



干式空心电抗器使用手册

User Manual for Dry Type Air-core Reactor

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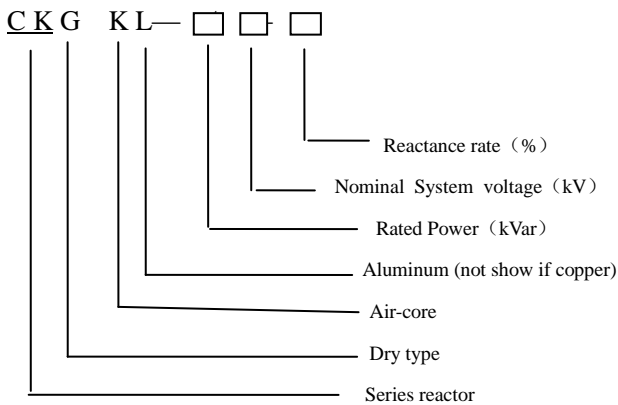
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Chapter I Reactor type and model interpretation

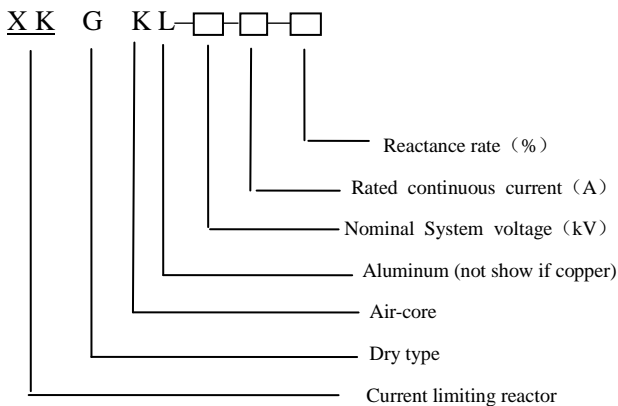
1. Dry type air-core series reactor: CKGK(L)
series dry type air-core reactors are suitable for in series with high voltage shunt capacitor bank, to reach restrain waveform distortion in network voltage, control harmonic component flowing through capacitor bank and limit surge current when capacitor bank put into power grid.

Model interpretation:



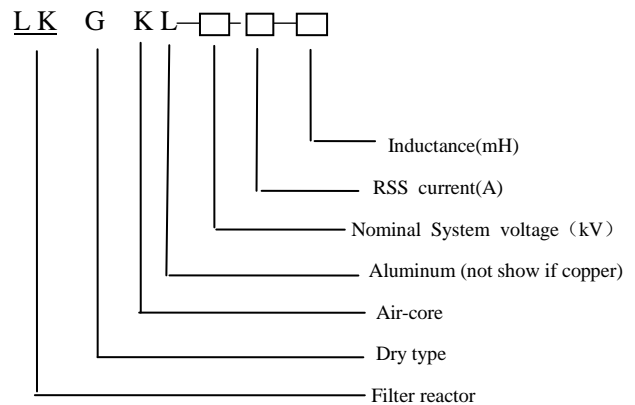
2. Dry type air-core current limiting reactor: XKGKL
XKGKL series dry type air-core current limiting reactors are suitable for series connection in system circuits, to add system impedance. To limit short current when system break down, reduce the fault current to admissible value.

Model interpretation:

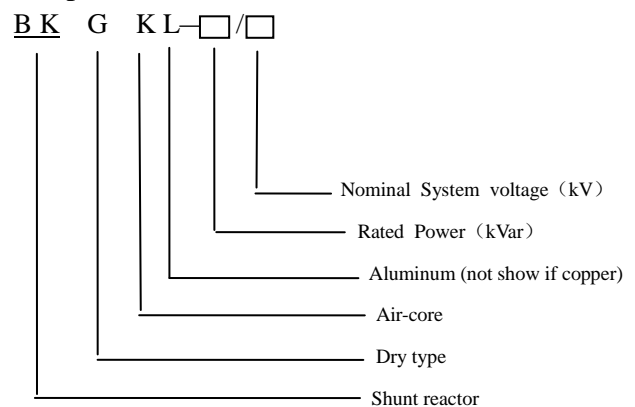


3. Dry type air-core filter reactor: LKGKL
series dry type air-core filter reactor connected in series with filter capacitor bank form a resonant circuit, make it resonance at a certain frequency point, filter specified high harmonic, at the same time it can realize power system reactive compensation and limit the surge current when capacitor bank put into power grid.

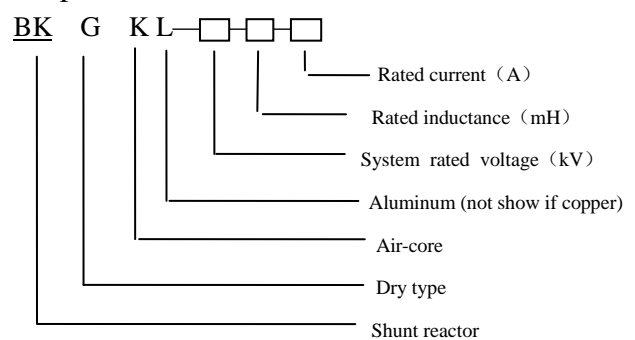
Model interpretation:



4. Dry type air-core shunt reactor: BKGKL
series dry type air-core shunt reactors parallel connect to LV sides of 750kV, 500kV or 220kV substation, to use for capacitance reactive compensation for long distance transmission line, to stabilize voltage operation of power transmission and distribution system. Model interpretation:



5. Dry type air-core TCR reactor: TCR reactors used in static reactive power compensator, through the thyristor control the current flowing through the reactor, realize to capacitive reactive compensation system. Model interpretation:



Chapter II Service conditions of dry type air-core reactor

1. Service location

Dry type air-core reactor can be divided into outdoor type and indoor type according to the different design. Outdoor running reactor can be run in outdoor environment not greater than design conditions, also can be run in indoor environment. Indoor running reactor only can be run and store in indoor environment.

