표면조건에 따른 에폭시/고무 계면의 V-t 특성에 관한 연구

배덕권, 김충혁*, 오용철*, 김진사*, 신철기*, 이성일
충주대학교, 광운대학교*

Study on the V-t Characteristics of the Interface between Epoxy and Rubber According to the Condition of Surfaces

Duck Kweon Bae, Chung-Hyeok Kim*, Yong Cheul Oh*, Jin Sa Kim*, Cheol Gee Shin*, and Sung Ill Lee
Chungju National University, Kwangwoon University*

Abstract: In this paper, AC dielectric strength of the interface between Epoxy and EPDM (ethylene propylene diene terpolymer) was investigated. Air compress system was used to give pressure to the interface. Specimens were prepared in various ways to generate different surface conditions for each type of interface. Increasing interfacial pressure, decreasing surface roughness and spreading oil over surfaces improve the AC interfacial dielectric strength. Especially, the dielectric strength was saturated at certain interfacial pressure.

Key Words : macroscopic interface, interfacial pressure, roughness of interface, dielectric strength

1. Introduction

Cable jointing devices and accessories are weak-link in the practical underground power delivery systems. In Korea, about 40% of underground power transmission line failure is related with cable joint devices and accessories. Because most high voltage insulation systems consist of different materials forming composite insulation, the macroscopic interfaces are existed in the systems.

The interfacial breakdown between two internal dielectric surfaces is a main cause of failure in multiple insulation systems [1].

The interfacial dielectric breakdown is a complex phenomenon, and interfacial discharges leading to a dielectric failure and space chargeformation due to different permittivities of the contacting dielectrics are main causes of breakdown [2].

Many factors can affect the dielectric performance of an interface [3]. Among these factors interfacial pressure plays a major role in interfacial dielectric strength. In order to better understand this phenomenon, breakdown experiments were performed on the interface between Epoxy and EPDM pressed one against the other. To archive this, interfacial dielectric strength tester with air-compress system was prepared.

2. Experiment

The specimen consists of Epoxy and EPDM. Epoxy is Bisphenol-A liquid type resin [100phr] + MeTHPA (Methyl tetra Hydro Phthalic Anhydride) [100phr]. EPDM is an industrial manufacture.

The glass transition temperature of Epoxy and EPDM is 90 100[℃] and -60[℃] respectively. In other words, EPDM is a material has elasticity at operation temperature, but Epoxy is not. Cavitiesof elastic materials are easily reduced by pressure. So surface condition of Epoxy is likely to affect electric properties of interface more.

The manufacturing process is shown in Fig. 1. After 1st curing, specimens were sanded with sandpaper, and electrodes were molded. And then 2nd curing was carried out.

Test method was selected according to short-time test(current setting: 10[mA], rate-of-rise: 500[V/s]) of ASTM D 149-95a(Dielectric breakdown voltage and dielectric strength of solid electrical insulating materials at commercial power frequencies). Fig. 2 shows the structure of the interfacial dielectric strength tester. Interfacial dielectric strength tester was made of Teflon and Acetal. Air-compress system was used to press the specimens.

3. Experimental Results and Discussions

Fig. 3 presents variation of the interfacial AC dielectric strength due to interfacial surface condition at room temperature. Specimens were sanded with various sandpapers(# 200, #400, #600, #1200). Applied interfacial

