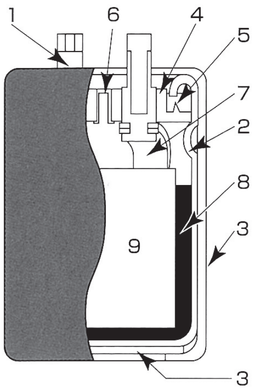
I. STRUCTURE, CHARACTERISTICS AND FAILURES OF ALUMINUM ELECTROLYTIC CAPACITORS

1．Diagram of internal structure of aluminum electrolytic capacitors



No.	Parts name	Materials
1	Terminal	aluminum
2	Case	aluminum
3	Exterior material	PVC, PET Polyolefin
4	Insulation Cap	Phenol
5	Rubber ring	EPT
6	Vent	Silicone rubber
7	Leads	aluminum
8	Fixing compound	Petroleum pitch
9	Element	See Fig.2

Fig.1 Diagram of Internal Structure (Screw terminai type)

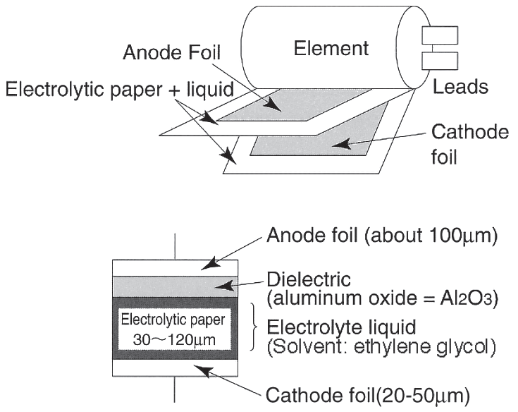


Fig.2 Diagram of Device and Basic Structure

2．Meanings of terms

① Working voltage (W.V.) and surge voltage (SV)

W.V. is the voltage that can be constantly applied while SV is the maximum voltage (450SV at 400W.V.) that can be withstood for a short period of time (30 seconds according to JIS C 5101-4).

② Permissible tolerance in electrostatic capacitance

The allowable range of dispersion in electrostatic capacitance. Aluminum corrodes the electrodes (etches), which increases the amount of surface area and causes the dispersions.

③ Equivalent Series Resistance

The Equalizer Series Resistance puts together electrical resistance of anode and cathode foils, electrolytic fluid resistance, and contact resistance of each connecting section.

④ Tangent of loss angle (generally called Tan delta (tan δ))

When current is placed on an ideal capacitor, the current moves ahead 90 degrees in phase from the voltage. However, because some loss occurs in the general capacitor, the forward angle of phase is 90° − δ). The δ is called dielectric loss. Tan δ is obtained by the following formula.

$$\tan\delta = \omega CR$$

ω : $2\pi f$ [f= frequency (Hz)]
C : electrolytic capacitance (F)
R : Equivalent Series Resistance (Ω)

⑤ Impedance [Z]

Resistance in an AC circuit $|Z| = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}$

R : Equivalent Series Resistance (Ω)
C : electrolytic capacitance (F)
L : inductance (H)
ω : $2\pi f$ [f = frequency (Hz)]

⑥ Leakage current (generally called LC)

DC current will not flow in an ideal capacitor after it has been completely charged with DC Current But, in the real, dielectric resistance is not infinite and a micro-current will flow through the capacitor. Electrolytic capacitors in particular can be damaged during processing by oxide film and when that is recovered the micro-current will flow.

3. Manufacturing processes for aluminum electrolytic capacitors

① Etching (expanding surface area)
The processing for expanding the surface of aluminum foil.
High purity aluminum foil, 500mm wide and 0.1mm thick is continuously processed electrochemically by flowing direct current through a chlorine bath solution. The surface area is expanded 50- 100 times for low-voltage use capacitors and 10-40 times for medium to high-voltage use capacitors.

