Preventive measures of the tracking fire generated between a home electric outlet and plugs

Shota Yuyama
Student
Kogakuin University
2665-1 Nakano, Hachioji
Tokyo 192-0015, Japan
cm12029@ns.kogakuin.ac.jp

Norimitsu Ichikawa
Member
Kogakuin University
2665-1 Nakano, Hachioji
Tokyo 192-0015, Japan
ichikawa@cc.kogakuin.ac.jp

Tetsuo Sakamoto
Non Member
Kogakuin University
2665-1 Nakano, Hachioji
Tokyo 192-0015, Japan
ct13087@ns.kogakuin.ac.jp

Abstract – **A fire by tracking is generated occasionally. The cause of tracking is a dust of space between an electrical outlet and a plug. Spark discharges at the space covered with dust are generated when the dust absorbs moisture. A fire caused by tracking is generated by changing the isolated surface between plugs into a carbonized surface. This type of fire of 35 cases occurred at the first half of 2011 in Japan. Such fire occurs in the hidden electrical outlet. Therefore, the determination of the fire, whether the fire occurs, is not so easy in the early stages.**

The experimental objective is to study the preventive measures of fire caused by the tracking. In this paper, we study the difference between an enhanced tracking plug and a normal plug. The experiments are carried out when water is dripped between the electrical outlet and the plugs with dust.

***Index Terms*— tracking, electric outlet and plugs, dust**

I. INTRODUCTION

There is a tracking [1], [2] which is the cause of fire in a home [3], [4]. The tracking caused by discharges at a carbonized part generated between two plugs. The part, which is between an electric outlet and plugs, collects a dust gradually when the cleaning does not carry out. Spark discharges are repeated between two plugs by the adhesion of moisture. Thus, the tracking by the occurrence of discharges occurs.

A fire by the tracking generated between a home electric outlet and plugs is often caused. The fire accident of 50 cases every year is caused. The fire accident does not decrease though we can prevent easily the accident by the cleaning of the outlet and plugs. There is some enhanced plugs for preventing the tracking. However, it is not clear whether the use of the enhanced plugs leads to that the fire accident is prevented completely or not. For this reason, it is needed for the study on the tracking to prevent the fire accident.

The paper reports the comparison of the tracking by the use of normal plugs or enhanced plugs. The experimental study is carried out by the condition that we add 5 drops of water to the space of 5 mm between the outlet and plugs. The space is added with a home dust of 0.1 g. We use the load of 36 W for this comparison. The results show that the tracking by discharges occurs for both cases of the normal plugs and the enhanced plugs.

Table 1 shows fire accidents in Tokyo.

Table. 1 Fire accidents in Tokyo. [5]

(January - June 2011)

Causes	Reasons							
	Total	Heating metal contact	Contact combustible	Short electric wires	**tracking**	Insulation deterioration	others	unknown
Total	442	96	66	57	35	23	156	9
Electric stove	84	2	47	3	-	-	31	1
Electrical outlet	43	37	-	-	2	-	3	1
Electrical cord	25	4	-	13	-	-	7	1
Electric cooker	23	-	2	-	-	-	20	1
Plug	21	3	-	2	14	-	2	-
Inside wire	18	8	-	6	1	-	2	1
Table tap	14	5	-	2	4	1	2	-
Fluorescent light	12	3	-	1	-	7	1	-
others	202	34	17	30	14	15	88	4

Note: Except for arson, playing with fire, vehicle of excluding fires

II. EXPERIMENTAL METHOD

Fig.1 shows the experimental circuit. The experimental circuit consists of a power line of constant 100 VAC, an electrical outlet and plugs, and an electrical load of 36 W. The power line connects a voltmeter and an ammeter in the figure. The ammeter of DMM4040 of Tektronix Co. is used. The electrical outlet and plugs are used of JIS C8282-1 in February 22, 2011. The arrangement of electrical outlet is perpendicular to the surface of the experimental table.

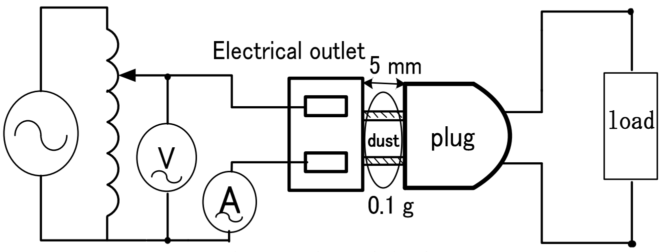

Fig.1 experimental circuit

The arrangement of the plugs is parallel to the surface of the table (see Fig. 2). In the experiments, the normal plugs and the enhanced plugs are used. The enhanced plugs have two electrodes covered with the insulating materials. There are the insulating materials of length 5 mm from the root of electrodes of the plugs.

