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FINDING OF POWER TRANSFORMER FAULTS BASED ON FUZZY THREE-RATIO

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Abstract: *The Dissolved gas-in- oil analysis (DGA) is one of the most valuable strategies to detect transformer beginning flaws. Among the assorted customary DGA strategies, IEC three-proportion technique is widely used, but in many cases this strategy can not precisely diagnose (such as no matching, numerous flaws). This paper proposes fuzzy three-proportion technique; it is considered that the disadvantages of the customary three-proportion method lie in: when the ratio crosses the coding boundary, codes change sharply, however in reality the boundary should be fuzzied. Based on this presumption, this paper initially propose the fuzzy membership functions for codes*

- *"zero",*
- *"one",*
- *"two",*

The nit exchange the regular rationale

- *" AND" (and)*
- *"OR"*

Utilized as a part of IEC three-proportion technique into fuzzy logic and advanced the diagnosing ventures of this technique. Reproduction demonstrates the proposed technique can overcome the drawbacks of the regular three-proportion technique that cannot diagnose multi-blame and no coordinating codes for finding, accordingly, it greatly enhanced diagnosing precision.

Key words: *Power transformer, fuzzy logic, dissolved gas-in- oil analysis(DGA), Three-Ratio Method..*

I. INTRODUCTION

Control transformer is the most basic hardware in an electrical framework, it's blame may bring about the intrusion of control supply, the budgetary misfortune will be incredible, so it is of crucial significance to recognize the nascent blame of the transformer as ahead of schedule as would be prudent [1]. At the point when there is an overheating or release blame inside a control transformer, it will create comparing trademark gas in the transformer oil, so broke down gas-in–oil investigation (DGA) is the most generally utilized technique to analyze control transformer fault. Through the investigation of the convergences of broken down gasses, their gassing rates, and the proportions of certain gasses, DGA technique can decide the blame sort of transformer. The ordinarily gathered and examined gasses are H2, CH4, C2H2, C2H4, C2H6, CO, CO2. Among differing DGA techniques, the most normally utilized is the IEC three-proportion strategy. In any case, this technique is just the speculation of exact understanding, and cannot offer totally objective, precise conclusion for every one of the shortcomings. In a few cases, the DGA comes about can't be coordinated by the current codes; and in various blame conditions, gasses from various issues are stirred up bringing about confounding proportions between diverse gas segments, in this way making conclusion unsuccessful. As of late computerized reasoning (master framework and neural system) are generally utilized as a part of the transformer blame analysis, better outcomes are got. In any case, the master framework has the hindrances of troubles of learning obtaining and administration of database; while the neural system has an extremely high prerequisite for preparing set and can't deliver etymological yield. Through the blend of fluffy rationale what's more, IEC three-proportion technique, this paper advanced fluffy three-proportion technique. It fuzzifies the coding limit, therefore overcomes the disadvantages of coding limit sharp evolving. Reproduction demonstrates the proposed technique can conquer the disadvantages of the traditional three-proportion strategy that can't analyze multi-blame and no coordinating codes for finding. In this way, it significantly upgraded diagnosing exactness.

II. LITERATURE REVIEW

Zahriah Sahri, Rubiyah Yusof, and Junzo Watad proposed a productive non parametric iterative attribution technique named FINNIM, which contains three parts:

1) The Ascription Requesting;
2) The Attribution Estimator; And
3) The Iterative Ascription [2].

The connection amongst gasses and issues, and the rate of missing esteems in an example are utilized as a reason for the ascription requesting; though the conceivable esteems for the missing esteems are evaluated from k-closest neighbour occasions in the attribution estimator, and the iterative ascription permits finish and deficient occurrences in a DGA informational index to be used iteratively to impute all the missing esteems. Test comes about on both falsely embedded and genuine missing esteems found in a couple DGA informational indexes show that the proposed strategy beats the current techniques in attribution exactness, order execution, and meeting criteria at various missing rates.