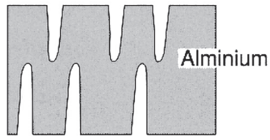


Fig.3 Diagram of etching model

② Forming (dielectric formation)
The process of forming the dielectric (Al_2O_3).
The dielectric is formed in a continuous electrochemical process by passing a voltage that is 120-200 percent of the working voltage through etched aluminum foil that is in a bath of boric acid ammonium. The dielectric is extremely thin, about 14Å/V.

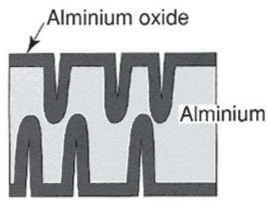


Fig.4 Diagram of formation model

③ Slitting
The formed aluminum foil (anode foil), cathode foil and electrolytic paper are slit according to the product size.

④ Winding
Electrolytic paper is inserted between the slit anode foil and the opposite cathode foil and rolled into a tube. Leads are connected because both electrode foils are concerted to a terminal. To prevent mechanical contact between the anode and cathode electrode foils, the electrolytic pass functions to hold the electrolytic liquid which is a cathode electrode.

⑤ Impregnation
The process of inserting the electrolytic liquid into the device by pressurization and depressurization.
The electrolytic fluid is uses such things for solvents as boric acid and organic acid ammonium with ethylene glycol as the main medium. These have a very big effect on the life, frequency characteristics, range of operating temperature and temperature characteristics of the capacitor.

⑥ Assembly
After making holes on lead tab insulation cap are connected to lead.

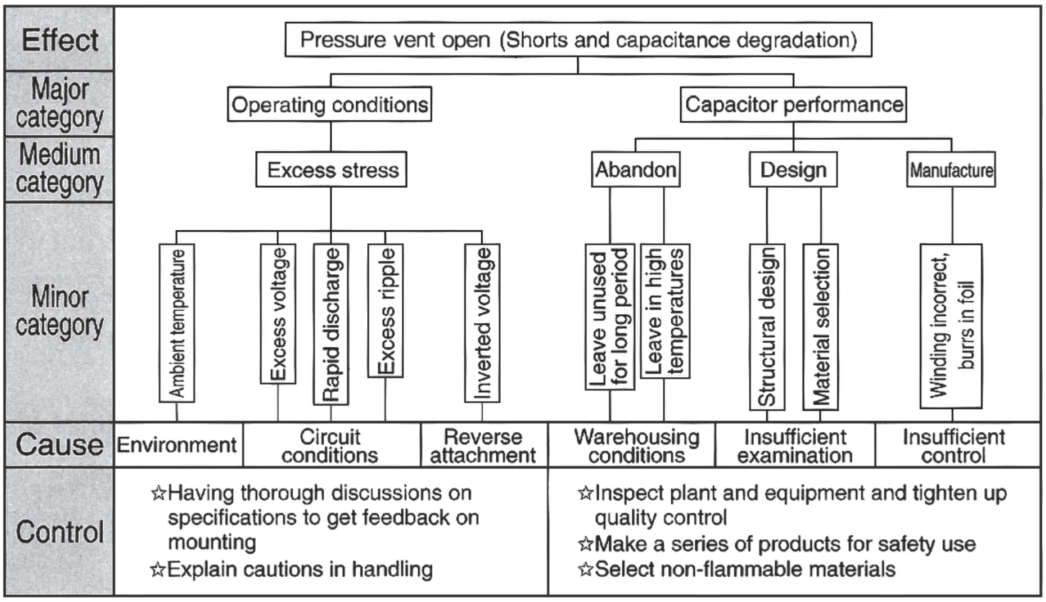
⑦ Sealing
The impregnated device is sealed by an aluminum case and sealant to keep it airtight.

⑧ Reforming (aging)
This is the process of applying voltage at high temperature to debug, to form the dielectric that has been damaged during assembly and to shear the anode foil during slitting.