2. Altitude

Not more than 1000m in normal (If more than 1000m, should note when order).

3. Service temperature and range of temperature

-40℃ ~ +40℃, day average temperature not more than 30℃, the maximum range of day temperature should be less than 25K.

4. Relative humidity

Indoor type reactor, month average relative humidity not more than 90%, day average relative humidity not more than 95% (25℃).

5. Maximum wind speed

35m/s (from land 10m height, 10 minutes wind speed)

6. Seismic resistance ability

8 degree (horizontal: 0.3g, vertical: 0.15g).

7. Others

There is no gas, steam, dust in installation site, which can affect the insulation, also no other explosive, electrical conductivity and corrosive medium.

There is no strong electromagnetic interference or sensitive electrical and electronic components in the range around the reactor at 1.7 times of reactor diameter.

When the using condition cannot meet the above normal ambient condition, make necessary adjustments according to the relevant

national standards. If users have special requirements for using conditions, should be mentioned in contract.

Chapter III Ordering instruction

Thank you for choosing our products. Please state below technical data and requirements in written form when you order, to make us to meet your requirements better.

1. Service conditions

1.1 Working environment (Indoor and outdoor)

1.2 Altitude of service location

1.3 Pollution grade of service location

1.4 Minimum and maximum temperature of environment

1.5 Installation arrange model of reactor

1.6 Inlet and outlet angle of reactor

1.7 Other special technical condition need be mentioned

2. Reactor technical data

2.1 Reactor rated capacity

2.2 Reactor rated voltage

2.3 Rated frequency

2.4 Rated reactance

2.5 Rated reactance rate (series and current limiting reactor)

2.6 Maximum work voltage

2.7 Long period maximum work current

2.8 Outer diameter and total height of reactor

2.9 Other technical requirements

Chapter IV Installation of reactor

Section I Carried Standard

1. GB 50303-2002 "Building electrical engineering construction quality acceptance

specification”;

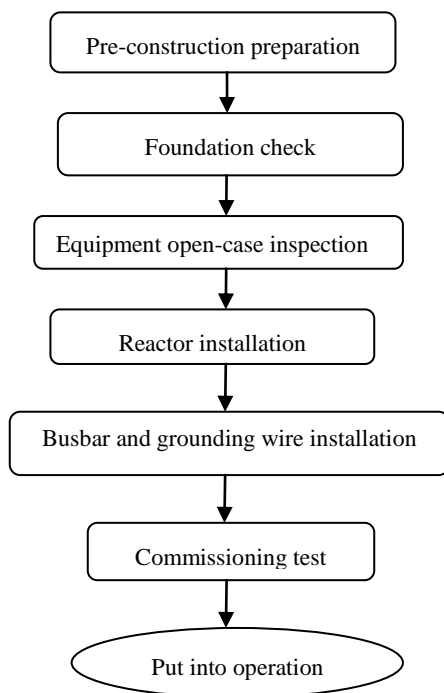
2. GB 50171-2012 “Code for construction and acceptance of switchboard outfit complete cubicle and secondary circuit electric machines electric equipment installation engineering”;

3. GB 50169-2006 “Code for construction and acceptance of earthed device electric equipment installation engineering”;

4. GB 50256-1996 “Code for construction and acceptance of electric device of crane electrical equipment installation engineering”;

5. GB 175-2007 “Common Portland Cement”.

Section II Process flow chart of installation



Section III Pre-construction preparation

1. Technical preparation

Make a construction scheme and construction personnel for technical disclosure according to installation instructions, assembly drawings and technical agreement.

2. Personnel organization

Construction team should have one own technical director, installation director, safety and quality director.

Table 1 Personnel list

Process name	Suggestion number of workers	Number of responsible people	Number of guard people
Foundation check	3	1	1
Equipment open-case inspection	4	1	1
Reactor installation	6	1	1
Busbar and grounding wire installation	4	1	1

Note: The worker quantity depended on the project scale.

3. Installation equipment preparation

Prepare, check and maintain installation equipment according to construction requirements before construction.

Table 2 Main equipment and instrument list

No.	Name	Type/No.	Unit	Qty.	Remark
1	AC welder	380V 20kW	Set	2	
2	Level gauge	DS05	Set	1	
3	Torque spanner	8.8-274.6 Nm	Set	1	
4	Nylon sling	10T 8m	Pcs	4	

5	Crane	25T	Set	1	
6	Electric force compound grease	/	kg	2	
7	Wood beam	/	Batch	1	

Note: Equipment and instrument equipped according to the specific size of quantities; the wood beam equipped according to the actual weight of reactor.

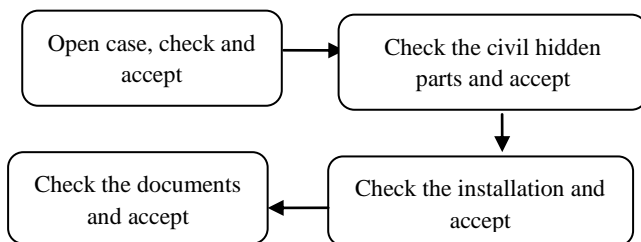
4. Preparation for materials of construction

No.	Description	Spec No.	Unit	Qty	Remark
1	U-steel	/	Pcs.	2	
2	Shim plate	/	Pcs.	/	
3	Welding stick	E4303	Pcs.	1	
4	Cement	C20	kg	10	
5	Silver powder	/	kg	1	
6	Earthing flat iron	/	Meter	/	
7	Bolt	/	Set	/	

Note: Materials of construction should be equipped with according to the specific size of quantities and reactor type.

Section IV Equipment acceptance check

1. Operation flow chart of acceptance



2. Equipment storage

When the equipment ship to the site, should be stored in indoor or outdoor flat without water on the ground according to its application; Take

rain-proof measures to custody reactor.

3. Equipment open-case inspection

3.1 The main check item: check whether the type of equipment, the design parameters like product type, rated capacity, rated voltage and rated reactance rate are conform to the design drawing. Product certification, product manual, test data, drawings, as well as spare parts, special tools are complete.