Fredi Jakob and James J. Dukarm, propose a less complex approach in view of the standardized vitality power (NEI), an amount related straightforwardly to blame vitality disseminated within the transformer[3]. DGA blame seriousness scoring based on NEI is appeared to be delicate to all IEC blame sorts and to be more receptive to shifts in the relative groupings of the blame gasses than scoring in light of blame gas concentrations. Instead of at least eight gas fixation limits, NEI scoring requires just a few restricts that can be experimentally inferred to suit nearby necessities for any populace of mineral-oil-filled power transformers. The NEI DGA scoring technique, in view of hydrocarbon blame gas fixations and enthalpies of arrangement, gives a numeric blame seriousness score that is specifically identified with the sum of blame vitality exhausted in the oil, notwithstanding to arc sort deficiencies. Since NEI depends on all hydrocarbon gas focuses, not just on each one in turn, it reacts better to continuous increments in blame seriousness. It is touchy to each of the IEC transformer blame types, and its general affectability can be balanced with a predictable impact by changing the cut off points. For an IEEE-style scale of DGA scores from 1 to 4, just three NEI breaking points are required. The NEI is effortlessly figured and, with just a few points of confinement to consider, the scoring rationale is exceptionally straightforward.

Jiyu Wang, Ruijin Liao, Yiyi Zhang, and Fanjin Meng, proposes an enhanced model to survey the financial existence of energy transformers [4]. The new model offers a more effective approach than past strategies of evaluation, with a particular concentration of utilizing the yearly net salary as discrete criteria for deciding the financial files of constant operation, redesign, and retirement procedures of transformers. The financial existence of energy transformers is separated into three segments as indicated by various systems to better resolve the evaluation issue in this field. A contextual analysis is given to demonstrate the possibility and legitimacy of the proposed financial life display. The contextual analysis accomplishes the fine administration objective when the electric power undertaking is required to make the support and retirement system choice.

The proposed model is by and large relevant by and large. The blame likelihood bend of the power transformer can be fitted by the factual information. Subsequently, the diminished level of blame likelihood after update will be taken into account. The important parameters in the model can be acquired by the producer's data and operation information. The leftover monetary existence of testing the transformer will be accomplished at last by looking at the changed techniques. The contextual investigation demonstrates to begin with the possibility and legitimacy of the proposed financial life model and its capacity to give the electric power venture with a reference technique to build up a more productive arrangement for the support and retirement of energy transformers.

David Topolanek, Matti Lehtonen, Mohd Rafi Adzman and Petr Toman, proposed the likelihood for an earth blame localization with the guide of synchronized information recorded on the low-voltage side of the medium voltage/low voltage transformers in remunerated nonpartisan dispersion systems which are outfitted with helper resistor for brief time expanding of the dynamic piece of the blame current. The depicted strategy utilizes voltage hangs evoked by interfacing of the helper resistor for finding the broken area. The proposed technique is tried with the assistance of numerical model which exhibits a piece of the conveyance organize [5].

The upside of the strategy is the likelihood of its utilizing for meaning of broken area which is influenced by a hilter kilter shortcomings, for example, single-stage short out in viably or resistance earthed systems, line-to-line or too line-to-line to ground short circuits, though the length of the characterized segment is subject to the number and area of observed DTSs and on the level of blame current. The necessity for an expansive number of DTSs to delimitation of the briefest defective area and likewise the prerequisite for high estimation of blame current foreordain the technique for use in urban or sub-urban MV dispersion systems described by a high thickness of DTS area and higher blame current level (low blame circle impedance).

Cheng Shu, Li Wei, Ding Rong-Jun, and Chen Te-Fang, proposed a novel blame conclusion technique and a blame tolerant plan for open-circuit blames on a footing rectifier [6]. At the point when open circuit blame happens in any leg of the rectifier, sign will be produced precisely to distinguish the defective leg without usage of any additional sensors. Besides, the flawed rectifier can be reconfigured to keep up its full yield rate to forestall footing rectifier breakdown. The blame conclusion process is neither identified with control trigger flag nor the heap variance. The included parameters are the information and yield voltage of the rectifier, which are the most well-known parameters in rectifier control. Working under zero voltage and zero present, five extra switch sets are embraced for the blame tolerant control procedure to reconfigure the topological structure between the footing rectifier and the footing transformer, in the interim the first structure of the rectifier is held. Examination, plan, and actualizing thought for both typical and unusual working circumstances of the footing rectifier are available in this paper. The test is prepared to confirm the adequacy of the hypothetical investigation.