⑨ Inspection of all parts
Inspection is made of the external appearance and the electrical characteristics of all aged parts.

⑩ Sampling, packaging and shipping
An inspection is made according to fixed sampling standards and the capacitors that pass the inspection are packed and shipped. Detailed tests are made periodically to check quality.

4. FTA map of failures



Ⅱ. NOTES TO USERS OF ALUMINUM ELECTROLYTIC CAPACITORS

1. Operating environment

(1) Water, saltwater, oil or other electrically conductive liquid on a capacitor, or using a capacitor when it is damp with dew may cause a failure. Oil on the rubber seal or safety vent may cause a decline in airtightness. Do not use any capacitor in contact with liquid. Do not use capacitors that have been immersed in rainwater or other contaminated water.

(2) Do not use or leave a capacitor in areas where there is halide compound gas such as hydrogen sulfide, nitrous acid, sulfurous acid, chlorine and bromine, or ammonia or other hazardous gas. The ingress of any of these gases into a capacitor may corrode it.

(3) Do not use or leave a capacitor in an area exposed to ozone, ultraviolet light, or radiation.

(4) Powders (dust, etc.) that settle between terminals can absorb moisture and cause corrosion and tracking of the terminal. When there is conspicuous dust between terminals, stop the current, allow the capacitor to discharge, and wipe the terminals with paper or a towel lightly dampened with water or ethanol. Do not use cleaning agents or other chemicals.

(5) Do not use a capacitor in an area subject to excessive vibration or impact.

2. Operating conditions

2-1 Operating temperature, ripple current

(1) Check the operating and installation environment and use the capacitor within the range of the rated performance specified in the catalog or specifications.

(2) Maintain operating temperature and ripple current within the specified ranges. Base your choice of capacitors on the maximum load conditions. A capacitor will overheat under excessive current, potentially resulting in short circuit, fire, or other major failure.

(3) A capacitor also generates the self heating. Please bear in mind that the capacitor heats up the interior of the equipment, and take appropriate precautions. Operate the unit under normal conditions and check the temperature of the area surrounding the capacitor.

(4) The permissible ripple current declines with the rise in ambient temperature (the temperature of the capacitor's surroundings). Consider the permissible ripple current at the maximum predictable ambient temperature.

(5) Electric characteristics change as frequencies change. Check frequency changes in order to choose the right capacitor. Special attention needs to be given to the self heating and short life time both low and high frequency, when equivalent series resistance and inductance change.

2-2 Applied voltage and other operating conditions

(1) In general, capacitors have polarity. Applying reverse voltage or AC voltage to a capacitor may activate the vent or cause a short circuit, fire or other major failure.

(2) Use a bipolar capacitor for circuits whose polarity reverses. However, as in any other case, do not use a bipolar

capacitor in an AC circuit. Use a special AC capacitor for AC voltage.

(3) Do not apply voltage in excess of the rated voltage. When an AC voltage is superimposed on DC voltage, prevent the peak value from exceeding the rated voltage. Excessive voltage may cause a short circuit, fire, or other major failure.

(4) Specifications on surge voltage have restricted conditions and therefore do not guarantee long hours of operation. Voltage should never exceed the rated voltage of the capacitor, even for brief periods. Choose your capacitor accordingly.

(5) When connecting more than one capacitor in parallel, give proper consideration to the resistance of the wiring. Establish the connections so that the wiring resistance will be equal at every capacitor.

(6) When connecting more than one capacitor in series, all must be of identical rating, then the balancing resistors connected in parallel. At that time, design the circuit so that equal voltage levels are applied to all the capacitors. Ascertain that the voltage applied to each individual capacitor does not exceed its rated voltage.

(7) Take into account the service life of the equipment in the use of the capacitor. Use of the capacitor beyond its service life risks such failures as safety vent activation or short circuit. Replace as necessary at regular inspection.

