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# Life Prediction of Mold Transformer for Urban Rail

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**Abstract.** In this paper, the life prediction of mold transformer was described by using the Arrhenius equation for urban rail. The life of urban rail power equipment for the development of prediction algorithms in real-time on-site diagnostic technology and on-line inspection technology skills to apply. Evaluation of Urban Rail aging power plants by applying the algorithm to algorithm and system is necessary to maximize the effect. Thus, the aging of urban rail power equipment to determine which algorithms or parallel coupled-line diagnosis techniques and technologies are needed.

**Keywords:** polymer transformer, Arrhenius equation, temperature.

## 1 Introduction

Transformers are commonly used in urban rail, the rated capacity is determined according to the application. The transformer for urban railway is mold transformer and oil transformers. Urban rail power equipment used in the form of molded transformers are not an expression transformer flows used. Oil immersed transformer in comparison with a cast resin transformer is maintenance and management is easy, and can be compact and light weight advantages. Urban rail power equipment located in the basement because it is primarily by absorption may occur in the deterioration of the facility[1-2]. Because of the mold in a vacuum molding method for making a mold transformer transformer suitable for the performance of urban rail has. Transformers with a rated capacity of urban rail depending on the application for gobae, small details, can be classified as rectification. In this paper, three transformer applies an algorithm was developed for both models. Cited in the report under modified equipment used for transformer cast resin transformer rectifier will be a focus on development[3].

## 2 Mold Transformer failure causes

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Mold partial discharge phenomenon that occurs in transformers to measure the degree of deterioration of the non-destructive techniques for diagnosing and uninterruptible diagnosis is possible. In order to measure the partial discharge sensor There are several different applicable, representatively Rogowski coil sensor, an ultrasonic sensor, a coupling sensor, HFCT (High Frequency Current transformer) sensors and the like are used. Urban rail operating agencies of power equipment for partial discharge measurements in accordance with IEC60270 standard diagnostic testing facilities to be implemented. Power equipment, including mold transformer partial discharge measurements for the diagnosis, monitoring signals in addition to the partial discharge signal with unwanted external noise and noise signal detected and to remove these unnecessary signals to accurately monitor the partial discharge signal is an important diagnostic technology acts as a factor. Degradation caused by power plants in the over-temperature phenomena involving a large proportion accounted for . Cast resin transformer , rectifier is driving heat stress caused by various factors during the development of progress and isolation performance degradation and eventually failure of the development of the facility . This may be for diagnostic purposes utilizing infrared thermal imaging techniques can be performed effectively diagnostic equipment. Infrared thermography equipment by the power plant inspection and diagnosis of the overall temperature distribution is easy to check the status , the local overheating phenomena due to defects can be detected. Table 1 Criteria for mold transformer content of the fume temperature by thermal imaging when diagnosing mold transformer temperature limits can be judged by the overall condition. Among the cast resin transformer is in operation mainly in the core area and the cable connection to the heat generated. If the mold clamping cable connection terminal of the transformer is bad or overheating occurs when the insulator thermal anomalies can be identified techniques. Also, the image data of the periodic diagnosis secured, power equipment by analyzing the change in the thermal condition can be judged whether the above.

**Table 1.** Mold transformer heating temperature

| Power Equipment | Temperature [°C] |
|---|---|
| Core part | 100 ~ 120 |
| | 120 |
| Epoxy surface | 70 ~ 80 |
| | 80 |

Power plant using thermal imaging cameras diagnostic methods other than the diagnosis of mobility, convenience, speed is excellent, and the diagnosis of contactless technology. Thermal image diagnosis because of the external temperature and direct sunlight, and the image distortion due to an error can be avoided. In addition, most of the power plant location yeoseo visual inspection thermal imaging camera capable of shooting angle does not involve the error. These advantages of infrared imaging diagnosis of the state of the urban rail and is very suitable for power plant technology.