Levy Costa, Giampaolo Buticchi, and Marco Liserre, proposed a reconfiguration conspire for the SRC for the instance of disappointment in one semiconductor, which could radically decrease the need of excess. Utilizing the proposed plot, the full-connect based SRC can be reconfigured in a half-connect topology, to keep the converter operational even with the disappointment [open circuit (OC) or short out (SC)] of one switch [7]. As a downside of this procedure, the yield voltage drops to half of its unique esteem. Accordingly, a novel reconfigurable rectifier in light of the voltage-doublers topology is proposed as an answer for keep the yield voltage steady after the blame. To check the plausibility of the proposed plot, the converter is tried tentatively in a 700–600 V model with 10 kW of yield power. Protected entryway bipolar transistor (IGBT) SC blame is tried and the outcomes affirm the viability of the proposed approach.

The fundamental favorable circumstances of the proposed converter are post blame operation, basic execution, decreased number of extra segments, and no effectiveness crumbling. In any case, the resounding capacitor must be intended for higher voltage and the present exertion on the sound gadgets in disappointment mode operation is twice than that in typical mode operation. Test comes about for a 10 kW model were acquired and the viability and favorable circumstances of the proposed blame tolerant SRC has been illustrated.

Xianggen Yin, Zhe Zhang, Xuanwei Qi, Gan Li, Wenbin Cao, and Qian Guo, proposed a physical test in light of a useful CT and parameter recognizable proof are displayed to take care of the issue. The fundamental hysteresis circles of P, PR, and TPY class of down to earth current transformers are gotten through physical tests [8]. In this manner, the J-A model parameters are recognized utilizing a half breed hereditary/reproduced strengthening calculation, in light of which transient recreation models of various class CTs are developed. The viability of the proposed technique is checked through unique physical reenactment tests. A regular mischance is dissected in light of these models.

The enhanced model in view of the proposed technique can be straightforwardly utilized for building plan and mishap examination. P, PR, and TPY class current transformers in viable utilize are picked as articles in physical tests, from which fundamental hysteresis circles are acquired. Another technique, named HGSA, is advanced to recognize the parameters of the J-A model consolidated with the physical test outcomes. The strategy takes care of the parameter recognizing issue of the confused nonlinear J-A model. In this manner, distinctive transient reproduction models of P, PR, and TPY class CTs are developed.

A physical recreation test for a run of the mill control matrix and a no mutilation estimation framework is built at State Key Laboratory of Advanced Electromagnetic Engineering and Technology, HUST, which has the ability to mimic distinctive short out deficiencies. The fantastic execution of the CT models in this paper is checked by looking at physical reenactment test result and estimation framework result. A run of the mill unintentional mal-operation of a transmission line zero-grouping differential assurance, created by neighboring transformer stimulation, is examined utilizing these models.

III. EXISISTING SYSTEM

In IEC three-proportion strategy: the important coding definition what's more, blame sort arrangement appeared in table 1 and table 2. In spite of the fact that IEC three-proportion strategy is broadly utilized as a part of transformer blame finding, but since the quantity of code blend is bigger than blame sort number, no coordinating frequently happens in the determination. Additionally in different blame conditions, gasses from various flaws are stirred up bringing about befuddling proportions between various gas segments. This must be managed with by the guide of more refined examination strategies, for example, the fluffy three-proportion technique introduced in the paper [1].

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TABLE 1
THE CODING RULE OF THREE-RATIO METHOD

Ranges of gas ratio	Codes of different gas ratios		
	C2H2/C2H4	CH4/ H2	C2H4/C2H6
<0.1	0	1	0
0.1-1	1	0	0
1-3	1	2	1
>3	2	2	2

TABLE 2
CLASSIFICATION OF FAULT TYPE THROUGH IEC THREE-RATIO METHOD

No.	Fault type	Codes of the Ratios		
		C2H2 /C2H4	CH4/ H2	C2H4 /C2H6
1	No fault	0	0	0
2	Partial discharge of low Energy density	0	1	0
3	Partial discharge of high Energy density	1	1	0
4	Discharge of low energy	1 or 2	0	1 or 2
5	Discharge of high energy	1	0	2
6	Thermal fault of low temperature<150 C	0	0	1
7	Thermal fault of low temperature150~300 C	0	2	0
8	Thermal fault of medium temperature300~700 C	0	2	1
9	Thermal fault of high temperature>700 C	0	2	2

The paper advanced novel transformer blame analyse strategy in light of fluffy three-proportion technique. This strategy can beat the downsides of the customary IEC three-proportion strategy, for example, no choice, can't analyse different issues. At the same time this technique does not have to invest a ton of energy for "taking in", it's customizing is simple. Reproduction comes about from functional era and appropriation transformer information demonstrates the program function admirably and the precision of the proposed technique is considerably higher than the customary IEC strategy.