3.2 Check if there have any damages and deformation on reactors during transportation; check whether there have foreign matters in the coil seams, whether it is loose, crack on all joint and connecting wires, whether there is damage for insulation or surface is dirt.

3.3 Record the check results faithfully, confirmed and signed by three parties. After open case checking, all data collected by full-time librarians, all accessories kept by material person and handover them until the project finished. Table 1 shows the record format.

4. Acceptance check of invisible portion in civil engineering

4.1 Test the levelness of embedded steel plate by level gauge, line out the highest and lowest point of base, and adjust all embedded steel plate to levelness, check the foundation and the metal component embedded in the foundation is consistent with the drawings.

4.2 The metal fence of dry type reactor, embedded steel plates, supports, rebar in foundation and grounding conductor shall be connected open loop and one point should connect to the main grounding network and shouldn't form a closed loop.

4.3 The ground resistance of dry type reactor shall not more than 0.5Ω.

4.4 The vertical distance between open loop grounding grid of dry type reactor and dry type reactor shall be greater than 0.5 times of dry type reactor diameter.

4.5 The cement foundation of dry type air-core reactor shall use C20 or above concrete. The steel bar usage amount is depending on the reactor weight. Please be noted that the rebar shouldn't form closed loop circuit.

5. Acceptance check during installation procedure

- 5.1 Equipment installation conforms to related equipment installation specification and requirements mentioned in supplier's manual.
- 5.2 Reactor shall be installed according to the serial number and supplier's technical requirements.
- 5.3 The weight of reactor should be evenly distributed in all post insulator, and fixation.
- 5.4 The connection of terminals and busbar shall comply with current *GB50149-2010 "Electric device installation, busbar device construction and acceptance regulations"*. When the rated current get 1500A or above, shall use bolts which be made of nonmagnetic metal.
- 5.5 All component parts in reactor interval must be made of stainless steel bolts.
- 5.6 The grounding of the post insulator of reactor coil shall meet the following requirements:

- (1) When stacked installing, all post insulators at the bottom shall be earthed, the rest post insulators in top layer shouldn't be earthed.
- (2) When installed each single phase alone, each phase post insulators shall be earthed.
- (3) The grounding wire of post insulators shall not formed a closed loop.

5.7 The post insulators and coils shall not be damaged or deformation during lifting and installation

6. Handover data and files when put into operation

- 6.1 Collect complete as-built drawings, change design evidence documents.
- 6.2 Equipment manual, test report, certification,

installation drawings and other technical documents

6.3 Field debugging records and installation records

6.4 Spare parts list

Section V Reactor Installation

Hoisting of reactor

1.1 When hoist the reactor with lifting holes in the conductive arm, firstly make the U-rings through the hoisting hole in the conductive arm, then use chain or wire rope to hoist rings;

1.2 When hoist the reactor equipped without a lifting hole in the conductive arm, should use a long crane boom with a pin hole to penetrate into the center hole of reactor and then put on a pin and hoist. After hoisting, take it out of the crane boom;

1.3 It is forbidden to use wire rope to hoist reactor conductive arm end directly. If hoisted by wire rope directly, will do damage to reactor performance.

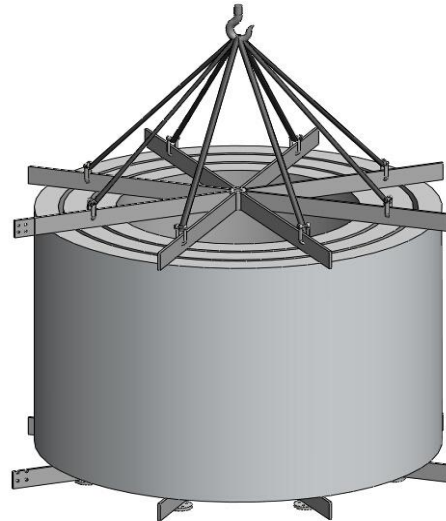


Figure 1 Lifting with hoisting holes

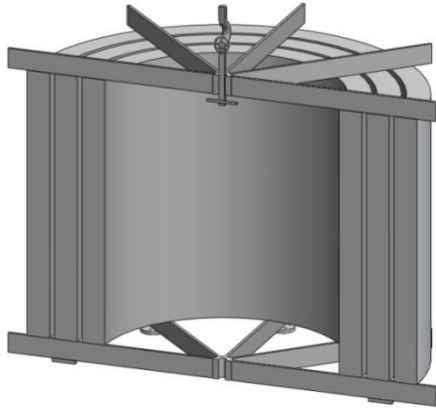


Figure 2 Lifting with hanging bar

Reactor installation type

There are four basic mounting modes: three-phase vertically stacked arrangement, two-phase stacked and one-phase horizontal arrangement, three-phase side-by-side arrangement and three-phase delta arrangement.