(8) Do not use a capacitor for a circuit that is quickly charged and discharged repeatedly. Use a dedicated capacitor for an application like a welding unit or photo flash charging/discharging. Consult us for selecting the proper capacitor, since the control circuits of certain rotation equipment, like servo motors, charge and discharge repeatedly.

(9) Even slow charging/discharging can shorten the service life of a capacitor, resulting in premature failure, where there are marked changes in voltage changes. Check the installation in your equipment carefully and consult us.

(10) General purpose capacitors should not be used for a circuit involving rapid charge and discharge or an AC circuit. Capacitors specially made for such applications should be used. → Check the self heating of the capacitor used in such a circuit in addition to the types and levels to be imposed to the capacitor of the rapid charge/discharge, rush current and voltage.

(11) The circuits described as examples in this catalog and the "delivery specifications" are featured in order to show the operations and usage of our products, however, this fact does not guarantee that the circuits are available to function in your equipment systems. We are not in any case responsible for any failures or damage caused by the use of information contained herein. You should examine our products, of which the characteristics are described in the "delivery specifications" and other documents, and determine whether or not our products suit your requirements according to the specifications of your equipment systems. Therefore, you bear final responsibility regarding the use of our products. Please make sure that you take appropriate safety measures such as use of redundant design and malfunction prevention measures in order to prevent fatal accidents and/or fires in the event any of our products malfunction.

3. Installation

3-1 Before installation

(1) Check the specifications of the capacitors, and install them within the prescribed specifications.

(2) Do not reverse the polarity. Do not use a capacitor where reverse voltage is applied, even if it appears problem-free. Not taking these precautions could lead to a major failure.

(3) Dropping or otherwise impacting a capacitor may result in a decline in its electric performance, causing a failure. Do not use any capacitor whose packaging has a noticeable abnormality on delivery.

(4) Do not distort the shape of the capacitor, which may lead the major failures such as liquid leakage or short circuit.

(5) Do not reuse a capacitor that has previously been installed on a machine and energized. No capacitor can be reused (with the exception of removal for measuring electrical performance during periodic checkups).

3-2 Installation method

(1) Do not install wiring or a circuit pattern near the vent. When the vent is activated, electrolyte may spurt out, resulting in short circuit followed by fire or other secondary hazard due to tracking or migration.

(2) Do not lay out heat-generating components near the capacitor. Radiated heat and other partially high temperatures may shorten the life of the capacitor. PCB temperature that is higher than the internal temperature of the capacitor markedly hinders the dissipation of heat inside the capacitor, greatly shortening its life. When designing equipment, check temperature distribution first.

(3) When installing the vent of the capacitor against the PCB, drill a gas bleeder hole to allow the gas to escape when the vent is activated. If the diffusion of gas is hindered while the vent is in operation, the internal pressure can rise, with danger of explosion, fire or other serious failure.

3-2-1 Snap mount type capacitors, Radial type capacitors

(1) When fixing with the snap mount type capacitors had two claw terminal and the length of the capacitor more than 55 mm to PCB, use adhesive glue.

(2) Do not connect the blank terminal (reinforced terminal) of multi-terminal (3-, 4-) snap mount capacitors, as this could cause a short circuit.

(3) Use a completely isolated circuit between the case and the electrode terminal, and between the case and the circuit pattern.

(4) Do not hinder the activation of the vent. Allow for the following clearance above the vent. If dissipation of gas is inhibited while the vent is in operation, the inner pressure will rise, with danger of explosion, fire or other major failure.

Capacitor diameter	Clearance
φ 10 ～ 16	2mm or more
φ 18 ～ 35	3mm or more
φ 40 or more	5mm or more

(5) Exterior sleeves are for labeling purposes, not for insulation. Consult us if you need insulation.

(6) Failure to tightly solder the capacitor to the PCB may result in one of its terminals breaking or its pattern peeling off due to vibration. Insert the capacitor snugly and correctly into the designated holes in the PCB, then solder it.