 

The life of the product attached to the electric component in a short period of time, or evaluating the failure rate is quite important. Reliability tests in actual use conditions, a test is carried out to simulate the stress but very long, ranging from the normal life time consuming. Decades, especially in the case of power equipment costing more because not practical. Because of this short period of time in an acceleration test to evaluate the life characteristics is required. If the accelerated degradation mechanism is a simple test is relatively easy, but the actual electrical components are intricately linked to the action of a lot of stress, so it is difficult to predict the lifetime and failure rate. In this case, what is the dominant degradation factor is that the dominant degradation factor to derive a simpler system focused on it as a test to be carried out. Performance is also used in electrical components at the same time, the test results are compared to the reference.

Transformer winding temperature is the ability to instruct, but this is the average winding temperature, and cooling mechanisms , such as the winding arrangement according to the design specifications will be generated and the temperature difference between the winding position , the position of the winding hottest hotspots (hot spot) is referred. It is the largest thermal stress of the insulating paper point. Thus, the fast-paced, and the deterioration of the insulating paper, insulation deterioration due to the probability of an accident increases. Therefore, the point of the transformer and the temperature of the hot spots of the transformer has a close relationship with life . IEC 60076-7 and IEEE C57.106 hotspots in temperature is explained. Hotspot temperature is the ambient temperature of the transformer , the load in accordance with the coil temperature rises and hot spots the temperature correction value is

expressed by the sum . IEEE , the ambient temperature of 30 ℃, the temperature rise at rated load winding hot spot temperature of 65 ℃ and 15 ℃ summing corrections transformer at rated load , based on the hot spot temperature to be 110 ℃ . When the deterioration of insulating paper by heat, mechanical force is lowered , so that the life of the insulating paper is evaluated by measuring the tensile strength and the degree of polymerization . The relationship between the life and the voltage of the voltage and the following equation representing the relationship between life and the Arrhenius equation using the formula being utilized Simoni equation.

$$L$$

$$L \quad ( \; v$$

$$v_{\omega} \ddot{\eta}^{-} n \qquad (1)$$

L : The life of the voltage V (V: Rated Voltage), L0 : the life of voltage Vo (Vo: the applied voltage), n: by changing the voltage acceleration index dielectric (air corona discharge accrual basis). The tensile strength for the life limit , the polymerization degree depends on the value of the electric power company can be set. Typical lifetime of the transformer limits the initial tensile strength of the insulating paper , 50% or 25%, to be set . Transformer according to the deterioration of the insulating material inside the temperature and life as a function of time according to IEEE Std C57.12.56-1986 following the Arrhenius theory is applied, the insulation

system on the basis of 55 ℃ when the following expression below[4-5].

$$\text{Life (h)} = \exp\left(\frac{15000}{T}\right) - 27.064) \qquad (2)$$

Where, life (h): life expectancy (h), Hotspot absolute temperature (T, transformer transformer winding temperature + temperature + hotspots around the calibration temperature (11.5 ℃ + 273 ℃) temperature rise in this way is a lot of time and a large current because it requires the facility scale is large. Shortening the life of the transformer epoxy insulation material when heat is applied and the maximum temperature is dependent upon the time. Rectifier diode leakage current increase of the failure modes, Short, and can be divided into Open. The partial discharge occurring inside the transformer spectrum as follows on the basis of the above measurement, the critical, the normal state can be displayed.

## 3 Decision Algorithm of the Mold Transformer

Deterioration of the mold transformer and rectifier for detecting the data is determined as follows: temperature, humidity, partial discharge, the following algorithm is determined by the edge degree.

