

LOW VOLTAGE POWER FACTOR CORRECTION
CAPACITORS AND EQUIPMENT STANDARD LIFE
SERIES

General information

DUCATI energia uses the name Standard Life, (SL), to define all capacitors produced with metallized polypropylene technology.

Metallized polypropylene technology (PPM - MKP) utilizes the technique of depositing, with vacuum evaporation, an extremely thin layer of metal on one side of the polypropylene film.

The capacitive elements are obtained by winding two polypropylene films.

The plates of the capacitors are formed by the metallization of the two films and the dielectric by the polypropylene film.

The most important feature of the capacitors with metallized plates is their ability of self-regeneration.

This means that they are capable of restoring their electrical properties even after the occurrence of a short circuit between the plates.

Due to the reduced thickness of the plates, the current generated by a short circuit in the area of the fault is capable of vaporizing the metallization, thereby automatically extinguishing the short circuit without an appreciable reduction in capacity or expenditure of energy.

To ensure protection, the capacitive elements that make up the unit are individually fitted with an overpressure safety device.

The function of this device is to interrupt the short circuit when, at the end of its useful life, the capacitor is no longer able to regenerate itself.

This device interrupts the connections of the terminal by using the internally developed pressure resulting from the decomposition of the film due to the overheating caused by the short circuit.

It should be noted that an external fuse is not as reliable since the current of the short circuit, strongly limited by the metallization, is largely variable.

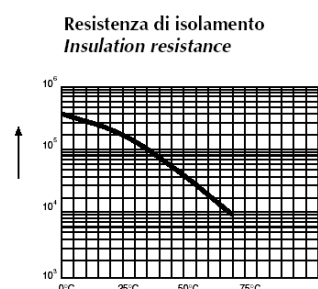
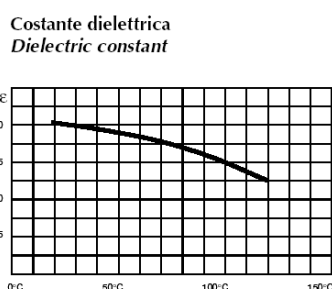
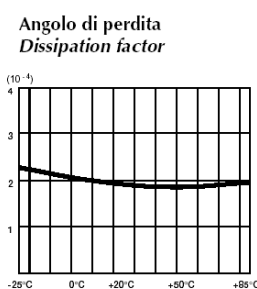
The capacitors produced with PPM technology are commonly known as “dry” capacitors since the smooth surface of the film does not allow the air entrapped during the winding process to be substituted with oil.

The impregnating agent in the SL series consists of a polyurethane resin, which is more stable than the liquids eventually used for the filling and insulation of the active part of the metallic capacitor.

The SL capacitors are built with environmentally friendly materials conforming to reference standards IEC 831-1/2, EN 60831-1/2. Many models are certified by institutes, all are manufactured fully complying the said standards' requests.

Andamento tipico delle caratteristiche elettriche del film polipropilene metallizzato in funzione della temperatura

Typical performance of electrical characteristics of metallized polypropylene film vs. temperature



DEFINITIONS

Rated voltage (U_n)

This is the maximum effective value of the alternate sinusoidal voltage for which the capacitor was designed.

Rated power (Q_n)

This is the reactive power delivered from the capacitor with the rated voltage and frequency applied.

Rated capacitance (C_n)

This is the value which permits the delivery of the rated power applying the rated voltage and frequency to the terminals.

Rated current (I_n)

This is the effective value of the alternate current that circulates in the capacitor when the rated voltage and frequency are applied to the rated capacity.

OPERATING CONDITIONS

Unlike most electrical equipment, power factor correction capacitors, each time they are energized, continuously operate at full load or at loads which differ from this value only as a consequence of variations in voltage and frequency. Overstressing and overheating shorten the life span of the capacitor. For this reason the operating conditions (temperature, voltage and current) must be carefully controlled in order to obtain optimum results as respects the lifespan of the capacitor.

Voltage

The capacitors are produced in accordance with reference standards IEC 831-1/2, EN 60831-1/2 which regulate their manufacturing, testing, installation and application and which indicate the following maximum values for overvoltage applicable to the capacitors:

- +10% for 8 hours every 24 hours
- +15% for 30 minutes every 24 hours
- +20% for 5 minutes every 24 hours
- +30% for 1 minute every 24 hours.

Overvoltages in excess of 15% should not occur more than 200 times in the lifespan of the capacitor.

Often when there is the presence of overload conditions during service, in the presence of a moderate harmonic load for example, it is common to use oversized capacitors in terms of voltage.

In such cases the output power at operating voltage will be reduced with respect to that of the rated load. It is advisable to evaluate the reduction experienced in the output power on the basis of the correlation between the operating voltage and the rated voltage.

$$Q_{output} = Q_n \cdot \left(\frac{U_e}{U_n}\right)^2 - U_e = \text{operating voltage}$$

- $Q_{output} = \text{output power at } U_e$

The following table indicates the output power of a 100 kvar capacitor used on a 400 V network with a rated voltage of 450, 500, and 550 V.

Un	450	500	550
Q resa kvar	79	64	53
Q output kvar			

Temperature

The temperature of the capacitor during operation is the parameter that, along with the voltage, has the greatest influence on the life span of the capacitor. It is important that the capacitor always be placed in a position where the cooling air can freely circulate, avoiding the radiant heat of hot surfaces of other components.

