Product Brief 2019

Medium-Voltage Capacitors

For Power Factor Correction

As a global leader in power capacitors, TDK offers a wide range of medium-voltage (MV) capacitors for various applications.

Technology

MV power capacitors are produced in film technology where two metal foil electrodes are separated by a sheet of plastic film. The electrodes are made of aluminum foil.

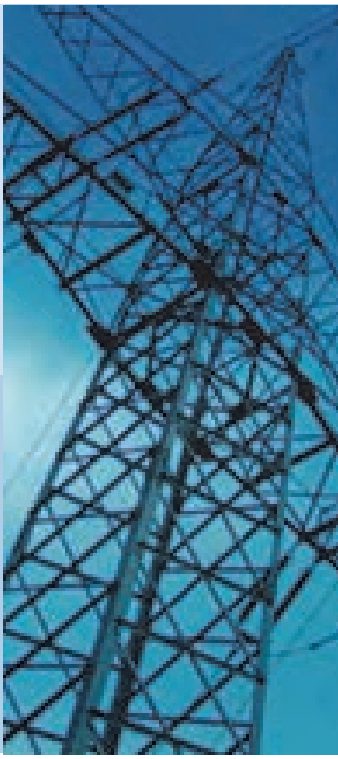
The most widely used plastic film is polypropylene and hence film capacitors are also known as all polypropylene (APP) capacitors.

Film capacitors in general are characterized by high insulation resistance, good capacitance stability, low losses even at high frequencies, high pulse current and high harmonic current capabilities.

Design

Reliability is built into the capacitors right from the design stage. Time-tested design rules assure the exceptional quality of the capacitors. A multilayer design ensures that a weak spot in any film will not result in an instant failure. Further, each element is tested to remove weak elements at the initial stage. Only healthy elements are processed further.

To reduce the effect of stress concentration at the electrode edge, a corona ring is provided by continuous edge folding of the aluminum foil along the length. This eliminates sharp edges caused during mechanical slitting.



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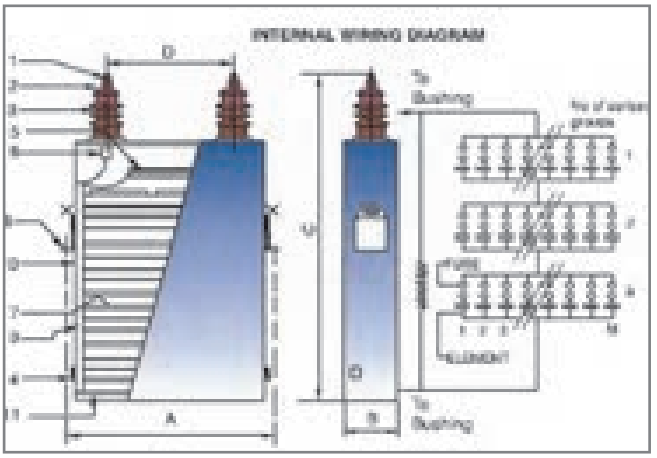
Construction

In comparison to a laser cut foil edge, edge folding provides additional thickness with a rounded edge to substantially reduce stress and improve partial discharge inception voltages. To further enhance the operating life, the design stress is limited to a very low value.

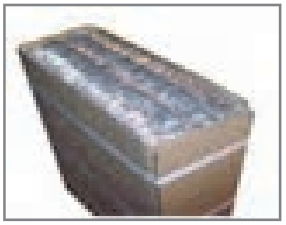


1.	Terminal 12 mm	7.	Elements
2.	Two washers	8.	Slot 10 x 15 mm
3.	Porcelain bushing	9.	Insulating material
4.	Earthing bracket	10.	Case (stainless steel)
5.	Discharge resistance assembly	11.	Bottom cap
6.	Paper sleeve		

Materials

Superior quality raw materials are used to ensure high quality and reliability. Dielectric film is a key component for capacitor quality. Film is manufactured from a very pure isotactic homopolymer with high stereoregularity and super clean electrical grade resin. It has very low catalytic residues and low ash content.

Both sides haziness improves penetration of impregnating oil both between layers of film and between film and foil. The surface of the film is even and uniform, free from defects like wrinkles, crackles, bubbles, grains and extraneous contaminations. During heat treatment, the film remains wrinkle-free due to low thermal shrinkage. The thickness variation is also low and impregnation is easy. The film has very low dielectric losses and high breakdown strength.



The electrode is made of high purity, dead soft annealed aluminum foil. The impregnant has very high aromaticity and low viscosity to enable better gas absorption even at low temperatures. Mono/di-benzyl toluene (Jarylec 101 C) is used as an impregnant. An epoxide, used as an additive, improves capacitor life at elevated temperatures. Other raw materials such as insulating paper, solder sticks, bushings, etc. conform to the world class standards.

Manufacturing

Production is carried out entirely in a state-of-the-art manufacturing facility. Capacitor elements are wound in a controlled environment. Temperature and humidity are controlled to consistently obtain better quality of winding. Dust particles are reduced by using air filters and uniform laminar clean air flow during winding. To avoid foreign particle entry into the clean winding room, positive air pressure is maintained. A double-door arrangement with air shower is used for operator entry. The advanced automatic winding machinery is handled by trained and experienced operators. Winding tension is kept low to avoid creasing when the windings are flattened. The winding parameters are controlled using programmable logic controllers.

The oil is processed through a series of filters to remove solid particles. Moisture is also removed from the oil to improve its dielectric strength. Further, dissolved gases in oil are removed as well. Degassed oil extends capacitor life due to its better ability to absorb gases that are generated during partial discharge events. Breakdown strength, dielectric dissipation factor and moisture content in oil are checked before allowing oil inside the impregnation chamber.

