Resin-Encased, Metallized, Humidity-Resistant Film Capacitor, "MKCP4T"

Chie Kaneko　*Yuji Ogawa*
Capacitor R&D Dept.,
Advanced Battery & System Development Center,
R&D Headquarters

Kengo Suzuki
Design Dept., Haga Works　Manufacturing Div.,
Hitachi AIC Inc.

1 Abstract

In recent years, an increasing number of renewable energy systems now use film capacitors, which last longer than aluminum electrolytic capacitors, for their DC link circuits. Today, there is a growing need for film capacitors that meet the UL-94 flammability standard's V-0 rating, and that are long-lasting and humidity-resistant.

Achieving both flame retardancy and humidity resistance is difficult, because a side effect of adding flame retardants to resin is a decrease in humidity resistance. Lower humidity resistance allows moisture to enter the capacitor, which in turn can shorten the capacitor's lifespan. As such, there is a need to improve the case and filler resin of encased film capacitors.[1)]

To this end, we developed the new MKCP4T series of capacitors that use thinner dielectric film, as well as a new outer case and epoxy resin. These adaptations allow MKCP4T capacitors to achieve both flame retardancy and humidity resistance, with specifications of 1,000 hours at 85℃ and 85% RH, guaranteed.

2 Characteristics of the Product

- Resin-encased film capacitor that offers both humidity resistance and flame retardancy, and that is suitable for DC link circuits used in high-humidity environments.
- Guaranteed specifications of 1000 hours at 85℃ and 85% RH.
- Outer case and filler resin that meet the UL-94 V-0 rating for flame retardancy.

3 Background of the Development

Usually, DC link circuits use aluminum electrolytic capacitors that have a large electrostatic capacity per unit volume. Disadvantages of aluminum electrolytic capacitors include a large dielectric loss tangent (tan δ) and a short actual service life of 5 to 10 years. In contrast, while film capacitors have a smaller electrostatic capacity relative to aluminum electrolytic capacitors, film capacitors offer the advantages of a small tan δ and a longer actual service life of 10 to 15 years. For these reasons, recent years have seen an increase in the use of film capacitors in DC link circuits. In particular, the use of such capacitors has increased in the field of renewable energy, as a way to conserve the time and money spent maintaining devices. As such, there is demand to further extend the actual service life of film capacitors to 20 to 25 years.

There is also strong demand for flame-retardant film capacitors. However, it is difficult to simultaneously improve flame retardancy and extend the service life, as these properties have a trade-off relationship. In this paper, we examine how to make resin-encased film capacitors flame-retardant while also extending their service life. To evaluate these properties, we performed a high-temperature and high-humidity bias test (THB test) at 85℃ and 85% RH. This test is an accelerated test that allows us to estimate the actual service life. A result of 1,000 hours under these test conditions corresponds to an actual service life of 20 years.[2)]

4 Technical Details

The MKCP4T series we developed uses parts with improved humidity resistance, which helps prevent moisture from entering the capacitor and in turn guarantees specifications of 1,000 hours at 85℃ and 85% RH. **Table 1** lists the capacitor's specifications. A polyphenylene-sulfide (PPS) material that helps prevent the infiltration of moisture is used for the outer case. (See **Figure 1**.) As a new sealing resin, we used an epoxy resin, which offers both humidity resistance and flame retardancy. In addition, by using a thinner dielectric film, we were able to miniaturize the condenser parts and increase the amount of filler resin, helping to prevent moisture from entering the device.

By applying the newly developed MKCP4T series, we achieved a capacity change rate of under ±5% after 1,000 hours of THB testing. (See **Figure 2**.)

Table 1 Specifications

Item	Description		
Operating temperature	−40 ～ +105℃		
Rated voltage UN	700 Vdc	900 Vdc	1100 Vdc
Capacitance	15 ～ 80 μF	9 ～ 40 μF	6 ～ 30 μF
Dimensions［T×H×L］	21.5 mm × 38.5 mm × 43.0 mm ～ 35.0 mm × 60.0 mm × 57.5 mm		
Capacitance tolerance	±10%		
Dielectric	Polypropylene		
Humidity resistance	85℃ 85% RH with UN, 1000 h, ΔC ≤ ±5%		
Standards	IEC61071：2007		
Electrode	No internal safety device		
Case and filling material	UL94V-0		
Environmental regulation	Comply with RoHS		

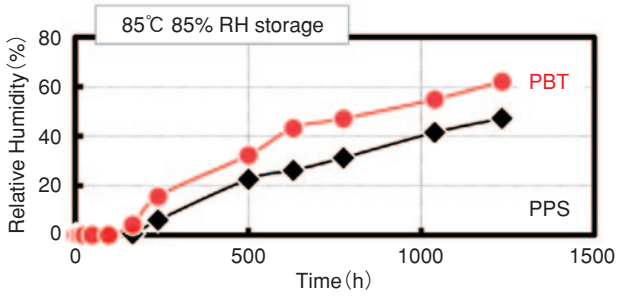

Figure 1 Moisture infiltration results

＊preparation
Embed temperature sensor to PPS and PBT cases and scaled with epoxy resin
＊Testing
Place samples in high temperature / humidity oven (85℃ 85%)
Calculated water penetration amount by sensor value

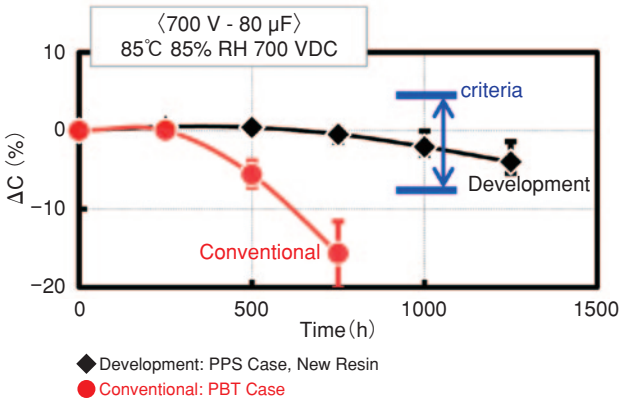

Figure 2 THB test results

5 Future Business Development

- Additional of products with a rated voltage of 450 V.
- Addition of large products of at least 45 mm in thickness and 80 mm in height.
- Development of products with guaranteed specifications of 1,500 hours at 85℃ and 85% RH.

【References】

1) Masatoshi Ichi, Yukihiro Kiuchi, "Flame proofing of epoxy resin using new mechanism," Material Life Society Journal 15 [2], pp. 56–60 (Apr. 2003)
2) Renesas Electronics Corporation, Reliability Handbook, Rev. 2.50, p. 45 (Jan. 2017)