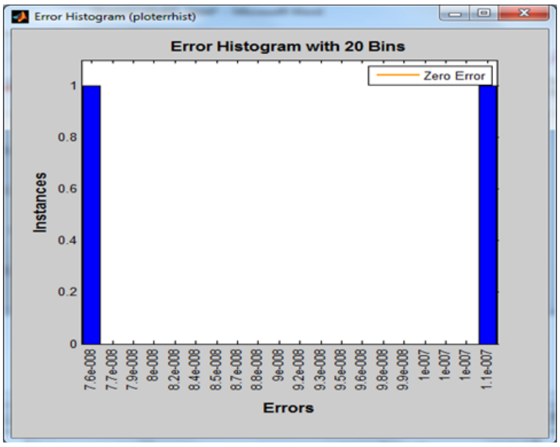

Fig.7 Error histogram

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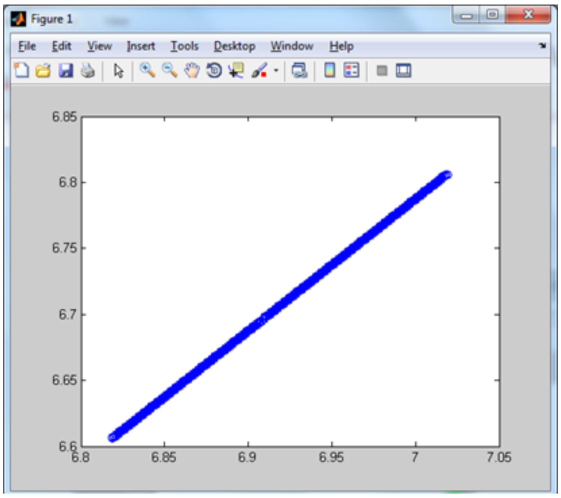

Fig.8 Initial Condition of data gathering

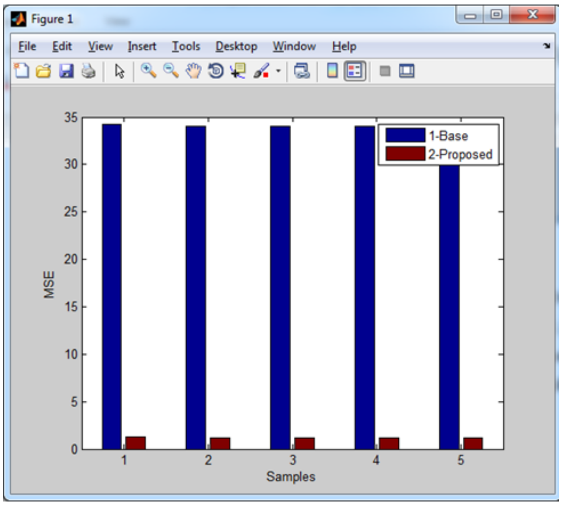

Fig.9 MSE Comparison of base and proposed work

The Base work has high error than the proposed one.

CONCLUSION

This paper presented an overview of basic FL concepts and provides insight into how FL can be applied to solve PTFD problems. The main advantage of the FL system is that multiple faults can be diagnosed, which may not be possible with any other method. Most DGA diagnostic techniques rely on expert analyses, which can be insensitive to slowly developing and insignificant faults. To handle uncertainties in fault diagnosis, based on gas contents extracted from transformer oil samples, various techniques, including the GA, FL, and ANN, have been applied to identify the relationships between fault symptoms and fault types based on gas-fault mapping schemes. The FL techniques can diagnose multiple faults in a transformer and quantitatively indicate the severity of each fault. The FL is effective in various aspects of uncertain knowledge representation while ANN is an efficient structure for learning from examples. However, no single method can be considered the best diagnostic method. The techniques should be considered complementary. Other new AI techniques now being explored and combined with FL techniques for efficient and fast condition monitoring are likely to have a significant role in future PTFD methods. Although condition monitoring can provide early warning of insulation conditions, no single technique can detect the full range of faults and reliably estimate remnant life. Each method has its own strengths and weaknesses. Outputs from various DGA diagnostic methods must be aggregated into an overall evaluation. Therefore, instead of using one diagnostic method, intelligent hybrid methods that combine the strengths of each method require further study to improve detection of incipient faults in power transformers.

Moreover, different transformer diagnosis approaches (e.g., DGA, thermal analysis, frequency response analysis, and partial discharge analysis) also have different advantages and limitations, which complicate the selection of diagnostic

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methods. Thus, a relatively more intuitive approach is to combine the diagnostic results derived from all major test approaches and integrate their data for an overall evaluation. By analyzing integrated data, an engineer can obtain detailed information about insulation status in a transformer in real time. This will facilitate assistant analysis and be the basis of decision-making for condition-based maintenance of power transformers.