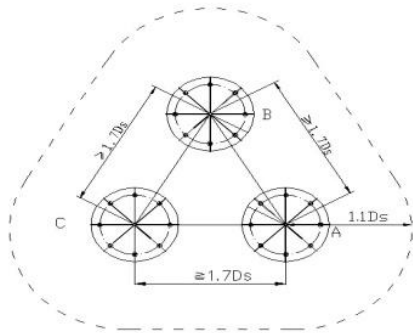


Figure 3 3-phase delta arrangement

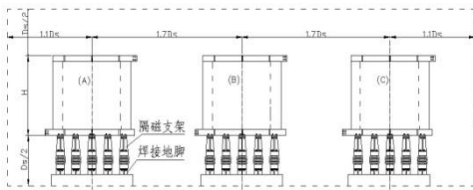


Figure 4 3-phase side by side arrangement

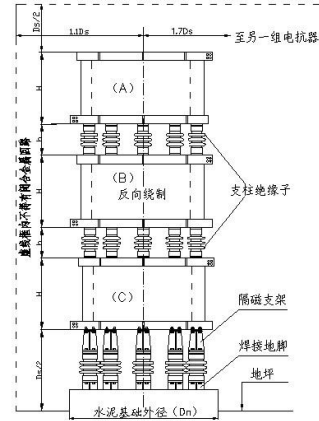


Figure 5 3-phase vertically stacked arrangement

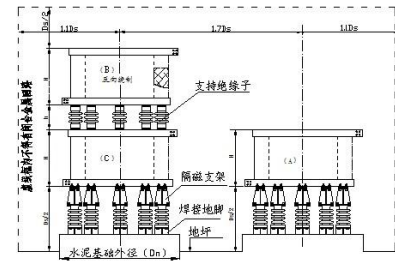


Figure 6 two-phase stacked and one-phase horizontal arrangement

3. Reactor installation considerations

3.1 When install reactor, the distance between the ceiling, floor, walls, fences and adjacent reactor should satisfy the requirement given in the dotted box .(figure 3 to 6)

3.2 When the reactor is installed in the indoor, should take measures to prevent resonance to avoid the resonance between reactor and building.

3.3 The phase sequence, outlet and inlet installation should be in strict accordance with the technical agreement and installation drawings, which cannot be changed random.

3.4 If reinforce the cement foundation of reactor with rebars, be attention to not form a closed metal loop among the rebars. If necessary, should take enough insulation measures or increase the reactor height from

the ground.

3.5 Before reactor installation, users should embed the embedded parts according to the anchor size provided by the reactor drawings in advance and do level correction.




3.6 During the installation, if any metal matters such as bolt, nut, flat spring washers and etc fall into the airway of reactor, should clear away in time.


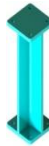

3.7 All operators shall wear protective gloves, safety helmets during installation process. The lifting operation should be operated by 2 persons at minimum. When bottom unprotected, under no circumstance don't allow the operator to arm or other parts of the body put into the bottom to work.

3.8 After reactor installation, should remove the U-shaped rings, boom and outer packaging materials of reactor.

3.9 After the support accessories installation finished, please check the perpendicularity of support accessory, the tolerance of perpendicularity should be less than 10 mm.

4. Relevant accessories in reactor installation

No.	Description	Type	Function	Schematic diagram
1	Rubber gasket	XJD-106	Work as support attachments to reduce shock and noise.	
		XJD-122		
2	Insulator	FZSW-72.5/10	Insulator is used to support and fixed reactor, and make enough insulation distance between reactors or between reactor	 
		ZSW-35/4L		
		ZSW-35/8L		
		TR205		
		TR220		

3	Magnetic separation bracket	CJ-200	Magnetic separation brackets usually made of 6061 aluminum. Mainly is used to support reactor, increase the magnetic distance from reactor to earth.	 
		CJ-400		
		CJ-400/140-F		
4	Welding anchor	TJ-8	Iron anchor is generally made of Q235A steel plate after cutting, galvanized processing. It is one supporting part, usually be welded with users embedded parts.	
		DXTJ-8		

5. Installation of dry type air-core reactor

5.1 Installation preparation

According to the construction requirements and reactor installation drawings, check the type of support accessories model and quantity, bolt type and quantity.

Check carefully the outlet and inlet wire position and the location of embedded parts, ensure the installation direction of terminals.

5.2 Installation of 3-phase stacked arrangement Mounting sequence

Step1. According to the installation drawing, select support type, and assemble all support parts into a whole, as shown in figure 7-9.



Figure 7 Installation of double magnetic separation bracket



Figure 8 Installation of single magnetic separation bracket



Figure 9 Installation of insulator directly

Step2. Firstly lift the reactor, then fix the assembly on the bottom of reactor with bolts one by one.

Note: Please don't fasten the bolt tightly, it is better to reserve 2-3 wire, as shown in Figure 10-11.

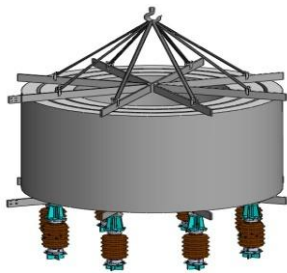


Figure 10

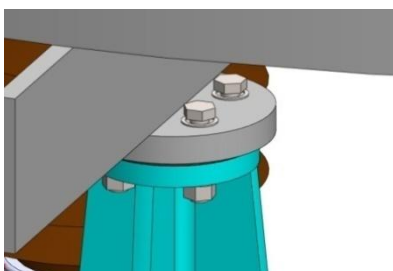
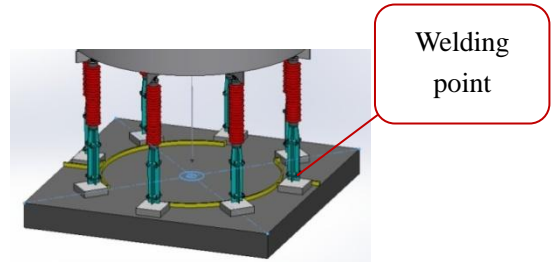


Figure 11

Step 3. After fasten the bottom bolts, align the reactor circle with basis circle, at the same time fill the gap between iron anchor and embedded parts with flat iron, then weld the iron anchor and embedded flat iron into one organic whole, as shown in Figure 12.



✧ **Note: When the reactor drop down, should ensure the inlet and outlet position are according with drawings.**

Step4. Lift the middle phase reactor and connect the insulators between phases to bottom foot. Be note that shouldn't fasten the bolt completely and drop down the middle phase slowly. Then connect the insulators between phases to upper foot. Finally fasten all bolts completely, as shown in Figure 13.

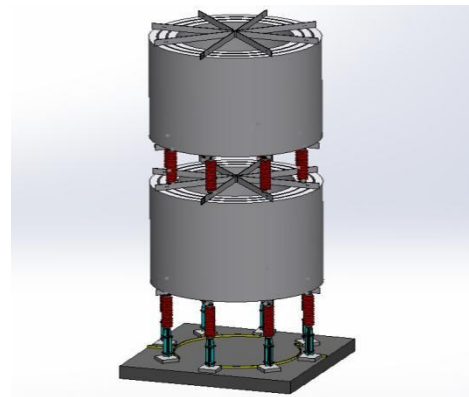


Figure 13

Step 5. Same method with step 4, install the upper phase reactor onto the middle phase reactor, as shown in Figure 14.

