Assessment Techniques for DistributionTransformers

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Abstract:

Examing of service transformers plays a vital role as a considerable number of service transformers are found in the distribution framework, the testing status of this indicates which they can fulfill the customer's requirements. Many strategies have been enlarged to judge the good physical condition of service transformers. These techniques help us to know the current position of the service transformer and help in responding effectively. The checking of transformers with various techniques and how to overcome all these can be seen in the paper.

Keywords: Distribution transformers, microcontroller, Arduino UNO,Circuit Breakers,WiFi Module

1. Introduction:

A service converter also called a distribution transformer transmits the alternating current electric energy by magnetic induction postulate. It consists of primary and secondary winding which is used to rise or drop the potential difference levels of a circuit. The distribution grid plays an essential part in accelerating the power system which in-needed. The grid can get defective due to technical issues, electronic loss, thermic loss, and bending disproportion to safeguard from the above-mentioned failures the transformer should be examined by using the transformer try-out process.

2. Distribution Transformer Failure Modes

Distinct inspections and tests have been managed to know the principal causes and to recognize the welfare plans to circumvent the matter. In paper **[1]**, the role that is designated regarding insularity with an event rate of about 41%, then elements appearing with lofty remissness rates are windings, 14% business, 10%, and on-load tap exchange at about 10% and tap changes at about 10%. In papers **[2,3,4],** the analytical data are collected from distribution transformers and can accept a three-aligned model of failures they are mechanism, linkages, and modes. The power transformers and service transformers have identical main operating principles and main components such as insularity, windings, core, and so on but still, these transformers differ in compound and size. In this Section, degraded modes are concerned with this commonly

employed proposition and components and inquire about the reasons for service transformer failure from the writing to recognize the components that are most censorious to distribution transformer healthiness. The basic design of the service transformer is:

Figure 1. The basic structure of distribution transformer

Distribution transformer is of 2 types:

1. Pole-mounted service transformer

Figure 2. Pole-mounted distribution transformer

2. Substation transformers

Figure 3. Substation transformers

Typically the failures occurring are in the combination of electrical, mechanical, and thermal factors mentioned in the paper**[1].**

The transformer failure modes are basically in 3 methods:

- **Electrical Factors**: These electrical factors are classified into 3 categories.
    1. Partial Discharge.
    2. Electric discharge and converting surges.
    3. Temporary or transient-voltage circumstances.
- **Mechanical Factors**: Mechanical failure mainly occurs as the consequence of shipment damage, tremorous activity, and liabilities. The existence of biased discharges during an instigated voltage test can give important indications about a mechanical failure in a transformer.
- **Thermal Factors**: The reasons for thermal non-fulfillment may be as given beneath:
    1. Transformer overloading for an extended period.
    2. Performance of transformer on non-linear loads.
    3. Failure of the cooling system.
    4. Blockage of oil ducts.
    5. Operation of transformer in high ambient temperature.

3. Types of tests on transformers

The types of tests conducted on the transformer are of 2 types basically:

1. Tests that are conducted at the producer's premises.
    a. Type tests

b. Routine tests
c. Special tests

2. Tests that are conducted at the prospector's site:
   a. Pre-authorized check.
   b. Regular tests.
   c. Exigency tests.

1a. Type Tests:

The variety of tests is the type of tests that are conducted under the manufacturer's premises. These are discharged in an epitome part, the main motive of these tests is to authenticate the fundamental and main blueprint standard of the transformer. The different types of type tests are:

- Winding resistance examination of transformer
- Measurement of iron deprivation and no-load current through the open-circuit test
- Measurement of bypass impedance
- Measurement of copper losses
- Transformer vector group check
- Computation of insularity resistance
- Non-conductor check of converter
- On-load tap-changer examination
- Temperature increase examine
- Vacancy test of tank and boilers.

