The Estimation of Aging Condition of the Outdoor Insulator Using the Weibull Distribution and the Chaos/Fractal Mathematics

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Abstract: Using the supposed Chaos/Fractal method, an experimental work have been carried out on the application of Surface Discharge(SD) image data used to be calculated in FD processing. The first important step is to select a type of discharge image pattern that has good discriminating power. Especially, FD of virgin sample and its derivatives such as image complexity have been extensively used for comparative estimation or separation. The shape of discharge image and various frequency spectra provide another way to discriminate of discharges. The result was estimated on the fractal characteristics as possibilities of identification of manufacture state for long period stabilities. At the second, the dangerous area was easily found to the recurrent phenomena. However, such area is very difficult to analysis of mechanism and to predict the lifetime in present state, it is possible to discriminate by means of data accumulation

1 INTRODUCTION

Despite of the growing number of applications and development of outdoor power system, the question how the estimated quantities relate to the residual lifetime of specific object , still remains open. The complexity and fuzziness of measured ageing patterns in the real operational condition, such as acoustically, chemically, electrically, thermally or any other methods, can be interpreted as a type of imprecision that items from grouping elements into classes that do not have sharply defined boundaries.

For recognition of our ambiguous, vague measured information of their pattern features from outdoor power system, fractal mathematics can be a better or effective representation model than conventional information.

Recently, image processing of chaos/fractal engineering methodology has been introduced and addressed a variety of applications in many different fields. Fractal application of discharge image has ability to classification the estimation of aged system without knowledge of mathematical relationship.

In this respect, this paper presents adaptive fractal application of recognizing system in analysis of measured discharge image. The value of aged apparatus and models are studied and discussed a Korea practical applicability in the monitoring/diagnosis and maintenance of power system.

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2 FRACTAL MATHEMATICS

The fractal have been very successful tool to express the naturally occurring phenomena and the shape which were impossible to descript mathematical and quantitative analysis in conventional mathematical methods looks like an Euclidean geometry.

In Fractal dimension, we suppose the same pattern as the virtual existence sum of region(Nr) when those size of virtual area is the r(const). The Fractal dimension (FD) is defined as following

$$FD = -\frac{\log(N(r))}{\log(r)}$$

The method here for FD calculation used to carry out cover method which was one of the typical negative gradient value in logarithm graph between the virtual existence sum of region(Nr) and the variable size(r) of virtual area. In part of tree research, many researcher has been a tendency to select 2 dimensional observation system more than 3 dimension method, so those non-linear characteristics of 3 dimensional observation method was represented a broad area between 1.5 and 1.8 dimension. One of the other serious problem for on-line measurement in the fractal application is some image noise during the processing, If image data has a some kinds of noise during the processing, Fractal dimension would value than original Fractal dimension. Furthermore, fractal mathematics has a some boundary for exactly numeric expression of image data in case of 2 dimensional observation. .

3 EXPERIMENTAL BACKGROUND

The important parameters to characterize discharge are structure appearance, a boundary of land and environmental aging factors. The those distribution consist of the operation atmosphere, the electrical stress, environmental atmosphere, rainy(wet) day, dust and fog rate and the system ability, Most of typically cases, the outdoor power system is pretested by a accelerating testing of laboratory condition which are example of the IEC-60587. For the last couple of year, almost research works on outdoor power system has been concluded the experienced estimation by an aging level using visual inspection.

Our experimental selection of a land boundary was based the south sea-coast area in Korea for the comparative of aging stress. Aging map of outdoor power system represents 6-point in sea-coast of Korea. The key-point in map construction can be divided into three research vision; possibility of estimation, difference of aging cycle and the capital environment.

From 1996, EPDM insulator has been adopted a new outdoor system in Korea, Specialty, the important parameters to exchanging was a economical aspect of maintenance according to EPL reports.

