Support Note

Expected Lifetime of Aluminum Electrolytic and Aluminum Polymer Capacitor

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The life cycle of a capacitor depends on many factors of the application. An important factor is the temperature or rather thermal load, as it is responsible for the fact that internal structures age over time and the electrical properties deteriorate. This results in increased leakage current, increasing the ESR, which in turn leads to a further increase of the temperature. The reason for the temperature increase is the power loss generated by the ESR. If these limits are not exceeded, high lifetime expectancies are possible when the inner temperature load of the component is in a lower range. For liquid electrolytic capacitors, the expected lifetime doubles when the temperature at the component is reduced by 10 °C (Eq. 2).
For polymer electrolytic capacitors, the life increases tenfold when the temperature at the component is reduced by 20 °C (Eq. 1)

Formula for aluminum polymer capacitors:

$$L_x = L_{nom} \cdot 10^{\frac{T_0 - T_a}{20}} \qquad \text{(Eq. 1)}$$

Formula for aluminium electrolytic capacitors:

$$L_x = L_{nom} \cdot 2^{\frac{T_0 - T_a}{10}} \qquad \text{(Eq. 2)}$$

To further illustrate this, the calculated lifetime values are shown in Table 1 with some example temperature values. Here, the maximum specified component temperature is used to compare aluminum electrolytic and aluminum polymer capacitors.

Temperature	Aluminum Polymer Capacitor	Aluminum Electrolytic Capacitor	Factor Polymer vs. Electrolytic
105 °C	2.000 h	2.000 h	1.00
95 °C	6.300 h	4.000 h	1.58
85 °C	20.000 h	8.000 h	2.50
75 °C	63.000 h	16.000 h	2.94
65 °C	200.000 h	32.000 h	5.25

Table 1: Lifetime overview with different ambient temperatures

The application temperature is defined in the formulas (Eq. 1) and (Eq. 2) as the ambient temperature T_a. The hour's definition at 105 °C in the two following columns for the aluminum polymer and aluminum electrolytic capacitor is the nominal lifetime of the component L_{nom}. This is linked to the maximum specified temperature at the component and is defined as T_0. The other hours in the table are the calculated lifetimes L_x using the formulas (Eq. 1) and (Eq. 2). The calculated factor in the last column is the relation between the calculated lifetime for aluminium electrolytic and aluminium polymer capacitors. In the aluminum polymer capacitor column, the calculated lifetime is 200.000 h at 65 °C ambient temperature. This means a theoretical lifetime of 22 years. The typical maximum expected lifetime, which is defined by different vendor, is between 13 and 15 years. Furthermore, you can clearly see in this table at which ambient temperature aluminum polymer capacitors have their advantage in lifetime. If the specified component temperature for aluminum electrolytic and aluminum polymer capacitors is the same (for example 2000 h at 105 °C), it can be seen at 95 °C the polymer electrolytic capacitor has a longer lifetime. Only in cases of aluminum electrolytic capacitors with a long specified lifetime at the maximum specified component, temperature (for example 5000 h at 105 °C) has a higher intersection point but the point of intersection will always occur (see Fig.1). The specified hours in this diagram are always the nominal lifetime value of the component at this temperature.

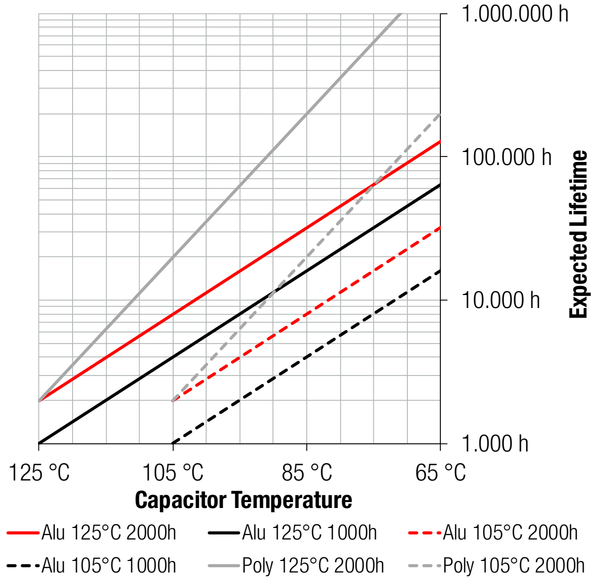

Figure 1: Overview of the expected lifetime of aluminum electrolyte and aluminum polymer capacitors

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