1b. Routine Tests:

Routine tests are the tests for a transformer that are executed to confirm the productivity of the transformer and that are being executed on every unit measured, refer to Fig. 4

The backing tests are incorporated into the regimen tests:

1. Winding Resistance check of converter
2. Transformer quota test
3. Transformer vector group trial.
4. Examing of impedance voltage
5. Measurement of load loss
6. Examination of no-load loss and current
7. Quantification of insulation resistance
8. Pressure tests of the transformer.
9. Examination on on-load tap-changer.
10. Oil compulsion test on the transformer

Fig.4 Distribution Transformer

1c. Special Tests:

Special trials of a transformer are carried out depending on the customer's requirements for gathering, the information that is practical during the working and conservation of the transformer, refer to Fig. 5

The special trials followed out on the transformer are,

- Insulator trials of the transformer
- Short-circuit examination in the transformer.
- Examination of the impedance of three-phase and zero-sequence transformer
- Measuring the auditive noise level of the measurement.
- Measurement of the harmonics of the no-load current in the transformer
- Estimating the amount of potential taken by the oil pumps and fans in the circuit
- Examination of a few components in the circuit such as the Buchholz relay, and
- pressure relief devices,

Fig.5 Substation Transformer

2a. Pre-commissioning tests :

This trial is conveyed just before approving the generator in the area. This helps to examine the enthronement procedure and helps to know the consequences of the generator that is to be used.

Pre-appointing examination of the transformer includes,

- Operative examination of the preservation system
- Insularity resistance (IR) computation.
- Examination of capacitor bushings
- Quantifying of voltage ratio (turns ratio)
- Examination of the polarity of the transformer
- Prescribing of winding resistance
- Examination of vibration of the transformer
- Examination of the magnetic balance of the transformer
- A measure of the prevalence stability Response of the transformer
- Measurement of buoyant neutral point
- The examination of short-circuit impedance and magnetizing current of the transformer
- Effective measurement of OLTC
- Measurement of stability of differential
- Measurement of bushing current transformers (BCT)

2b. Periodic tests:

Periodic tests help to enhance the efficiency and check the conditions of the transformer periodically. The conditions are monitored periodically such that the transformer can meet up the customer's requirements. The monitoring of the transformer depends on the type of transformer that is used. This type of monitoring helps to know the faults during the early stages only.

Some important tests of the transformer are discussed below:

Winding Resistance Examine of Transformer: The winding opposition check of a transformer can be carried out as

both types of tests additionally routine tests. It is carried out to control the IR losses in the windings of the transformer. There are numerous methods obtainable to measure the winding resistance of the transformer as mentioned below:

- Galvanometer-Voltage meter method
- Bridge method
- Kelvin-bridge procedure
- Automatic winding resistance computation kit

Transformation Ratio Test

The voltage change proportion is the principal factor that very much affects the presentation of a transformer. Therefore, the modification ratio trial is an important test of a transformer. The transformation ratio trial is carried out by appealing a 3-phase supply to the high-voltage winding, by possessing the low-voltage winding open-circuited, the persuade voltage is then

measured at the HV-winding terminals and LV-winding terminals of the transformer to determine the actual transformation proportion of the transformer.

4. Methodologies for prevention and measures taken for failure of distribution transformer

Existing methodology

Fuses, circuit breakers, and electromechanical relays were the components that were used for the protection of power systems for 10 years. But still, they are unreal.

- Commercially, transformers are currently observed mechanically where a person regularly visits a transformer site for conservation and records parameters of importance.

- These types of methods used for observing cannot provide information about the casual overburdens and searing of the transformer windings and the transformer oil.

These above-mentioned factors can directly reduce the transformer's life.

Transformer Failures:

The failures occurring in the transformer lead to serious losses of revenues in so many ways. If the transformer fails that leads to insulation of the consumers from the grid and the respective distribution companies are asked to pay the penalties. Due to this, the revenue losses are seen on account of its failure in supplying the generated power to its customer.