Table 1. Merits and Demerits Comparison of a Polymer and Porcelain Insulator

	Polymer insulator	Porcelain insulator
Merits	·Domestic troubles exp. ·Reduction of expenditure No scattering	·Inactivity surface ·Flame retardant ·Authoritativeness
Demerits	·Short spot experience ·Aging by using years ·Corona Discharge	·1000[%] Weight ·High cost ·physical impact

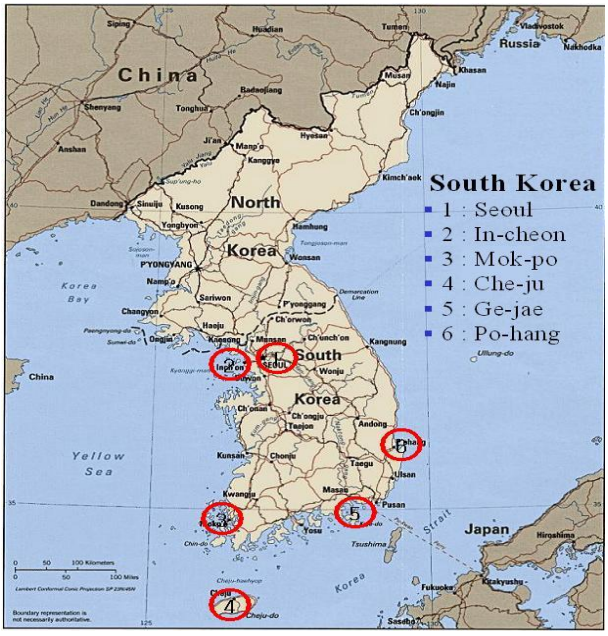
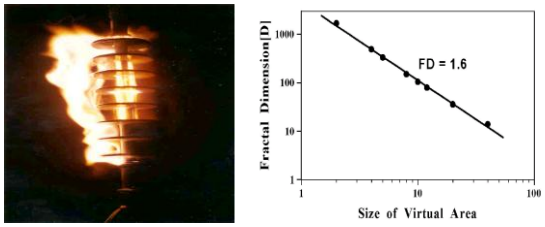


Photo 1. Sampling Area

4 APPLICATION AND EXPERIMENTAL STUDY ON FRACTAL DIMENSION

Using the supposed FD method, an experimental work has been carried out on the application of SD image data used to be calculated in FD processing.

The Fig. 1(b) is shown the result the FD algorithm. The method called FD has a good linear characteristic. But conventional FD method whose purposed value is one-line measurement has long calculation time to numeric expression of electrical stress.



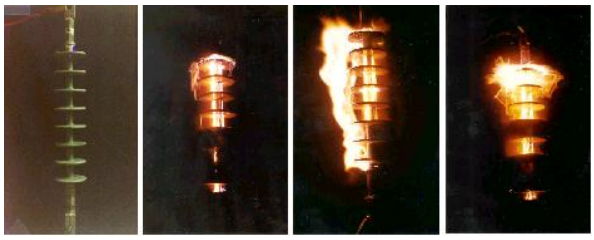
(a) SD (b) FD Result

Fig 1. SD testing of EPDM insulator according to operated area. (Company C at Mok-Po City, used 3 years)

The new method called FD has both a good reappearance characteristics and an estimation ability in part of aging level more than conventional visual observation method. Fig. 1 represents the computer result from FD algorithm.

We easily confirmed discharge characteristics. As results of FD, we take a quantitative value as electrical aging, resulting from supposed method define the accelerating level.

Although the application of fractal mathematics to complex discharge image patterns obtained at this time would appear to be somewhat premature, there is some evidence that in terms of the changes in the OIT(Oxidation induction time) distribution patterns, it may be possible to predict the breakdown of outside power systems under intense discharge conditions. However, the most significant advances made in the area of aging pattern recognition primarily concern the discrimination between stress and environmental condition.



(a) Virgin (b) Che-Ju (c) Mok-Po (d) Ge-Jae

Photo 2. The accelerating examples

The first important step, the selection of discharge image pattern, has good discriminating power.

Especially, FD of virgin sample and its derivatives such as image complexity have been extensively used for comparative estimation or separation. The shape of discharge image and various frequency spectra provide another way to discriminate of discharges. To reduce the dimension of original discharge data, 0.0 dimension of FD, characteristic feature or internal knowledge properties of the virgin data should be extracted from the data. Due to lack of a knowledge or information of concerned new systems there in no unique way to do this.

Statistical parameters (average, deviation, skews) and fractal features (fractal dimension. chaos, complexity) are just few examples of such features. The trade-off between the number of features, time for the calculation of the features, discrimination power of the features and the final speed of classification should be considered when designing the features. To create a data base for reliable aging recognition various aspects such as the effects of test voltage level, aging, availability of starting electrons must be taken into account.