(7) Terminal pitch and dimensions for the terminals are specified for a capacitor. → Check whether the terminal pitch and the mounting holes on the board match properly. The electrolyte leaks from inside if mismatched.

(8) Solder at 260℃ for not more than 10 seconds (In the case of dip) or at 380℃ for not more than 3 seconds (In the case of tip of iron). Exceeding these specifications may result in a decline in electrical performance, leading to trouble. Do not let the tip of the soldering iron come in contact with the capacitor body.

(9) If it becomes necessary to remove a capacitor after soldering, melt the solder with a soldering iron to avoid subjecting the terminals to stress.

(10) Flux on the rubber seal may result in corrosion. Do not let flux stick to any part other than the terminals.

(11) Some cutting oils contribute to swelling of rubber, with the risk of corrosion and a decline in air-tightness. If the rubber surface will be exposed to cutting oils, use washable capacitors.

(12) Do not twist or otherwise physically move the capacitor after soldering it to the PCB. Do not take hold of the capacitor to move a PCB either, as this may deform the terminal or decrease its air tightness.

(13) Do not apply physical impact to the capacitor (striking, etc.) after it is soldered to a PCB. When stacking PCBs, make sure that the capacitors don't contact PCBs or other components.

3-2-2 Screw-terminal type capacitors

(1) Don't turn cap face to downward. If a capacitor is installed sideways, please put anode terminal or vent upward.

(2) Recommended tightening torque and terminal permissible current (maximum current a terminal can withstand) for each terminal screw are listed below. Consult us if you wish to use a capacitor on a machine that vibrates significantly.

Terminal	Recommended torque(permissible level) [N.m]	Terminal permissible current [A]
M 5	2.2 (1.5 ～ 3.0)	60
M 6	3.5 (3.0 ～ 4.0)	100
M 8	7.5 (7.0 ～ 8.0)	120

(3) Refer to page 21 for recommended clamping value of the bracket.

(4) The terminal screws (M5 standard under head: 10mm, M6 standard under head : 12mm, M8 standard under head : 16mm) in the separate package are designed for wire thickness not exceeding 2mm. Add to the screw length for wires more than 2mm thick. Heat generated due to a small screw clamping area could cause a failure.

(5) If a screw is loose or angled, that portion generates heat, with a danger of fire or other serious failure. Check that the screw is inserted on the perpendicular and securely tightened.

(6) Recommended a bar hole diameter for M5, M6, M8 terminals are listed below. An excessively large hole diameter may result in poor contact between the terminal surface and the bar, causing local heat buildup, with a danger of fire or other serious failure.

Terminal	A bar hole diameter
M5	φ5.5
M6	φ6.6
M8	φ9

(7) Do not apply physical stress (tightening with fixtures, etc.) to the curled portion (seal contacting the case and cap). Any such practice may cause a liquid leak or sleeve breakage.

4．About washing PCB and fixative

(1) In washing, please avoid using a material which destroy the ozone layer.

(2) For cleaning flux, we recommend an aqueous or higher alcohol detergent or isopropyl alcohol. The recommended concentration of flux with regard to the cleaning agent is 2wt% or less. Excessively high flux concentration may cause corrosion due to halide. For use of other cleaning agents, consult us.

(3) If you must clean the capacitor with halogen solvents, etc., we recommend that you use washable capacitors. Make sure that the cleaning conditions are within those stipulated in the specifications, and measure the cleaning agent for conductivity, pH, specific gravity and moisture content for contamination control. After cleaning, thoroughly dry the capacitors together with PCBs. Do not store the capacitors in the same atmosphere as the cleaning agent or in a sealed container. For details on washable capacitors, consult us.

(4) Thoroughly remove all traces of the cleaning agent from the capacitor. Even when not cleaning the flux, dry the flux itself. Cleaning agent or flux residue may cause the halide to penetrate the rubber seal, leading to corrosion.