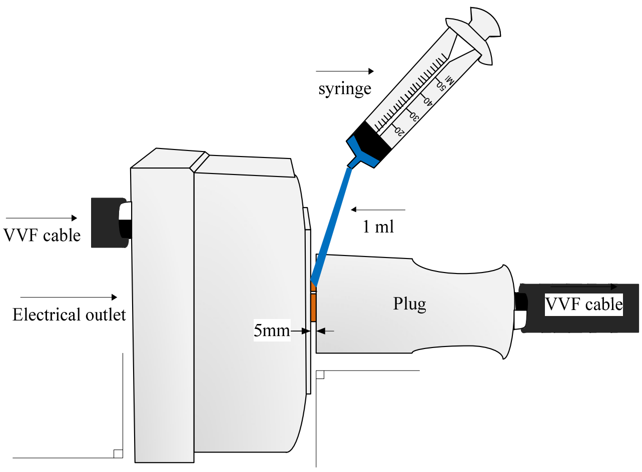

Fig. 2 The representation of the experiment setup

There is a gap length of 5 mm between the electrical outlet and the plugs. The reason, why the gap length of 5 mm is used, is that the length of the insulating materials is 5 mm. This gap is covered with the dust of 0.1 g (see Fig. 3). The liquids of the purified water and the saline solution are used for absorbing moisture in the dust. The liquid of approximately 1 ml, which volume is just 5 drips, drips in the space. Concentration of the saline solution is 3.5%. The plugs connect to the series load of 36 W. The load of a light bulb (36 W) is used.

The atmospheric condition in the room is approximately 5~15 degree and 45~55%R. H.

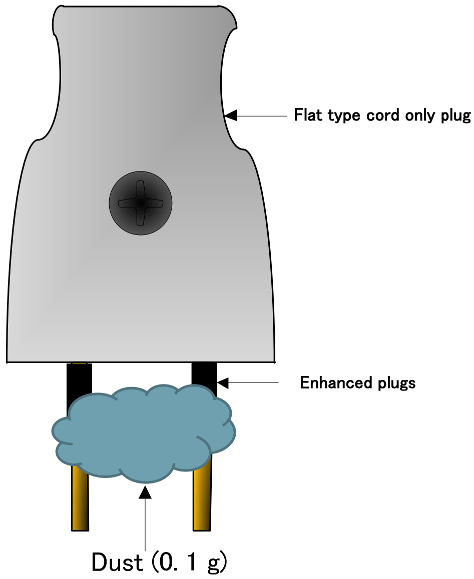

Fig. 3 The dust covered between the outlet and plugs

Liquids used in the experiments are purified water [6] and saline solution. The purified water does not include the impurities.

III. EXPERIMENTAL RESULTS

3. 1 An experiment for the case with the saline solution of 3.5%, the load of 36 W, and normal plugs

Fig. 4 shows the result in values of electrical current measured by using the ammeter when the saline solution of 3.5% drips into the space of 5 mm, which is covered with dust, between an electrical outlet and normal plugs. The load of 36 W is used in the experiments. The value of the current is approximately 0.37 A before the saline solution drips in the dust. The value of the current becomes the value of approximately 2.16 A just when the saline solution drips. Spark discharges occur continuously for 80 sec. after the saline solution drips. The value of the current decreases gradually as the time increases.

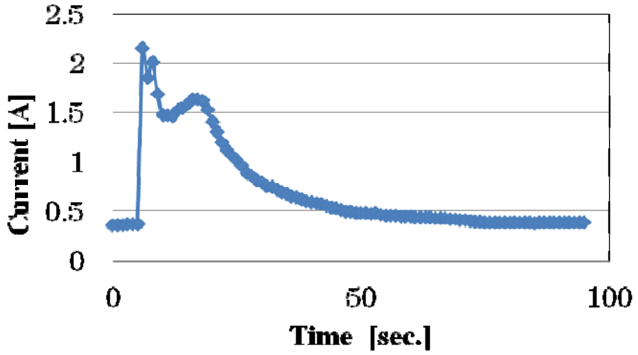

Fig. 4 An electric current of the result for the saline solution of 3.5%, the load of 36 W, and a normal plug when the tracking is generated.

Fig. 5 shows the photograph of the normal plugs at 80 sec. after the experiment is carried out. We can see that a part of the surface of electrode is carbonized. In the photograph, the dust is removed.

Fig. 5 The photograph of normal plugs at 80 sec. when the saline solution drips.