A number of mathematical methods are available to organize the database. Mapping techniques and cluster analysis methods can be used for this purpose but it should be realized that there is no 'best' method. Hence, the works reported in the literature are necessarily of a rather preliminary and rudimentary nature, and represents only the beginning in a much more formidable task of applying Fractal/Chaos pattern recognition techniques on actual power equipment and apparatus with the aim of deriving meaningful and reliable information from the discharge patterns in the cause of routine accelerating tests.

The present works in reference have demonstrated that even with the most simple of discharge patterns and sources the recognition capabilities of fractal application evaluated are not always perfect and reliable. Nevertheless, this positive result obtained on very simple artificial models and electrodes should not be misconstrued so as to impel indiscriminate application of fractal in areas where at this stage of their development and in terms of our current knowledge of the discharge process, their discharge image pattern recognition capabilities are clearly limited.

Almost of aging experiment depends upon acceleration test for analysis of aging processing. In this paper, we have investigated the availability applying different stress distinguished the availability applying different stress distinguished FD.

Those characteristics were predicted on the unclear pattern between 1.4 and 1.6 for FD discrimination, those results of the bellow FD test become more large than present FD data because of aging progress character of surface deterioration. Testing involved higher FD was calculated to much interested phenomena according to the Mok-Po area. At the first, the ambiguous results group by company dependence is clear different aging slop of the above all condition.

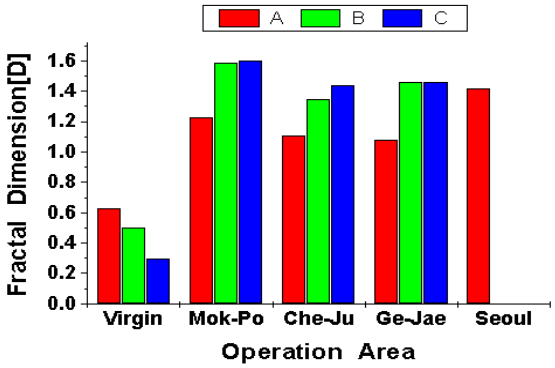


Fig. 2. FD estimation results used 3 years

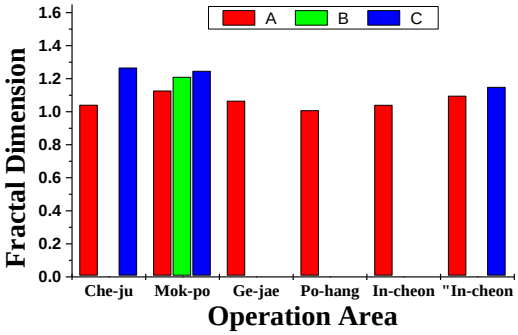


Fig. 3. FD estimation used 8 years

The result was estimated on the fractal characteristics as possibilities of identification of manufacture state for long period stabilities. At the second, the dangerous area was easily found to the recurrent phenomena of FD output. However, such area is very difficult to analysis of mechanism and to predict the lifetime in present state, it is possible to discriminate by means of data accumulation.

Table 2. Aging Acceleration Value Using Fractal Dimension (3 years)

	FD			Ave.	acceleration[%]		
	A	B	C		A	B	C
Mok-PO	1.23	1.59	1.60	1.47	111	143	144
Che-Ju	1.11	1.35	1.44	1.30	100	122	130
Ge-Jae	1.08	1.45	1.46	1.33	97	132	132
Seoul	1.42			1.42	128		
Po-Hang	1.11			1.11	100		

Table 3. Aging Acceleration Value Using Fractal Dimension (8 years)

	FD			Ave.	acceleration[%]		
	A	B	C		A	B	C
Che-Ju	1.04		1.26	1.08	100		121
Mok-Po	1.12	1.21	1.24	1.17	107	116	119
Ge-Jae	1.06			1.06	101		
Po-Hang	1.00			1.00	96		
In- Cheon	1.04			1.04	100		
"In-Cheon	1.09		1.15	1.12	104		110

5 CONCLUSION

In this paper a general outline of the development of image processing technique based fractal diagnostics is given with emphasis on problems of the validity of underlying models and the interpretation of results.