The capacitor units are dried under high vacuum to remove traces of moisture and air, which can both cause a potential weakness in the dielectric system. After complete drying and evacuation, the oil is filled at a controlled rate and under vacuum to allow the oil to soak and stabilize. After completion of the process, dry, clean gas is pumped into the tank for purging. The units are then taken out and quickly sealed to reduce the oil's exposure to the atmosphere.

Medium-Voltage Capacitors

For Power Factor Correction

To avoid ingress of moisture, air and oxygen into the capacitor during service life, the units are hermetically sealed and tested for leakage. To detect smallest leaks, the pressure inside the container is increased by heating the capacitor to 80°C, which is much higher than highest expected service temperature.

Testing and certification

Testing and quality assurance to comply with international standards is an essential part of the production process. TDK has world class testing facilities and laboratories in accordance with international standards. Quality assurance and testing is carried out at every stage as per a well-defined Quality Assurance Plan (QAP) and controlled procedure.

Test laboratory

The test and measuring facilities may include:

- 5100 kVA, 85 kV resonant power supply
- 300 kV impulse voltage generator
- 22 kV, 2000 kvar endurance test facility
- 150 kV AC / DC source
- partial discharge detector
- capacitance and dielectric loss factor bridge
- impedance analyzer
- harmonic current source
- hot and cold chambers
- thermal shock test facility, etc.

Some of the specialized testing include transient overvoltage tests, high current discharge tests, long endurance tests, vibration and shock tests, salt spray tests, etc.

The capacitors are fully certified at an external accredited laboratory complying with all relevant international standards such as IEC 871.

Typical specifications (MV capacitors)

Type	APP / Film-foil / NSH
Unit voltage rating kV	1 … 33
Rated frequency Hz	50/60
Rated output per unit kvar	50 … 750
Phase	Single/Three
Dielectric	Hazy polypropylene
Electrode	Soft annealed aluminum foil
Impregnant	NPCB
Case / container	SS / CRCA with painting
Discharged resisters	Internal (<50 V in 10 min)
Capacitor unit protection	Internal/external fuse
Bushings	Ceramic/Non-ceramic

Typical specifications (RC surge capacitors)

Range kV	1 … 33
Mfd	0.1, 0.125, 0.25 up to 10 mfd

Typical specifications (Energy storage capacitors)

Range KV	5 … 100 DC
Mfd	0.1 … 10 mfd

Special purpose capacitors

In addition to power capacitors, TDK also offers various special capacitors such as:

Surge capacitors

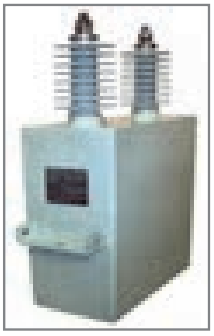
A typical surge capacitor/RC transient suppressor is comprised of a specially designed capacitor in series with a non-inductive resistor. This combination is connected across the power line. The capacitor (in conjunction with the line impedance) limits the rate of rise of transient voltage and thus protects the parallel connected equipment. In case inductive loads are switched through vacuum switching devices, the

Medium-Voltage Capacitors

For Power Factor Correction

RC transient suppressor increases the net capacitance. Thus, the magnitude of the voltage rise is limited across the equipment due to the energy stored in the inductance of the load.

The resistor is normally wound with nichrome wire and is



specifically designed and constructed to achieve a very low inductance (non-inductive design).

The capacitors are a specially designed low-loss all polypropylene (film-foil) type with a high surge handling capability.

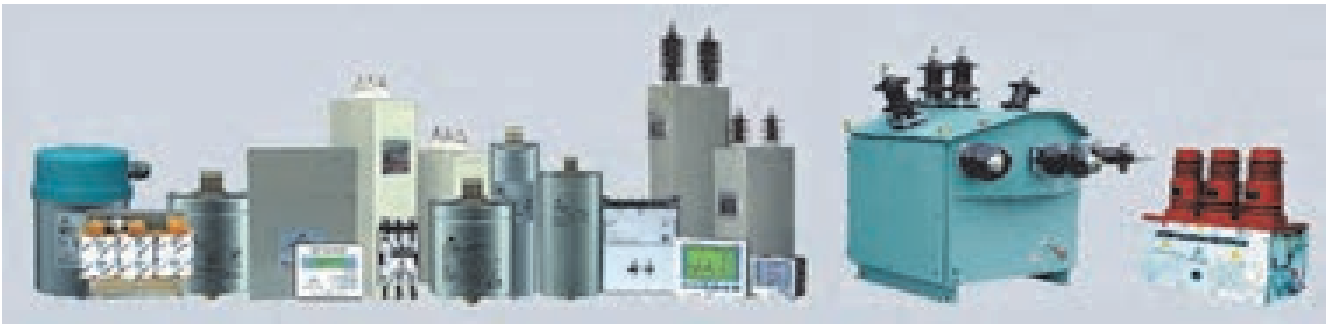
The capacitors can be produced as single-phase or three-phase units. For three phase capacitors, both star and delta configurations are available.

Energy storage capacitors

Energy storage capacitors are used for applications such as pulse discharge, pulse forming, impulse current and impulse voltage generation. These capacitors are characterized by low inductance design and high pulse current handling capabilities. Capacitors are available from 5 to 100 kV DC and from 0.1 to 10 µF.

Other associated products

- Medium-voltage vacuum capacitor switches
- Medium-voltage vacuum contactors
- Medium-voltage damping and current limiting reactors
- Medium-voltage automatic power factor correction panels
- Low-voltage power capacitors
- Low-voltage key components (detuning and damping reactors, AC6B contactors, thyristor switching modules, power factor controllers)
- Low-voltage PFC modules and racks
- Low-voltage automatic power factor correction panels



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