3. 2 An experiment for the case with the purified water, the load of 36 W, and the normal plugs

Fig. 6 shows the result in values of electrical current measured by using the ammeter when the purified water drips into the space of 5 mm, which is covered with dust, between an electrical outlet and plugs. The load of 36 W is used in the experiment. The value of the current is approximately 0.37 A before the experiment is carried out. The value of the current increases gradually after the purified water drips into the dust. The value of the current becomes the peak value of 0.56 A at approximately 100 sec. The value of the current decreases gradually after the value becomes the peak value. The value of the current decreases to the value of 0.37 A at 187 sec.

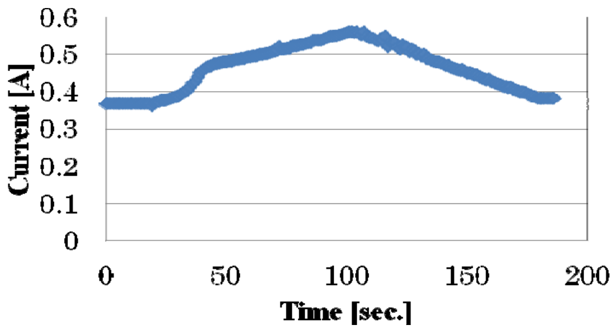

Fig. 4 An electric current of the result for the purified water, the load of 36 W, and a normal plug when the tracking is generated.

Fig. 7 shows the photograph of the normal plugs at 187 sec. after the experiment is carried out. We can see that the part of carbonized surface of the electrode is smaller than the part for the case that the saline solution drips into the dust in Fig. 5.

Fig. 7 The photograph of normal plugs at 187 sec. when the purified water drips

3. 3 An experiment for the case with the saline solution of 3.5%, the load of 36 W, and the enhanced plugs

Fig. 8 shows the result in values of electrical current measured by using the ammeter when the saline solution of 3.5% drips into the space with the dust. The value of the current does not change until 10 sec. The value of the current becomes the peak value of 2.19 A at approximately 11 sec. The value of the current decreases like an inverse proportion curve after the peak value. The value of the current decreases to the value of 0.37 A at 64 sec.

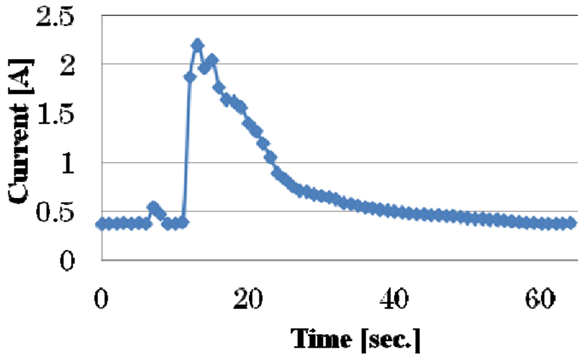

Fig. 8 An electric current of the result for the saline solution of 3.5%, the load of 36 W, and the enhanced plugs when the tracking is generated.

Fig. 9 shows the photograph of enhanced plugs without dust after the experiment. An exposed part of the surface of electrode is carbonized. We can see that the carbonized part is almost similar that in Fig. 5.

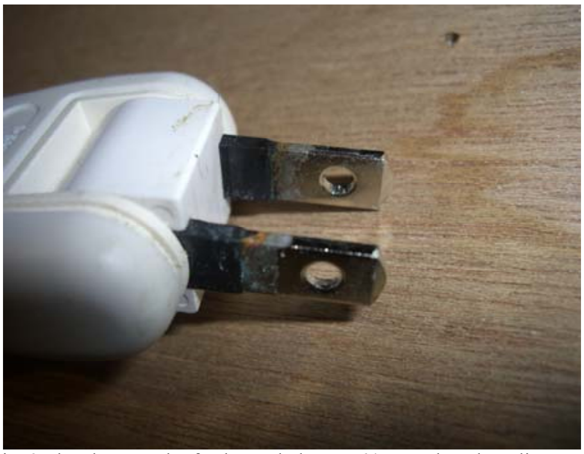

Fig. 9 The photograph of enhanced plugs at 64 sec. when the saline solution drips.

3. 4 An experiment for the case with the purified water, the load of 36 W, and the enhanced plugs

Fig. 10 shows the result in values of electrical current measured by using the ammeter when the purified water drips into the space with the dust. The value of the current is approximately 0.37 A before the purified water drips in the dust. The value is the same value in Fig 4, 6, and 8 before the experiment. The value of the current becomes the peak value of 0.58 A at approximately 70 sec. Any strong discharge is generated sometime when the purified water drips into the dust. The value of the current decreases to the value of 0.37 A at 190 sec.