(5) When fixing a PCB and capacitor with a coating agent or fixative, use a substance completely free of halide compounds. Thoroughly dry the flux or detergent before applying the coating. Do not let the coating block the entire surface of the seal. Any halide compound present in the coating may lead to corrosion.

5．Storage

(1) Store all capacitors indoors at a temperature of 5-35℃ and relative humidity of not more than 75%RH (25℃), away from direct sunlight. Store capacitors in their original packaging whenever possible.

(2) The maximum shelf life of capacitors is 3 years. The maximum shelf life of capacitors for snap mount capacitors is 2 years using leadless soldered terminals, beyond which solderability deteriorates.

(3) All capacitors which have been on the shelf for more than 2 years have an excessively high leakage current. Treat them with appropriate voltage before using. As treating method, it is used current density less than specified leakage current in room temperature.

Firstly, 80% of rated voltage applied and keep 1 hour after reaching 80% of rated voltages.
Secondarily, 90% of rated voltage applied and keep 1 hour after reaching 90% of rated voltages.
Finally, 100% of rated voltage applied and keep 1 hour after reaching 100% of rated voltages.

(4) Even after discharged, capacitors may hold an electrical charge due to re-striking. Do not touch the terminals with bare hands. Touching the terminals could cause an electric shock. Discharge all capacitors with a resistor (approx. 1kΩ) or a discharge plate before use.

6．About fumigation

(1) To control insects during export, fumigation may be done using halide compounds such as methyl bromide. Direct fumigation of capacitors or equipment incorporating capacitors or use of fumigated timber as a pallet may cause corrosion inside a capacitor, resulting in failure. Even when covered in plastic, chemicals may penetrate through small gaps. Likewise, do not apply insecticides directly on or near the capacitors.

(2) When using a sterilizer against infectious diseases, do not spray it directly on or close to capacitors and equipment incorporating capacitors. Some sterilizers contain a high concentration of halide compounds. The sterilizer spray may accelerate internal corrosion, resulting in failure.

7．Miscellaneous

7-1 Maintenance and servicing

(1) Conduct periodic checkups on capacitors for industrial equipment. Before each periodic checkup, turn off the equipment and completely discharge the capacitor.
following these checkpoints:
① Appearance: Condition of the vent (open, notably swollen), liquid leaks or other considerable abnormality
② Electrical performance: Capacity, tangent of loss angle, leakage current, and other items specified in the delivery specifications.
The standard temperature for measuring electrical performance is 20℃. Leave the capacitor at 20℃ and wait for the inside of the capacitor to reach the specified temperature before taking measurements.

(2) Please ask us the advisability of using capacitor which is inspected.

(3) Replace all capacitors whose service life has reached its end. When replacing one capacitor, always replace all of them. Mixing old and new capacitors may cause an imbalance in the ripple current or voltage sharing, risking failures such as activation of the vent or short circuit.

7-2 In an emergency

(1) If gas is detected while a product is in use, turn off the main power supply or unplug it.

(2) When the safety vent of a capacitor is activated, a hot gas exceeding 100℃ will escape. Do not place your face in close proximity to the vent and avoid proximity to areas exposed to the gas.

(3) Should the gas jet get in your eyes, wash them immediately with clean water. If you inhale the gas, gargle immediately. The gas is composed of a gaseous form of hydrogen or organic solvents.

(4) Should the electrolyte come in contact with your skin, wash with soap and water. Never put it into your mouth.

7-3 For scrapping

(1) Scrapped capacitors are classified as scrapped metal. For burial they are handled as controllable industrial waste because of the nature of the contents (electrolyte). Commission an industrial waste disposal specialist for their disposal. Ensure that no waste products enter the market.

(2) Most of the material is aluminum and cannot be completely burned. In incineration, take the following into consideration:

- Burning the capacitors in an airtight state may cause an explosion. Before incinerating, either pierce the exterior or break them open. Be sure to wear protective clothing during this operation, since electrolyte or gas will jet out if the inner pressure of the capacitor is high.
- Because of the exterior material (polyvinyl chloride), low-temperature incineration may emit hazardous gases. Burn the material at high temperatures (800℃ or above). Incineration requires separation of the exterior materials.