IV. SYSTEM OVERVIEW

The vast majority of energy transformers are full with oil that guides a few purposes. The oil is a dielectric medium which goes about as separator and as warmth exchange specialist. The early blames occurring in transformers give verification from the get-go in their change organizes through transformer oil gas analysis [8]. These shortcomings can prompt the warm debasement of the oil and paper protection in the transformer. The structure and amount of the gasses created rely on upon the sorts and seriousness of the deficiencies, and standard observing and upkeep can make it conceivable to recognize early defects before harm happens. The four principle sorts of transformer deficiencies are

- *Arcing or high current breakdown,*
- *Low vitality starting, or incomplete releases,*
- *Localized overheating, or problem areas, and*
- *General overheating because of deficient cooling or supported over-burdening.*

Dissolved Gas Analysis (DGA):

Dissolved gas analysis is a test used as a diagnostic and maintenance tool for oil-filled apparatus. Under normal conditions, the oil present in a transformer will not decompose at a faster rate. However, thermal and electrical faults can increase the rate of decomposition of the dielectric fluid, as well as the solid insulation [9]. Gases produced by this process are of low molecular weight and include hydrogen, methane, ethane, acetylene, carbon monoxide, and carbon dioxide, and these gases get dissolved in the oil. Experience accumulated throughout the world to diagnose incipient faults in transformers.

Methods of interpreting fault using DGA

1 .Key Gas method:-

In this strategy the focus and gassing rates of the key hydrocarbon gasses is observed. The key gasses examined are, hydrogen (H_2), methane (CH_4), ethane (C_2H_6), ethylene (C_2H_4), acetylene (C_2H_2). carbon monoxide (CO), and carbon dioxide (CO_2). The focuses are communicated in ppm (parts per million).

2. Ratio method:

This strategy is the most generally utilized technique for the blame translation. In this strategy proportions of gas focuses are utilized for the elucidation reason. Roger proportion technique, Dorren burg proportion strategy, and IEC proportion strategies are utilized by the utilities. IEC proportion strategy is utilized as an industry standard.

V. PROPOSED SYSTEM

1) First determine whether a problem exists. At least one of the hydrocarbon gases or hydrogen increasing at a generation rate (G2), before a problem is confirmed. To use this method, at least one of the individual gases must be at L1 level or above and the gas generation rate must be at least at G2.

The L1 limits and gas generation rates are more reliable. If there is a sudden increase in H2 with only carbon monoxide and carbon dioxide and little or none of the hydrocarbon gases, use (CO2/CO ratio) to determine if the cellulose insulation is being degraded by overheating.

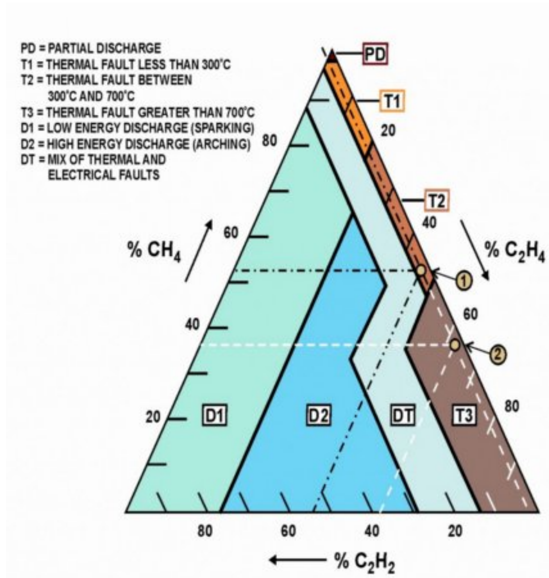
2) Once a problem has been determined to exist, use the total accumulated amount of the three Duval Triangle gases and plot the percentages of the total on the triangle to arrive at a diagnosis. Also, calculate the amount of the three gases used in the Duval Triangle, generated since the sudden increase in gas began. Subtracting out the amount of gas generated prior to the sudden increase will give the amount of gases generated since the fault began. Detailed instructions and an example are shown below.