When the capacitors are placed in closed cabinets it is necessary to have air vents which allow for an easy exchange of air between the interior and exterior of the cabinet. On the other hand, when the degree of protection of the cabinet does not permit this exchange of air, the internal spaces must be much larger and the positioning of the capacitors must be carefully studied to permit the necessary channels which allow for the circulation of cooling air.

In this case the forced cooling air will have to be provided by suitable fans. As a rule the temperature of the cooling air inside the cabinet should not differ by more than 5°C with respect to the external air at the control panel.

Cooling air temperature

This is the temperature of cooling air measured at the hottest point of the bank of capacitors, under working conditions, halfway between two capacitors or on the surface of one of these.

Categories of ambient air temperature

This represents the range of cooling air temperatures in which the capacitor is designed to operate. As a rule there are 4 categories represented by a number and a letter or by two numbers as shown in the table.

Categorie <i>Categories</i>		Temperatura dell'aria ambiente <i>Ambient air temperature</i>		
		Max	Valore medio più alto in un periodo di <i>Highest mean over any period of</i> 24 h	
-25/A	-25+40°C	40	30	20
-25/B	-25+45°C	45	35	25
-25/C	-25+50°C	50	40	30
-25/D	-25+55°C	55	45	35

The first number represents the minimum temperature of the cooling air at which the capacitor can be energized (-25°C) on request -40°C. The letter or the second number represents the upper limit of the temperature range and precisely the max. value indicated in the table.

Residual voltage

This is the voltage that remains after disconnecting the capacitor from the network. This voltage must be eliminated in order to avoid dangerous conditions for the operator. All three-phase capacitors are equipped with discharge devices that reduce the residual voltage to a value of minimum 75 V after 3 minutes.

It is important to bear in mind that the capacitors cannot be energized if there is a residual voltage of more than 10% across them. Particular attention must therefore be applied in harmonizing the capacitor discharge times with the response times of the control devices (Regulators).

In cases where the lag time of the regulators are shorter than the discharge time of the capacitor, it is necessary to provide additional discharge devices until the connection occurs with a residual voltage of less than 10%.

To reduce the residual voltage to 50 V in 20 seconds in batteries with a power less than or equal to 20 kvar at a voltage of 400 V, use 3 metal oxide resistors of 68 kohm, 4W in a delta connection.

Current

The capacitors are made to function continuously at an effective value of 1.3 times the value of the current at rated voltage and frequency.

Bearing in mind the capacitance tolerance, the maximum current can arrive to 1.5 I_n , the value to which it is necessary to refer in the scaling of the line of control and protection devices. This overcurrent factor can be determined by the combined effect of harmonics, overvoltages and capacitance tolerance.

Max inrush current

Transient overcurrents having elevated amplitudes and high frequencies occur when the capacitors are switched in to the circuit.

This is especially true when a bank of capacitors is put in a parallel connection with other already-energized capacitors.

It may therefore be necessary to reduce these transient overcurrents to acceptable values both for the capacitor and the contactor used by connecting the capacitor using suitable devices (resistors or reactors) in the power circuit of the battery.

The peak value of the overcurrent caused during manoeuvring operations must be limited to a maximum value of $100 I_n$ (crest value of the 1st cycle).

Complete the following phrases with the right answers

- 1) The most important feature of the capacitors with **metallized** plates is their ability of self-regeneration.
- a) thick
 - b) plastic
 - c) metallized
 - d) rubber
- 2) To ensure protection, the capacitive elements that make up the unit are individually fitted with an **overpressure** safety device. The function of this device is to interrupt the short circuit when, at the end of its useful life, the capacitor is no longer able to regenerate itself.
- a) underpressure
 - b) overpressure
 - c) overvoltage
 - d) undercurrent
- 3) The impregnating agent in the SL series consists of a **polyurethane** resin which is more stable than the liquids eventually used for the filling and insulation of the active part of the metallic capacitor.
- a) polyurethane
 - b) cheese
 - c) paper
 - d) aluminium
- 4) Definition of Rated voltage (U_n): This is the maximum **effective value** of the alternate sinusoidal voltage for which the capacitor was designed.
- a) effective value
 - b) real value
 - c) value
 - d) efficient value
- 5) Definition of Rated power (Q_n): this is the reactive power delivered from the capacitor with the rated **voltage and frequency** applied.
- a) capacitance

- b) voltage and frequency
- c) voltage
- d) current and frequency

6) Often when there is the presence of overload conditions during service, in the presence of a moderate **harmonic load** (1) for example, it is common to use **oversized** (2) capacitors in terms of voltage.

- a) loadstrong
- b) harmonic load oversized
- c) load power
- d) harmonic load undersized

7) The temperature of the capacitor during operation is the parameter that, along with the voltage, has the greatest influence on the life span of the capacitor. It is important that the capacitor always be placed **in a position** where the cooling air can freely circulate, avoiding the radiant heat of other components.

- a) Right cold surfaces of
- b) in a position hot surfaces of
- c) horizontally..... electric voltage of
- d) in a closed boxbig capacitance of

Fill the gaps

Residual voltage: this is the voltage that remains after (1) **disconnecting** the capacitor from the network. This voltage must be (2) **eliminated** in order to avoid dangerous conditions for the operator. All (3) **three-phase** capacitors are equipped with discharge devices, which reduce the (4) **residual** voltage to a value of minimum 75 V after 3 minutes.

It is important to bear in mind that the (5) **capacitors** cannot be energized if there is a residual (6) **voltage** of more than 10% across them. Particular attention must therefore be applied in harmonizing the capacitor (7) **discharge** times with the response times of the control devices (Regulators).

discharge voltage capacitors residual eliminated disconnecting three-phase