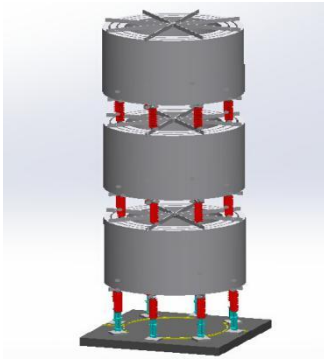


Figure 14

Step6. Install the whole reactor, do anti-corrosion treatment for welding parts of reactor and embedded flat iron, namely clean welding slag, paint a silver powder coat after antirust paint.

Note: The mounting method of side by side arrangement and two phases stacked, one phase horizontal arrangement can refer to the above steps.

6. Installation of busbar

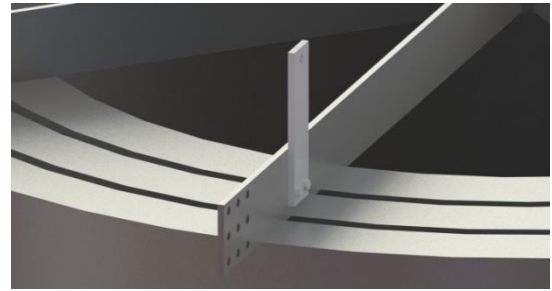
Firstly measured the busbar length by laying down, then pressured well according to the welding technique requirement. The busbar installation requires beautiful arrangement and adequate electrical distance. The distance from phase to earth and phase to phase should comply with relevant regulations. Paint electric force compounded grease on faying surface between busbar and terminal board; connect with stainless steel screw on reactor side.

7. Installation of ground lead

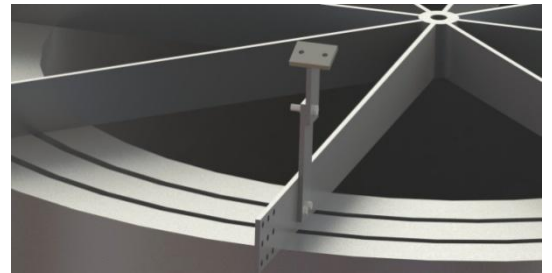
Weld the basis channel steel firmly, and weld galvanized ground round steel (or other rust-proof ground wire) on the embedded steel plate, but can't form a closed magnetic circuit. When stacking installation, the post insulator of bottom base should be grounded, the rest post insulators shouldn't be grounded.

8. Installation of protection cover

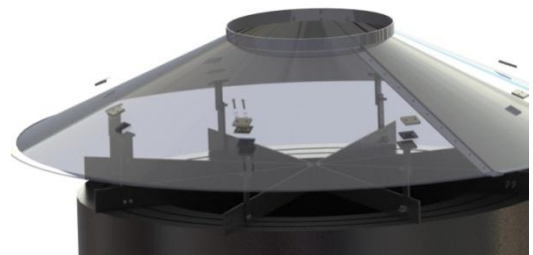
8.1 First fix protective cover bracket and top conductive arm with M12×55bolt.



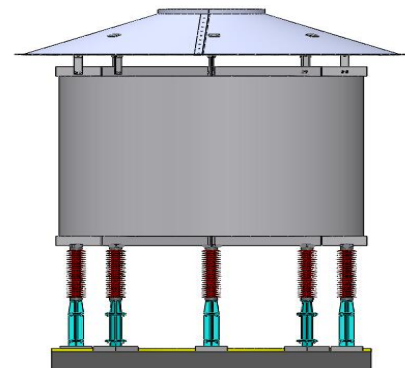
8.2 Fix the short support and long support of protective cover with M16×50 bolts.



8.3 Lift the arc shield by crane to the top bracket, and then fix the aluminum clamp, damping rubber gasket and protective cover with M12×55 bolts.



8.4 Finish assembly of protective cover



* Note: After installation finished, should remove the lifting ring, then screw down with M12×55 bolts at this position.

9. Quality control

9.1 Reactor installation site should be no gas, steam, chemical deposition, metal debris, severe dust pollution and other explosive and corrosive medium which would take serious effect on insulating.

9.2 The support and coil insulation shall not be serious damaged or crack, coils no deformation, post insulator and accessories are complete.

9.3 When vertical installation, each phase center line should be consistent. If upper reactor stacked with lower reactor, should put one rubber gasket on the top hat of insulator, whose size is same with the hat and its' thickness is less than 4 mm.

9.4 When reactor upper and lower stacked together, all bottom post insulators should be grounded, the others shouldn't be grounded. If each single phase installed separately, all its post insulators should be grounded. The grounding line of post insulators should not form a closed loop.

9.5 Three phases installation position shall not be changed, must according to the factory phase sequence and installation location mentioned in design drawings. The connecting line with expansion joints should comply with the design requirements.

9.6 The centre point of coil circle should align at the centre point of embedded foundation; the deviation in the horizontal direction is not more than 5mm.

9.7 The busbar spacers should be arranged staggered according to specification requirement.

9.8 The wire, connector and terminal blocks should be connected firmly.

9.9 After installation finished, please check it with torque spanner. Following table shows the torque size. All bolts, double-end bolts, thread, pipe thread, bolt clips and nuts should be made of stainless steel un-conducted magnetic materials according to ISO and SI standard. It is better that the bolts come out 2-3 teeth.

Table 3 Bolt type and torque value

Bolt type (mm)	Torque value (N.m)	Bolt type (mm)	Torque value (N.m)
M8	8.8--10.8	M10	17.7—22.6
M12	31.4--39.2	M14	51.0—60.8
M16	78.5--98.1	M18	98.0--127.4
M20	156.9--196.2	M24	274.6--343.2

9.10 The rain covers are installed firmly.

9.11 The safety enclosures are installed firmly and grounded well, the enclosure doors should be reliable closed and don't form closed circuit.

