A Study on Dependence of Arc Parameters on Interruption Current Immediately after Initiation of Low-Voltage DC Interruption

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Introduction

In recent years, with the increased use of DC, there has been a demand for more sophisticated DC interrupting technology. The authors have used the Mayr arc model as a method for macroscopic analysis of airborne low-voltage DC interrupting arcs and have mainly studied methods for estimating arc parameters (APs) immediately after the start of current interruption [1]. While the estimation of APs has been carried out only under certain conditions, this paper reports on a study of APs at different interrupting current values.

Experimental Procedures

The current interruption process can be calculated by coupling the Mayr model (equation (1)) with the circuit equation of a typical DC circuit (equation (2)), giving the APs, θ [s^{-1}] and N [W], and solving for the current $i(t)$.

$$\frac{1}{G}\frac{dG}{dt}=\frac{1}{\theta}\left(\frac{V_{arc}\cdot I}{N}-1\right) \qquad (1) \qquad\qquad E = Ri+L\frac{di}{dt}+V_{arc} \qquad (2)$$

The method of estimating APs is explained using the results of a measurement with a current I_{DC} to be interrupted of 30 A. First, as shown in Figure 1, the APs is adjusted and estimated so that the measured current waveform (Trend 1) immediately after the start of interruption is matched with the simulation results using the APs. As shown in the figure, even different combinations of APs have been found to reproduce Trend 1 well. Figure 2 then shows a straight line drawn based on the estimated APs on a graph (Mayr graph) plotting the measured results with arc power on the horizontal axis and the left-hand side of the Mayr model on the vertical axis. As can be seen from the diagram, there is a point (point A) where those lines intersect. This means that APs estimated from a straight line through point A may reproduce part of the current interruption process.

Results and Discussion

Figure. 3 plots the point A obtained from five measurements at I_{DC} = 10A, 20A, 30A and 40A. The figure confirms that point A appears at almost the same position if the I_{DC} is the same. The diagram shows that if the I_{DCs} are the same, point A appears in approximately the same position. It can also be verified that as the I_{DC} increases by a factor of n, the x-axis coordinates of point A also increase by a factor of approximately n. For the y-axis co-ordinates, It can be confirmed that the Y-axis is scaled by a factor of 1/n. Methods for estimating APs using this point will continue to be investigated.

Acknowledgement

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References

[1] Ido et al. "A Study on Method for Estimation of Arc Parameters Capable of Representing a Part of Low-Voltage DC Interruption Process" , Annual Meeting of the Institute of Electrical Engineers of Japan , 6-030 , (2025)

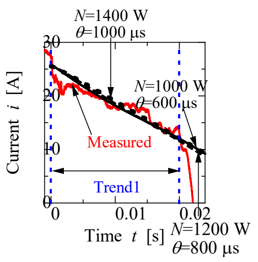

Figure 1 Current interruption simulation

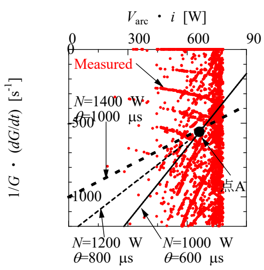

Figure 2 Mayr graph

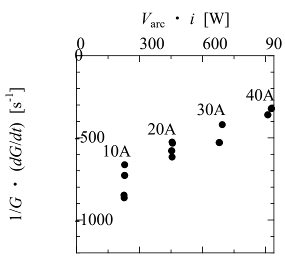

Figure 3 Transition of the Intersection Point