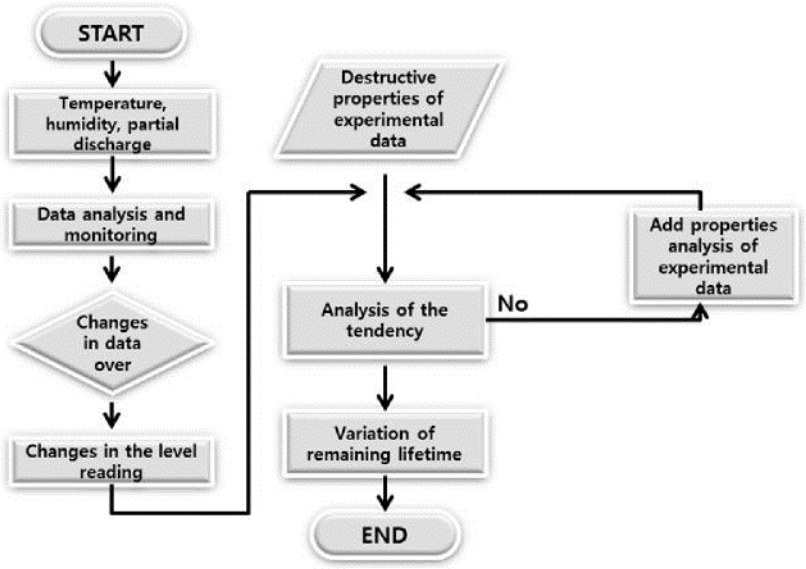


**Fig.1** Deterioration algorithm

Mold transformers are electrically isolated stable characteristics. In particular, completely independent of the structural phase-windings, or because it has one, two

 

primary degradation is almost not generated between. Therefore, consideration for the deterioration of the winding insulation between the inner layer can be limited. And if the diameter of the secondary winding is relatively thick due to less number of turns on the primary winding is less than the probability of failure. Estimate the remaining life of the transformer according to the life expectancy calculated by checking the state of aging of the addition can be determined.

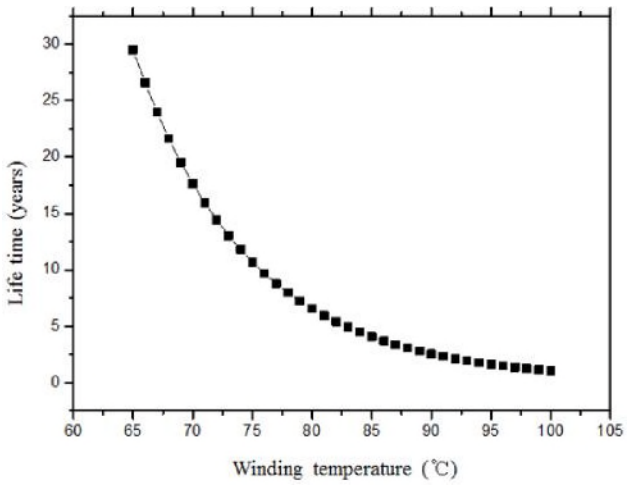


Fig.2 Life prediction of Mold transformer using the Arrhenius equation

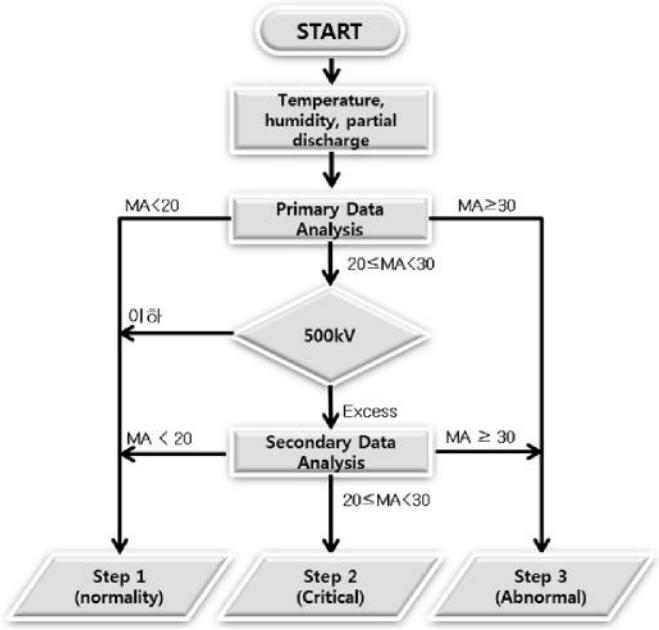


Fig.3. Deterioration calculated by checking the state of aging

## 4 Conclusion

In this paper, the life prediction of mold transformer was described by using the Arrhenius equation for urban rail. The life of the mold transformer windings, and these windings are selected to the conductor, the epoxy resin formulation and processing method, a mold and method according to the characteristics of the elements are determined and superiority. The epoxy resin and the metal of the conductor is essentially the difference between the thermal expansion coefficient varies according to temperature change or the like of thermal adaptability phenomenon occurs crack possibilities.

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