9.12 The factory test data and commissioning test data are qualified.

9.13 Handover data and technical files are complete.

10. Commissioning items check

After installation checking, should do following acceptance tests and the test results should conform to the routine test report.

10.1 Measurement of DC resistance

When measure the DC resistance on site, should use a double-arm DC bridge, the temperature of reactor and ambient temperature should be basic same, and convert the resistance value at 75°C.

10.2 Measurement of winding resistance

Use 2500V tramegger to measure winding resistance, the measured value shall conform to relevant standard and technical agreement.

10.3 DC leak test

10.4 AC withstand voltage test

10.5 Insulator inspection

10.6 RTV coatings hydrophobic performance test

10.7 Impact closing test under rated voltage

11. EHS Control measures

11.1 Control measures

11.1.1 Hoisting operation should be commanded by specially-assigned person, and the specially assigned person shouldn't go away during hoisting process.

11.1.2 When reactor is in place, should take measures to prevent crash. The manpower should be enough and in unified command, to avoiding to hurt person by dumping. In narrow place should prevent crushing.

11.1.3 When mounting the support porcelain should tighten the bolts uniformly, to avoid producing stress and porcelain crack occurred.

11.1.4 When entering the construction site should pay attention to protect the product. Keep civilized construction on site, and all the equipment, materials, and tools are in place orderly.

11.1.5 Working under high or low temperatures, the construction personnel should have enough protection facilities; Wear glasses correctly when fire welding and using polishing machine; the electric welding personnel should use the protective goggles masks.

11.1.6 It must be equipped with enough lighting equipment when construct at night, construction workers should have enough spirit and energy.

11.1.7 All hoisting tools must be inspected and meet the safety requirements. Hoisting steel wire ropes must be inspected periodically, unqualified shall not be used. Hoisting operation must be commanded by specially-assigned person, who cannot leave during the hoisting process.

11.1.8 When padding the equipment, shall not reach hand into the bottom of foundation. When equipment connection, be careful to crush hand.

11.2 Hazard identifying

Hazard identifying and controlling measures

Table 13-1

No.	Hazards	Control measures
1	Improper hoisting operation command	(1) Command signal from controller must be clear and correct. (2) The controller should stand on the safe place where suit the operator to see the clear command signal. When following load to command, should command load to avoid people and obstacles at any time.
2	Improper using hoisting tools	(1) Lifting chain hoist used must be in good condition, easy to operate; Lifting rope should be without damage and fracture barge, meet the load-bearing load less than 75% of total breaking force.
3	Welding operation	(1) Outer shell of welding machine must be reliable grounding, the grounding resistance should not be more than 4Ω. (2) It shall not be more than one in series connection grounding welding machine, the hot insulation resistance of all circuits to enclosure shall be not less than 0.4M. (3) Exposed conductive parts and rotating parts of welding machine must be installed protective cover. (4) The insulation of the electrode holder and welding wire must be good; Conductor cross section should be adapted to working parameters. Electrode holder and cutting torch should have good insulation ability.
4	Working at heights	(1) When working at heights must fasten the safety belt, safety belts should be hung solidly; The operator working at heights shall dress flexible suits with sleeves and trousers tighten, wear soft-soled shoes. (2) The place for working at heights, each platform, walkway and scaffolding shall not be stacked more than allowable load. The construction materials

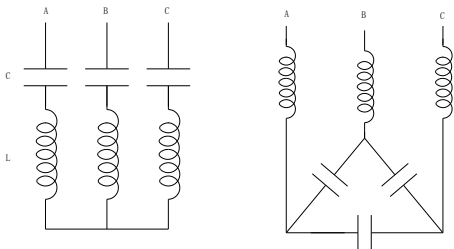
		should be used at any time. (3) The person working at heights should be equipped with tool bag. For larger tools should tighten with insurance rope; forbid throwing goods during pass.
5	Assembly equipment dump and hurt person	During the process of assembling, pay attention for cross-operation. The equipment support should steady and firm. It must be a guardian for assembling operation.

Chapter V Use of dry type air-core reactor

Section I Dry type air-core series reactor

1. Product application

CKGKL series dry type air-core series reactors are suitable for in series with high voltage shunt capacitor bank, to reach restrain waveform distortion in network voltage, control harmonic component flowing through capacitor bank and limit surge current when capacitor bank put into power grid.



Wiring diagram of series reactor and matching capacitor bank

2. Carried Standard

JB/T 5346-2014 Series reactor connected in series with high voltage shunt capacitors ;

GB/T 1094.6-2011 Power Transformer Part6:Reactor ;

IEC 60076-6-2007 Power Transformer Part6: Reactor

3. Structural feature

(1) Dry type air-core series reactors composed by main coil part, post insulator, non-magnetic metal support and welding anchor, connected by non-magnetic bolts into a whole.

(2) The coil main part of reactor adopts multi-layer parallel cylindrical aluminum (copper) structure, several packs inside, and each pack with several layers. This structure divides the conductor cross section into many small sections with insulation wire parallel winding, can reduce the inter-turn voltage, make the inter-turn insulation safety and reliability, and reduce eddy current loss. Because each layer is parallel winding, low coil inter-turn voltage, suitable for outdoor running.

(3) Reactor coil inside and outside are all wound of the insulated dipping glass fiber, after high temperature curing into a whole, with high mechanical strength, can withstand shock of big short circuit current, and small noise. No ventilation between each pack, easy for air convection and heat radiation.

(4) All outgoing line of reactor coils is lead to star conductive arm hangers, this structure can meet the requirements of coil fractions turns.