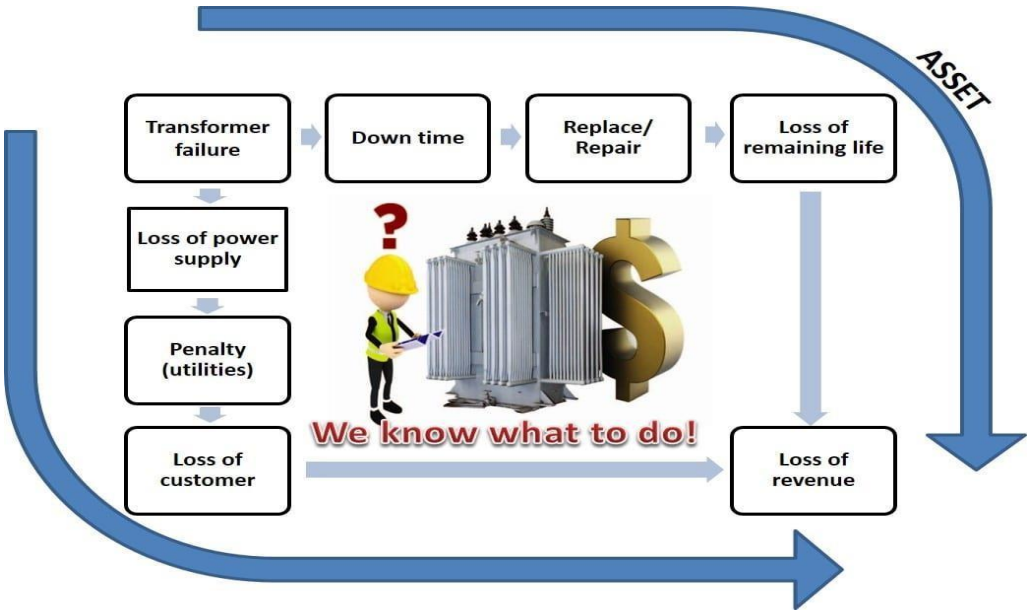

Fig 6. Diagram for transformer failures and measures to be taken.

Flowchart representing the proposed model

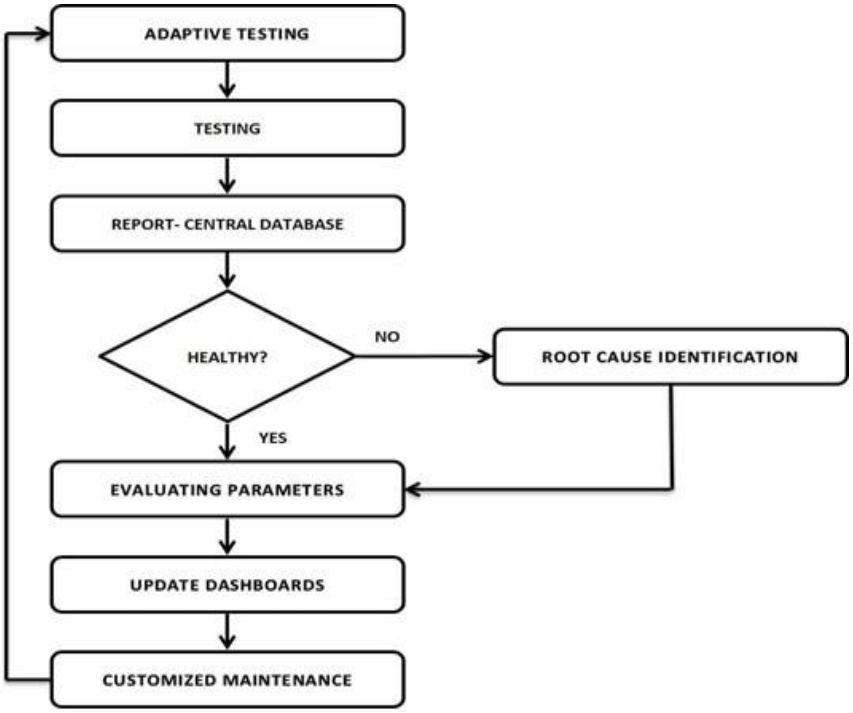

Fig 7. Flowchart representing the proposed model

As per the above requirements, there is a need for a distribution transformer for real-time monitoring such that we can detect all operating parameters and the monitoring takes place. This will assist to stay updated on the operational parameters of the distribution transformer. This will assist to recognize problems before any recognized failure which guides to significant cost savings and greater reliability. With the development of technology, the usage of GSM devices such as GSM modems has made them an attractive option for wide-area network applications.