(3) Do not attempt to crush the capacitors, as this may cause electric shock or injury.

7-4 Remarks

For details, see the Guidelines on the Operation of Fixed Aluminum Electrolytic Capacitors for Electronic Equipment EIAJ RCR-2367B March, 2002 issue.

Ⅲ. Service Life of an Aluminum Electrolytic Capacitor

1. Factors affecting service life

Environmental factors affecting the service life of an aluminum electrolytic capacitor include temperature, humidity and vibration (environment), as well as electrical factors, applied voltage, ripple current and charging/discharging conditions. In capacitors for mid-to-high-voltage filters, temperature and applied voltage are the most important controlling factors. The estimated service life may be calculated based on the core temperature of the capacitor and the applied voltage.

1-1 Temperature conditions

Capacitance change or tangent change for loss angle indicates that the product life has been affected by temperature. Generally, as the ambient temperature (neighboring temperature of the capacitor) increases, capacitance decreases and tangent change for loss angle takes place more rapidly. This is mainly because electrolytic solution generates gas due to electrode reaction and diffuses it outside via a sealing rubber. The following expression (1) indicates the relation between the ambient temperature and electric characteristic that changes with time (while the capacitor is used normally according to the rules of serviceability).

$$L = L_0 \times 2^{\frac{T_0 - T}{10}} \quad \cdots (1)$$

Where,

L : Estimated service life in actual use

L_0 : Standard service life when allowable ripple current load or rated voltage is applied at the maximum operating temperature

T_0 : Maximum core temperature setting when subjected to the maximum allowable ripple load at the maximum operating temperature (settings differ in different series or products. Contact us for details)

T : Core temperature of the capacitor during actual use

Therefore, the lower the core temperature of the capacitor during actual use, the longer the estimated service life is. The core temperature of a capacitor may be lowered by lowering either the ambient temperature or the load current (operating conditions), or by either boosting capacitance or lowering internal resistance. Some capacitors feature a radiating structure to lower the core temperature. Consult us for the selection of capacitors.

When multiple capacitors are connected in parallel, check the core temperature in each capacitors and the balance of the total series resistance to each capacitors. If capacitors are used at high frequency, the circuit resistance is especially need to considered. The estimating service life is needed to calculated from the maximum core temperature.

1 - 2 Voltage conditions

The service life of an aluminum electrolytic capacitor for mid- to high-voltage filters is affected by the applied voltage. If the applied voltage is between 60% and 100% of the rated voltage, the estimated service can be extended by lowering the applied voltage below the rated voltage. However, if the applied voltage is less than 60% of the rated voltage or the capacitor is used in low-pressure (100 WV or less) applications, the impact of the applied voltage on the service life is negligible. Therefore, service life is estimated assuming no impact from voltage. Continuous application of a voltage over the rated voltage rapidly increases leakage current in a capacitor. This may increase internal pressure due to generation of gases, resulting in activation of the safety vent in a short time and/or formation of an internal short circuit.

For this reason, the applied voltage must be maintained below the rated voltage during use. Besides, it should be noted that the circuit design is such that the applied voltage will remain 80% or less of the rated voltage during use.

Where more than one capacitor connected in series is used, the applied voltages across the individual capacitors may become out of balance, resulting in the application of excessive voltage to them. To avoid this, either choose a rated voltage allowing for voltage imbalances, or connect a voltage divider (resistors) to the capacitors. Please be careful about charge/discharge.