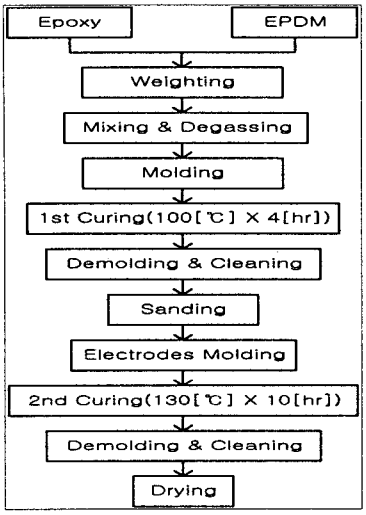

Fig. 1. Manufacturing process of Epoxy specimen

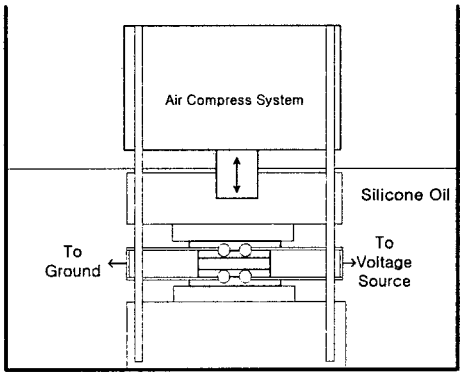

Fig. 2. Interfacial dielectric strength tester

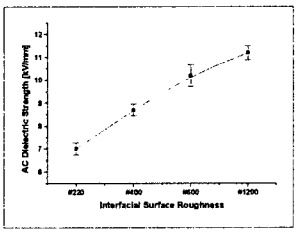

Fig. 3. AC dielectric strength versus interfacial surface roughness

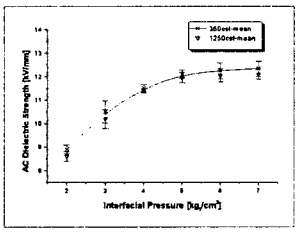

Fig. 4. AC dielectric strength versus interfacial pressure and spreading silicone oil over surfaces

pressure was 5[kgf/cm^2].

There are many results concerned with this factor. According to the decreasing of surface roughness, dielectric strength is increased[5] or decreased[6]. It is because of the difference of electrode's structure and materials. When surface roughness was decreased, AC dielectric strength of interface between Epoxy/EPDM increased in this investigation.

In the interface between Epoxy/EPDM, many defects exist such as void, unevenness, conductive contaminant, water and so on. According to the decreasing of surface roughness, quantity of voids and unevenness is reduced and the concentration of electric field to the unevenness is relieved, and then pre-breakdown discharge may be suppressed.

AC dielectric strength due to variation of pressure and silicone oil spreading over surfaces at room temperature is similar to 2., as shown in fig. 4.

Low viscosity silicone oil(350[cst]) and high viscosity silicone oil(12500[cst]) were spread over sanded surfaces with #1200 sandpaper. Oiling plays an important role in eliminatingcavities at interfacial surface.

However, high viscosity silicone oil spreading may make voids at interface because of its poor flowage. So low viscosity oil spread specimens have higher dielectric strength than high viscosity oil spread specimens.

Interfacial AC dielectric strength at 5[kgf/cm2] is 12.1[kV/mm](350[cst]) and 11.95[kV/mm](12500[cst]).

4. Conclusion

In this study, the interfacial AC dielectric strength depends on interfacial pressure, surface roughness and spreading oil greatly.

1. Pressure increasing and Roughness decreasing reduce volume and number of cavities, moreover, pressure increasing improves the discharge inception voltage of air or gas in cavities.
2. Spreading oil over surfaces provides a good cavity -filling function.
3. AC dielectric strength is improved by increasing of interfacial pressure, decreasing of surface roughness and spreading oil over surfaces. Especially, It is saturated at certain interfacial pressure level.

References

[1] Katsumi Uchida et al. " Study on Detection for the Defects of XLPE Cable Lines" IEEE Trans. on Power Delivery, Vol. 11, No. 2, April 1996

[2] C. Dang and D. Fournier, "A study of the interfacial breakdown in cable joints," 1994 Annual Report of Conference on Electrical Insulation and Dielectric Phenomena, Arlington, Texas, USA, Nov. 23-26, 1994, pp. 518-523

[3] C. Dang and D. Fournier "Dielectric Performance of interfaces in Premolded Cable Joints", IEEE Trans. on Power Delivery, Vol. 12, No. 1, January 1997