4. Main technical parameters

(1) Insulation level conforms to related standard, details see below table:

System rated voltage (RMS value) kV	Power frequency voltage (dry type) ((RMS value) 1min kV	Impulse withstand voltage (peak value) 1.2/50μs kV
6	32	60
10	42	75
35	100	200
66	165	325

(2) Insulation endurance class conforms to national standard, details see following table:

Part	Insulation system temperature °C	Temperature rise limit value K

Coil (resistivity method)	120 (E)	70
	130 (B)	75
	155 (F)	95
	180 (H)	120
	220 (C)	145

(3) At rated current, the sound level shall not exceed the data stipulated in below table:

Rated capacity kVar	Sound level dB
<80	48
80~125	50
125~200	52
200~315	54
315~500	56
500~800	58
800~1250	60
1250~2000	63
2000~3150	66

(4) Overload capacity: reactor can run continuously at largest working current when power frequency current is 1.35 times of rated current.

(5) Thermal stability: reactor can withstand the maximum short-time current impact for 2 seconds at rated current which is reciprocal times of rated reactance rate.

(6) Dynamic stability: dynamic stability current is 2.55 times of thermal stability, duration 0.5 seconds, without any mechanical damage.

Section II Dry type air-core current limiting reactor

1. Product application

XKGKL series current limiting reactors are suitable for series connection in system circuits, to add system impedance. To limit short current when system break down, reduce the fault current to admissible value.

2. Carried Standard

GB/T1094.6-2011 Power Transformer Part6:

Reactor;

IEC 60076-6-2007 Power Transformer Part6:

Reactor

3. Structural feature

(1) Dry type air-core current limiting reactors composed by coil main part, post insulator, non-magnetic metal support and welding anchor, connected by non-magnetic bolts into a whole.

(2) The coil main part of reactor adopts multi-layer parallel cylindrical aluminum (copper) structure, several packs inside, and each pack with several layers. This structure divides the conductor cross section into many small sections with insulation wire parallel winding, can reduce the inter-turn voltage, make the inter-turn insulation safety and reliability, and reduce eddy current loss. Because each layer is parallel winding, low coil inter-turn voltage, suitable for outdoor running.

(3) Reactor coil inside and outside are all wound of the insulated dipping glass fiber, after high temperature curing into a whole, with high mechanical strength, can withstand shock of big short circuit current, and small noise. No ventilation between each pack, easy for air convection and heat radiation.

(4) All outgoing line of reactor coils is lead to star conductive arm hangers, this structure can meet the requirements of coil fraction turns.

4. Main technical parameters

(1) Insulation level conforms to national standard, see following table:

System rated voltage (RMS value) kV	Power frequency voltage (dry type) (RMS value) 1min kV	Impulse withstand voltage (peak value) 1.2/50μs kV
6	32	60
10	42	75

35	100	200
66	165	325

(2) Insulation endurance class conforms to national standard, detail data is shown in below table:

Part	Insulation system temperature °C	Temperature rise limit value K
Coil (resistivity method)	120 (E)	70
	130 (B)	75
	155 (F)	95
	180 (H)	120
	220 (C)	145

(3) The sound level of reactor at rated current shall not exceed the stipulated in the below table:

Rated capacity kVar	Sound level dB
<80	48
80~125	50
125~200	52
200~315	54
315~500	56
500~800	58
800~1250	60
1250~2000	63
2000~3150	66

(4) Thermal stability: reactor can withstand the maximum short-time current impact for 2 seconds at rated current which is reciprocal times of rated reactance rate.

(5) Dynamic stability: dynamic stability current is 2.55 times of thermal stability, duration 0.5 seconds, without any mechanical damage.

Section III Dry type air-core filter reactor

1. Product application

LKGKL series filter reactor in series with filter capacitor bank form a resonant circuit, make it resonance at a certain frequency point, filter specified high harmonic, at the same time it can realize power system reactive compensation and limit the surge current when capacitor bank put into power grid.

2. Carried Standard

GB/T1094.6-2011 Power Transformer Part6:

Reactor;

IEC 60076-6-2007 Power Transformer Part6:

Reactor

3. Working principle of filter reactor

(1) Filter reactor inductance adjusting

The inductance adjusting of filter reactor is divided into two types, turns regulating and pitch adjusting. Two structures of reactor see Figure 1 and 2.

(2) Working principle of regulating turns filter reactor

The turns regulating filter reactor is composed by main coil and regulating coil. Regulating coil installed outside of main coil through insulation block, total inductance value of whole reactor constitutes main coil and regulating coil. Inductance value of main coil is about 95% of total value, and the inductance value of regulating coil is about 5% of total value. Changed through turns of regulating coil can smoothly regulate the inductance value. By changing the direction of current in regulating coil can regulate the inductance value of main coil from positive and negative two directions. Just is $L=L_{main} + L_{regulating}$.

(3) Working principle of pitch regulating filter reactor

Pitch regulating filter reactor is composed by two same winding direction and same turns and iso-structural reactors. Two reactors through adjustable stainless steel bolts support each

other up and down form one reactor. By adjusting the stainless steel bolt to change the center distance of two reactors, namely changed the mutual inductance between two reactors, to smoothly regulate inductance value. That is $L=2L_1+M$

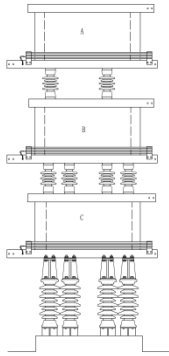


Figure18

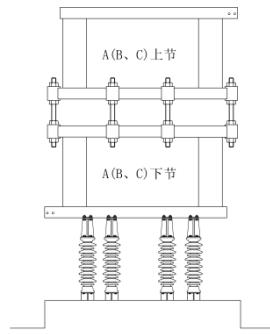


Figure19

4. Overall structure of filter reactor

4.1 Filter reactors composed by main coil, regulating coil, post insulator, and non-magnetic metal support, connected by non-magnetic bolts into a whole.

4.2 The main coil of reactor adopts multi-layer parallel cylindrical aluminum (copper) structure, several encapsulations inside, and each encapsulation with several layers. This structure divides the conductor cross section into many small sections with insulation wire parallel winding, can reduce the inter-turn voltage, make the inter-turn insulation safety and reliability, and reduce eddy current loss.