2. Formula for estimating service life

(1) Estimating from the core temperature of the capacitor and applied voltage Formula for calculating the service life of our capacitors in mid-to-high voltage applications (filters).

$$L = L_0 \times 2^{\frac{T_0 - T}{10}} \times \left(\frac{WV}{V} \right)^{2.5} \quad \cdots (2)$$

Where,

T_0 : Maximum core temperature setting when subjected to the maximum allowable ripple load at the maximum operating temperature

L_0 : Standard service life when core temperature is T_0 and rated voltage is (WV)

L : Estimated service life when core temperature is T and applied voltage is (V)

If V/WV < 0.6, use V/WV = 0.6.

(2) Estimating core temperature of a capacitor from load ripple current

We recommend that you estimate service life by measuring the core temperature of the capacitor with a thermocouple. We can manufacture samples with inserted thermocouples according to customer requests.

If for some reason it is impossible to measure the core temperature, you can estimate the service life by making a rough estimate of the core temperature of the capacitor from the load ripple current. As shown below, assuming the rise in temperature and the square of load current to be nearly proportionate, obtain the core temperature of the capacitor that occurs when the capacitor is loaded with a ripple current.

$$T = T_a + \Delta T_0 \times \left(\frac{I}{I_R} \right)^2 \quad \cdots (3)$$

Where,

T : Core temperature of the capacitor when ripple current I is loaded

Ta : Ambient temperature

ΔT_0 : Rise in maximum core temperature setting for the capacitor when permissible ripple current I_R is loaded

(settings differ in different series or products. Contact us for details)

Note : Observe the rule: $I \leqq I_R$. Never use a capacitor loaded with a ripple current greater than I_R.

For safety reasons, estimate the service life on the basis of the core temperature of the capacitor at maximum load. Temperature distribution should be taken into account when more than one capacitor is used.

3．Other factors affecting service life

(1) Reverse voltage

When a reverse voltage is applied to the capacitor, the capacitor's cathode foil that is not coated with oxide is energized, resulting in forced formation of an oxide film on its surface. During the process of forced formation, heat and gases are generated. This will shorten the service life significantly.

(2) Charge and discharge

Generally, where aluminum electrolytic capacitors are used in a charge/discharge circuit, oxide films are gradually formed on the surfaces of their cathode foils due to discharge current. This will shorten the service life significantly. For this reason, general-purpose capacitors are not suitable for circuits in which frequent charge and discharge are common. Examples include circuits for photo flash and welding.

(3) Inrush current

Upon switching on the power supply of a welding machine, a large current flows instantaneously at the beginning of charging. Such a current, called an inrush current, is 10 to 1,000 times as large as the normal value. Inrush currents pose no problem as long as they occur with very low fragment during operation. The reason for this is that their heat-generating energy is relatively small. However, if an inrush current occurs repeatedly during operation, it may shorten the service life significantly.

IV. Reducing Substances with Environmental Impact

As part of our initiatives for global environment protection under ISO 14001, we recommend products without any substances with environmental impact to our customers.

(1) Lead-free

Regarding Snap mount type and Radial type Aluminum Electrolytic Capacitors, our standard specification is to use Tin instead of Lead on the surface of terminal plating. We discontinued producing Tin ＋ Lead plating.

Regarding Screw terminal type Aluminum Electrolytic Capacitors, they do not contain Lead at all.

Please contact us for details.

(2) Eliminating Chromate Treatment

The previous chromate treatment on the surface of bracket contained hexavalent chromium.

To avoid this material, we changed to trivalent chromium.

The surface treatment is changed but no change in size or other specification.

In addition to Lead-free, aluminum electrolytic capacitors that we produce have suited RoHS Directive.

(3) PVC-free

For PVC-free Snap mount type and Radial type Aluminum Electrolytic Capacitors, the capacitors are covered with PET insulating sleeve, and The bottoms not covered.

Please contact us for other PVC-free products.

(4) Conform RoHS

All series (Screw terminal type Aluminum Electrolytic Capacitors, Snap mount type Aluminum Electrolytic Capacitors, Radial type Aluminum Electrolytic Capacitors) apply RoHS.