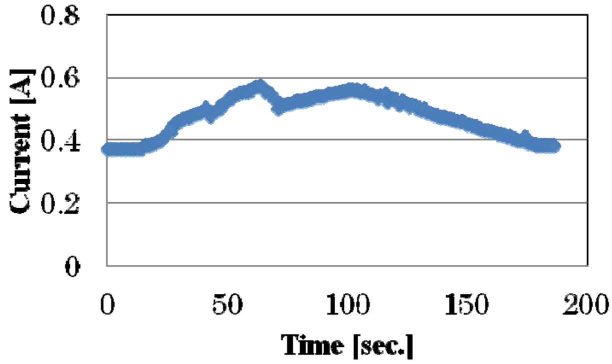

Fig. 10 An electric current of the result for the purified water, the load of 36 W, and the enhanced plugs when the tracking is generated.

Fig. 11 shows the photograph of enhanced plugs without dust after the experiment. There is the carbonized surface that is smaller than that in Fig. 9.

Fig. 7 The photograph of enhanced plugs at 190 sec. when the purified water drips

IV. DISCUSSIONS

Table 2 shows the comparison of results when normal plugs is used. The peak value of the current for the case, that the saline solution drips into the dust, is 2.16 A. On the other hand, the peak value of the current for the purified water is 0.56 A. Thus, the latter is smaller than the former. The reason is that the conductivity of saline solution is higher than that of purified water. The conductivity of the purified water is approximately 5 μS/cm.

The times, when the tracking is generated, are 80 sec. for the saline solution used, 187 sec. for the purified water. The difference of times is the reason that the value of the current by the tracking, when the saline solution drips, is larger than that for the purified water. For this reason, the moisture in the dust with the saline solution vaporizes quickly.

Table 2 The comparison of results when normal plugs are used

	Current before measurement [A]	Peak current [A]	Time of tracking [sec.]
Saline solution	0.37	2.16	80
Purified water	0.37	0.56	187

Table 3 shows the comparison of results when enhanced plugs are used. When we compare Table 2 with 3, the peak value of the current is almost same value. The time, when tracking is generated, differs for the results of both the normal plugs and the enhanced plugs. The reason is that the surface of the enhanced plugs are isolated. The time generated of the tracking for the enhanced plugs used is later than the time for the normal plugs used.

Table 3 The comparison of results when enhanced plugs are used.

	Current before measurement [A]	Peak current [A]	Time of tracking [sec.]
Saline solution	0.37	2.19	64
Purified water	0.37	0.58	190

V. CONCLUSIONS

We can summarize the results of this study as follows.

(1) When a tracking is generated, the peak value of the current for the normal plugs used is almost equal to that for the enhanced plugs used. The peak values for both two cases become the same values when the gap length between an electrical outlet and plugs is 5 mm. The peak value of the current for the saline solution used is larger than that for the purified water.

(2) If the gap length between the electrical outlet and the plugs is 0 mm, the tracking does not occur though the saline solution drips into the dust. The reason is that the surface of electrodes is not exposed and the surface is covered with the isolated material. Therefore, we can prevent the tracking if the enhanced plugs are used for the gap of 0 mm.

VI. REFERENCE

[1] Makoto Tubaki, Hiroki Nakagawa, Masanori Iwanami, Hironobu Nakano"Experimental Considerations of Tracking Phenomena of Wiring Devices", Bulletin of Japan Association for Fire Science and Engineering, Vol. 55, No. 2, pp. 33-39, 2005

[2] NITE National Institute of Technology and Evaluation Tracking phenomenon of the power plugs http://www.town.nonoichi.lg.jp/data/open/cnt/3/3277/1/3puragu.pdf

[3] MIC: Ministry of internal affairs and communications Fire Department April 23, 2011 http://www.fdma.go.jp/neuter/topics/houdou/2304/230428_3houdou/01_houdoushiryou.pdf

[4] Tokyo Fire Department : "Characteristics of fire accidents in 2011" (in Tokyo, Japan) http://www.tfd.metro.tokyo.jp/saigai/toukei/h23/d4/01.html

[5] Tokyo Fire Department: Public relations Subject (No. August 2011) http://www.tfd.metro.tokyo.jp/camp/2011/201108/camp1.html

[6] Masahiro Yagi, Yukio Mizuno, Toshiyuki Nakagawa, "Proposal of Detection Method of Leakage Current Between Electrodes of a contaminated and Wetted Cord Plug by Superimposed High Frequency Signal" IEEJ Transactions on Fundamentals and Materials, Vol. 128, No. 6, pp. 427-433, 2008