4. SELECTION RULES AND DEFINITIONS

SELECTION RULES

VOLTAGE

Select a capacitor with surge peak voltage (U_S), rated voltage (U_{NDC}) and rms voltage (U_{rms}) higher than the operating ones.

Consider that the rated voltage U_{NDC} shall be higher than the sum of the DC component and the repetitive peak of the AC component.

It is possible, within certain limits, to work above the rated voltage but this reduces the expected life of the capacitor.

During switching working condition, residual voltage before re-energizing shall not exceed 10% the rated voltage.

CURRENT AND FREQUENCY RANGE

Select a capacitor with maximum current I_{max}, higher than the operating I_{RMS}

Consider that:

- a thermal check shall be performed in order to verify that the chosen capacitor does not exceed the max operating temperature at operating I_{RMS}
- the I_{max} of the capacitors has been calculated for a $\vartheta_h - \vartheta_0$ of about 25°C and considering a voltage waveform composed by:
  - a 50Hz fundamental with rms value Urms, having an impact both on conduction losses (P_C) and dielectric losses (Q tan δ_0)
  - a voltage harmonics contents affecting only the conduction losses (P_C).

    $P_C = R_S * I^2_{rms}$ for MKP single phase cap.

    $P_C = 3 * R_S * I^2_{rms}$ for MKP-3P three phase cap.

    In reality the harmonics content affects also the dielectric losses but this can be only evaluated starting from an estimated or measured harmonics spectrum.

THERMAL CHECK

The dissipated power consists of dielectric losses (Q tan δ_0) due to the polypropylene film and conduction losses (P_C) due to the resistance of the electrodes and the connections.

Consider that :
the hot spot temperature can be estimated as follows:
$\vartheta_h = R_{th} * P + \vartheta_0$

the total dissipated power can be calculated as follows:
$P = Q \tan \delta_0 + P_C$

During stationary operation ϑ_h must not exceed 85°C. Power losses shall be strongly reduced when operating at an ambient temperature equal to 85°C. Please contact ICAR Tech. Dept. for derating according to ambient temperature.

At rated duty and hot spot temperature of 70°C the expected lifetime is 100.000 hours with a statistical failure rate of 300FIT (97% survival).

WARNING

The thermal check is based on the hypothesis that the heat generated into the capacitor is transmitted to the environment through the case surface. Possible localised overheating (poor connections, hot components in the nearby as other capacitors, operation with high harmonics frequency etc.) would bring the capacitor to a dramatic failure or to a reduction of the expected life. Special tests by means of thermocouples should be conducted to be sure that the maximum hot spot temperature is not exceeded even under the most critical ambient circumstances.

DEFINITIONS

C_N	Rated Capacitance measured at 20°C.
U_{rms}	Rated rms voltage
U_N	Maximum operating peak recurrent voltage of either polarity of a reversing type waveform for which the capacitor has been designed.
U_{NDC}	Maximum operating peak voltage of either polarity of a non reversing type waveform for which the capacitor has been designed for continuous operation.
U_S	Surge (not repetitive) peak voltage
U_I	Rated insulation voltage. Rms value of the AC voltage for which the terminal to case insulation has been designed and tested. Unless stated otherwise, the rated insulation voltage should be considered equal to the capacitor's rated rms voltage.
I_{MAX}	Maximum rms current value for continuous operation. Its value depends on the ambient temperature.
Clearance	Shortest distance in air between terminals conducting parts or between terminal and case
Creepage	Shortest distance along an insulated surface between terminals conducting parts or between terminal and case
Q	Reactive power $2\pi \times F_N \times C \times U^2_{rms}$ for MKP single phase cap. $3 \times 2\pi \times F_N \times C \times U^2_{rms}$ for MKP-3P three phase cap.
F_N	Fundamental frequency
R_S	Series resistance i.e. the resistance responsible for the current heat losses (P_C) in the capacitor.
tan δ_0	Dielectric dissipation factor. It can be considered constant in the normal working frequency range. Typical value for polypropylene is 2×10^{-4}
dv/dt	Maximum slope of the voltage waveform
I_{PK}	Peak current $I_{PK} = C\ dV/dt$.
P	Active power (losses) $Q \times \tan\delta_0 + R_S \times I^2_{rms}$ for MKP single phase cap. $Q \times \tan\delta_0 + 3 \times R_S \times I^2_{rms}$ for MKP - 3P three phase cap.
R_{th}	Thermal resistance between the hot-spot in the winding and the environment (natural cooling), so that: $P = (\vartheta_h - \vartheta_0) / R_{th}$ In case of forced air cooling the thermal resistance will be reduced of 20%.
ϑ_h	Hottest point in the capacitor winding = $R_{th} \times P + \vartheta_0$
ϑ_0	Operating ambient temperature. It is the air temperature measured under steady conditions, with natural convection at 0,1m from the capacitor case and at two-thirds of the height from its base.
T_C	Temperature coefficient of capacitance. The coefficient is equal to –260 ppm/°C
τ_C	Time constant between terminals: it is the product of insulation resistance between terminals at 20°C and the value of capacitance. The time constant between terminals for the MKP series is in general greater than 3000 s
Ha	Maximum altitude. The max. altitude shall not exceed 2000m corresponding to 0.7 bar
Ln	Expected life at rated voltage U_{rms} and hot-spot temperature of 70°C
L	Expected life at the actual working conditions
L_S	Self inductance of the capacitor. It is due to the internal connections, terminals, winding characteristics and physical dimensions.
λ	Failure rate (FIT) = 10^9 x failures/component x hour