6. Modern methodology

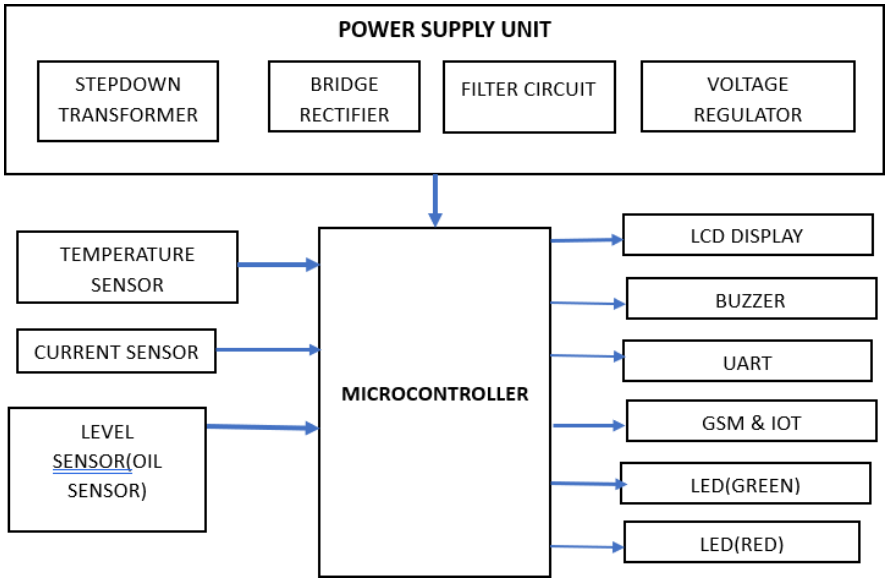

Fig 8. Block diagram of the model proposed

The entire system is designed to check the parameters which detect the faults occurring in the transformer and with the help of this system, it becomes easier to optimally use the transformer and have a regular update. This system, refer to fig 8., used four sensors for monitoring that is voltage sensor, a current sensor, a level sensor, and a temperature sensor. Here the model used a power supply to operate Arduino UNO and a Wi-Fi modem. The above figure shows the connection between all modules. The sensor identifies the data and the respective data is displayed on the LCD that the same time it is given to the user on a given IP address as per the program. If the system gets unsecured data about the system can avoid failure. This proposed a model of a real-time transformer monitoring system using GSM & IoT. This is classified into four parts-power supply, controlling, data processing, and data uploading. The hardware implementation is classified into the following modules: the ACS712 module, Temperature sensor module, Ultrasonic Sensor Module, GSM module, and voltage module.

GSM module:

The GSM module is used to send messages or call forwarding to the authorized person. The GSM module is shown below.

GSM module The GSM module is interfaced to the Arduino using level shifter IC MAX 232. When the program is executed, the module is synchronized with Arduino and sends the message to the phone number mentioned in the program.

Wi-Fi module:

Wi-fi modules are used for accepting commands over Wi-Fi. These are used for sending or receiving data over Wi-Fi. The ESP8266 is a cost-effective silicon chip with a brim-full stack, with capabilities of 2.4 GHz, an inter-integrated circuit, and a serial communication protocol. This allows the microcontroller to connect to the Wireless fidelity network and make simple TCP/IP interrelations. The operating voltage is 3V and the maximum voltage is around 3.6V.

How will the solution help Power distribution companies?

The below-mentioned solution helps the distribution companies in the following sectors,

- Monitor asset condition
- Fault prediction
- Increase reliability
- Asset life extension
- Schedule maintenance activity
- Downtime management

Conclusion:

The conferred paper is with the study of determining the most important factors on the distribution transformer working and their life. This helps to gather more information on the important parameters of the distribution transformer. Real-time monitoring plays a very important role in enhancing the functioning of the distribution transformer. The failures that are seen in the distribution transformer and then the respective measurements are taken to increase the shelf life of the distribution transformer bring a lot of advantages to the companies. Therefore, as per these benefits the pressure of using it in this environment, real-time monitoring turns out to be a booming topic in the power system. Manufacturing a cost-effective transformer, upgrading the safety measures, enhancing the life cycle of the transformer, and reducing all the failure modes by conducting effective tests will help to improve the power quality. With the developing computer, communication techniques, signal processing, and AI have become the hot and most powerful tools real-time monitoring equipped with these high levels of techniques will help to reach high levels of compassion, insightfulness, reliability, and cheapness.

Future Scope:

- As of now, the transformer maintenance is done manually on-site. By implementing these steps preventive measures can be taken into consideration.
- Development of complex algorithms and software that takes corrective actions when any fatal abnormality arises. A more inclusive way of taking corrective measures is by equipping the microcontroller to receive instructions through a secured server from the central grid and the microcontroller take the precautionary steps to rectify the faults are:
  - By using the anti-theft module
  - master software

GSM means of transmission; the service transformer monitoring system can analyze and rectify the wrong data. If the observation measurement is peculiarity, it will be an alarm in the master.

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