Some major fractal based approaches are reviewed in this paper, with a discussion of certain problems that also are significant for modern approaches. After a discussion of primary discharge events and resulting degradation, some basic matters regarding measurement employing fractal techniques and testing are described and their problems are discussed. The new method called fractal dimension has been introduced and it has shown both a estimation characteristic and the capability of higher recurrency calculation comparing with the case of the conventional visual inspection. In the experiment, the fractal dimension for discharge image has a possibility to aging level of estimation for lifetime diagnostic system. Possibilities inspired by the chaos/fractal engineering for monitoring the aging of power system by means of discharge recognition should also be further investigated.

6 REFERENCES

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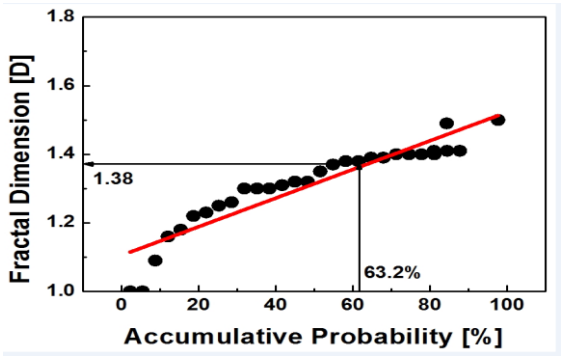
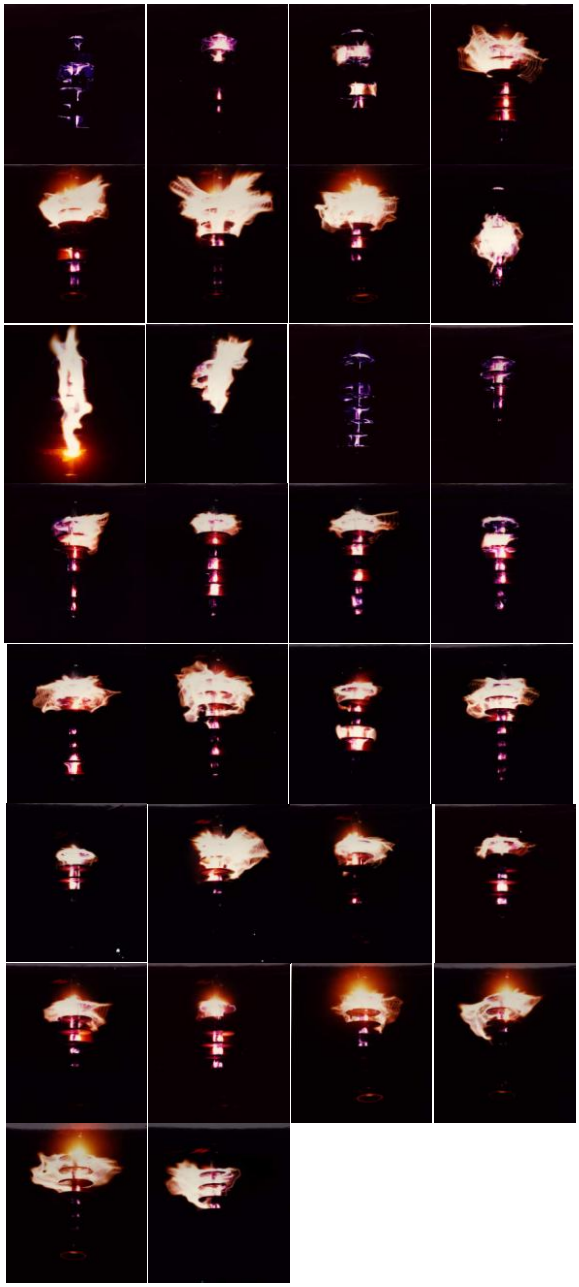
<APPENDIX>

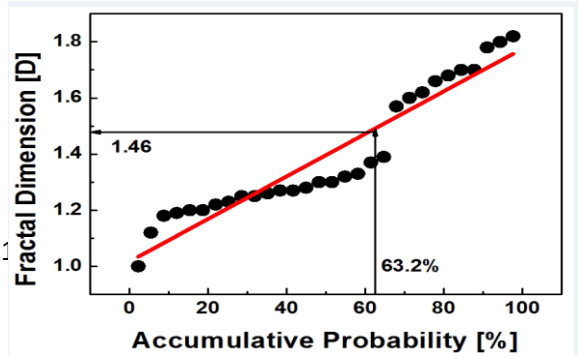
CASE 1. ALT 30-cycles (Company A)





CASE 2. ALT 30-cycles

(Company C, Old model)



CASE 3. ALT 30-cycles

(Company C, New model)