- Take the amount (ppm) of methane in the DGA and subtract the amount of CH4 from an earlier DGA, before the sudden increase in gas. This will give the amount of methane generated since the problem started.
- Repeat this process for the remaining two gases, ethylene and acetylene.

3) Add the three numbers (differences) obtained by the process of step 2 above. This gives 100 % of the three key gases, generated since the fault, used in the Duval Triangle.

4) Divide each individual gas difference by the total difference of gas obtained in step 3 above. This gives the percentage of increase of each gas of the total increase.

5) Plot the percentage of each gas on the Duval Triangle, beginning on the side indicated for that particular gas. Draw lines across the triangle for each gas, parallel to the hash marks shown on each side of the triangle.



Transformers are so complex that it is impossible to put all symptoms and causes into a chart. Several additional transformer problems are listed below; any of these may generate gases:

1. Gases are generated by normal operation and aging, mostly H2 and CO, with some CH4. H2 is the easiest gas to produce except possibly CO. Production of H2 and other gases can be caused by partial discharge (corona), sharp corners on bottom bushing connectors, loose core ground, wet spot on core from gasket leak above, loose corona shield on bottom of bushing, loose tap changer shield, etc. H2 is not very stable when dissolved in oil. Consecutive DGAs may show variation in amounts of H2 and other unstable gases. Acetylene is the most stable gas; variation in amounts of this gas in the upward direction means the transformer has an active arcing fault. If the variation is going up and down within detection limits of the test equipment in consecutive DGAs, this is simply a variation of the lab's test equipment and personnel.
2. Operating transformers at sustained overload will generate combustible gases.
3. Problems with cooling systems, discussed can cause overheating.

4. A blocked oil duct inside the transformer can cause local overheating, generating gases.
5. An oil directing baffle loose inside the transformer causes misdirection of cooling oil.
6. Oil circulating pump problems (bearing wear, impeller loose or worn, or pump running in reverse) can cause transformer cooling problems.
7. Oil level is too low; this will not be obvious if the level indicator is inoperative.
8. Sludge in the transformer and cooling system.
9. Circulating stray currents may occur in the core, structure, and/or tank.
10. An unintentional core ground may cause heating by providing a path for stray currents.
11. A hot-spot can be caused by a bad connection in the leads or by a poor contact in the tap changer.
12. A hot-spot may also be caused by discharges of static electrical charges that build up on shields or core and structures and that are not properly grounded.
13. Hot-spots may be caused by electrical arcing between windings and ground, between windings of different potential, or in areas of different potential on the same winding, due to deteriorated or damaged insulation.
14. Windings and insulation can be damaged by faults downstream (through faults), causing large current surges through the windings. Through faults cause extreme magnetic and physical forces that can distort and loosen windings and wedges. The results may be arcing in the transformer, beginning at the time of the fault, or the insulation may be weakened and arcing will develop later.
15. Insulation can also be damaged by a voltage surge, such as a nearby lightning strike, switching surge, or closing out of step, which may result in immediate arcing or arcing that develops later.
16. Insulation may be deteriorated from age and worn out. Clearances and dielectric strength are reduced, allowing partial discharges and arcing to develop. This can also reduce physical strength, allowing wedging and windings to move extensively during a through-fault, causing total mechanical and electrical failure.
17. High noise level can generate gas due to heat from friction. Compare the noise to sister transformers, if possible. Sound level meters are available at the TSC for diagnostic comparison and to establish baseline noise levels for future comparison.

VI. CONCLUSION

To deal with the life of transformers, to lessen disappointments furthermore, to develop the life of the transformer, a few tests must be taken. The tests are completed to demonstrate that the transformers are prepared to work or to discover the flaws. Gear disappointments do happen even with the best hardware plans accessible and utilizing the best utility rehearses. With a specific end goal to work a power framework dependably, transformer disappointments must be foreseen. Broken down gas investigation is vital to decide the state of a transformer, it can distinguish an issue for example, breaking down protection oil, overheating, partial release and arcing. The transformers have diverse gassing qualities in view of their size, structure, produce, stacking and support history.

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