REFERENCES

1. Medeiros, R.P. and Costa, F.B., 2017. A wavelet-based transformer differential protection with differential current transformer saturation and cross-country fault detection. IEEE Transactions on Power Delivery, 33(2), pp.789-799.
2. Senobari, R.K., Sadeh, J. and Borsi, H., 2018. Frequency response analysis (FRA) of transformers as a tool for fault detection and location: A review. Electric power systems research, 155, pp.172-183.
3. Tightiz, L., Nasab, M.A., Yang, H. and Addeh, A., 2020. An intelligent system based on optimized ANFIS and association rules for power transformer fault diagnosis. ISA transactions, 103, pp.63-74.
4. Ehsanifar, A., Dehghani, M. and Allahbakhshi, M., 2017, May. Calculating the leakage inductance for transformer inter-turn fault detection using finite element method. In 2017 Iranian Conference on Electrical Engineering (ICEE) (pp. 1372-1377). IEEE.
5. Bao, G., Gao, X., Jiang, R. and Huang, K., 2019. A novel differential high-frequency current transformer sensor for series arc fault detection. Sensors, 19(17), p.3649.
6. Tightiz, L., Nasab, M.A., Yang, H. and Addeh, A., 2020. An intelligent system based on optimized ANFIS and association rules for power transformer fault diagnosis. ISA transactions, 103, pp.63-74.
7. Santos, Raul T., Júlio C. Nievola, and Alex Freitas. "Extracting comprehensible rules from neural networks via genetic algorithms." In Combinations of Evolutionary Computation and Neural Networks, 2000 IEEE Symposium on, pp. 130-139. IEEE, 2000.
8. Pal, Sankar K., Sushmita Mitra, and Pabitra Mitra. "Rough-fuzzy MLP: modular evolution, rule generation, and evaluation." Knowledge and Data Engineering, IEEE Transactions on 15, no. 1 (2003): 14-25.
9. Mitra, Sushmita, Sankar K. Pal, and Pabitra Mitra. "Data mining in soft computing framework: a survey." IEEE transactions on neural networks 13, no. 1 (2002): 3-14.
10. Castro, Adriana Rosa Garcez, and Vladimiro Miranda. "Knowledge discovery in neural networks with application to transformer failure diagnosis." Power Systems, IEEE Transactions on 20, no. 2 (2005): 717-724.
11. Abu-Siada, Ahmed, M. Arshad, and Syed Islam. "Fuzzy logic approach to identify transformer criticality using dissolved gas analysis." In Power and Energy Society General Meeting, 2010 IEEE, pp. 1-5. IEEE, 2010.
12. Kaghed, Nabeel Hashem, Tawfiq Abbas, and Samaher Hussein Ali. "Design and implementation of classification system for satellite images based on soft computing techniques." In Information and Communication Technologies, 2006. ICTTA'06. 2nd, vol. 1, pp. 430-436. IEEE, 2006.
13. Saha, Tapan K. "Review of modern diagnostic techniques for assessing insulation condition in aged transformers." Dielectrics and Electrical Insulation, IEEE Transactions on 10, no. 5 (2003): 903-917.
14. Arakelian, V. G. "Effective diagnostics for oil-filled equipment." IEEE Electrical Insulation Magazine 6, no. 18 (2002): 26-38
15. Duval, Michel. "New techniques for dissolved gas-in-oil analysis." Electrical insulation magazine, IEEE 19, no. 2 (2003): 6-15.
16. Wang, Zhenyuan, Yilu Liu, and Paul J. Griffin. "Neural net and expert system diagnose transformer faults." Computer Applications in Power, IEEE 13, no. 1 (2000): 50-55.
17. Islam, Syed Mofizul, Tony Wu, and Gerard Ledwich. "A novel fuzzy logic approach to transformer fault diagnosis." Dielectrics and Electrical Insulation, IEEE Transactions on 7, no. 2 (2000): 177-186.
18. Wang, Martin, A. J. Vandermaar, and K. D_ Srivastava. "Review of condition assessment of power transformers in service." Electrical Insulation Magazine, IEEE 18, no. 6 (2002): 12-25.
19. J. L. Guardado, J. L. Naredo, P. Moreno, and C. R. Fuerte,"A comparative study of neural network efficiency in power transformers diagnosis using dissolved gas analysis,"IEEE Trans. Power Del., vol. 16, no. 4, pp. 643–647, Oct. 2001.
20. C.E. Lin, J.M. Ling and C.L Huang, "An expert system for transformer fault diagnosis using dissolved gas analysis." IEEE Transactions on Power Delivery, vol. 8, no. 1, pp. 231-238, 1993.