Because each layer is parallel winding, low coil inter-turn voltage, suitable for outdoor running. Regulating turns coil adopts special insulation conductor winding, through special epoxy bracket and fixed frame to fasten, effectively reduce the operation noise of reactor.

4.3 Reactor main coil inside and outside are all wound of the insulated impregnated glass fiber, after high temperature curing into a whole, with high mechanical strength, can withstand shock

of big short circuit current, and small noise. No ventilation between each pack, easy for air convection and heat radiation.

4.4 All outgoing line of reactor coils is lead to star conductive arm hanger, this structure can meet the requirements of coil decimal turns.

5. Tuning of filter reactor

5.1 Tuning of regulating turns filter reactor

5.1.1 Outlet end of reactor is lower conductive arm OUT terminal; fix epoxy board and aluminum junction plate here one by one.

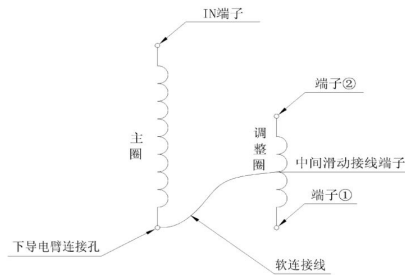
5.1.2 When reactor need positive inductance, please connect outlet terminal (lower conductive arm) and terminal 1 at bottom of regulating coil by flexible connection; connect terminal 2 at top of regulating coil to aluminum board by another flexible connection. Outside installation aluminum plate connect to aluminum board, then regulating coil is positive inductance, the inductance value is the maximum positive value of rated value.

5.1.3 When reactor need negative inductance, please connect outlet terminal (lower conductive arm) and terminal 2 of regulating coil by flexible connection; connect terminal 1 of regulating coil to aluminum board by another flexible connection. Outside installation aluminum plate (or cable) connects to aluminum board, then regulating coil is negative inductance, the inductance value is the minimum value of rated value.

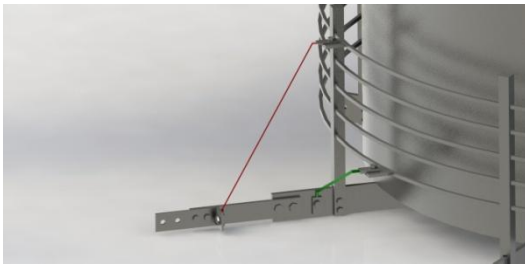
5.1.4 If the users need other inductance value except rated, maximum and minimum value, suggest priority to choose other welding terminals. Detail connection method is as follow: first connect the selected terminal with the nearest low conductive arm terminal, outlet position connected by positive terminal 2 (or negative terminal 1) via flexible connection to

aluminum board, then connect to outside aluminum plate.

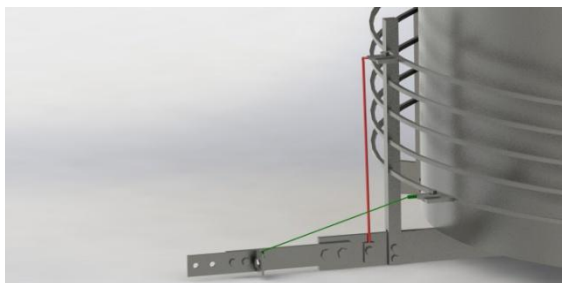
5.1.5 The oxide layer on electric joints should be wiped off and then coat the conductive paste, fix connecting bolts tightly.



Debug connecting diagram of regulating coil



Positive connecting picture
(Maximum inductance at this moment)



Negative connecting picture
(minimum inductance at this point)

5.2 Tuning of pitch adjusting filter reactor

5.2.1 When the center distance of upper and lower reactors is the maximum, the inductance value of regulating distance filter reactor is the minimum; when the center distance of upper and lower reactors is the minimum, the inductance value of regulating distance filter reactor is the maximum. Ensure the stability of reactor during transportation, the reactance value tuned the maximum position when leave factory.

5.2.2 Tuning of regulating distance filter reactor can proceed when measure the inductance. Connect the pen of inductance testing instrument on the up and down terminals of reactor, adjust the position of tuning bolt by spanner one by one. That can change the center distance of two reactors, when the show value of inductance testing instrument meet requirement, fasten all tuning nuts.

5.2.3 After tuning of regulating distance filter reactor, ensure the distances from upper and lower sides of tuning bolt to upper and lower star supports are same, ensure good touch between aluminum plate and terminals on middle start support, the contact face shall be wiped off oxide layer and coat conductive paste.

Section IV Dry type air-core shunt reactor

1. Product application

Dry type air-core shunt reactor is one type of dry type air-core reactor. It is connected in parallel in power system like substation. Main purpose:

- (1) Absorb capacitance reactive current, reduce transmission loss and suppress overvoltage in light load.
- (2) Suppress capacitive operation of generator in light load, improve stability, and prevent occurs abnormal voltage.
- (3) Compensate ground capacitance current of 6~35kV cable and overhead lines.
- (4) Match with TCR in SVC, reach tracking and balance the reactive.

2. Carried Standard

GB/T1094.6-2011 Power transformer Part

6: reactor

IEC 60076-6-2007 Power transformer Part

6: reactor

JB/T 10775-2007 6kV~35kVshunt reactor

technical data and requirement

3. Main technical parameters

(1) Insulation level:

System rated voltage (kV)	Power frequency withstand voltage (RMS value) 1min(kV)	Impulse withstand voltage (peak value) 1.2/50 μ S(KV)
6	32	60
10	42	75
35	100	200

(2) Temperature rise:

At rated frequency and maximum operation voltage, the allowable temperature rise of reactor shall not exceed the stipulated in the below table:

Temperature rise limits of dry type air-core reactor

Insulation class	Allowable temp.	Temp. measure method	Temp. rise limits	Temp. measure method
	Temp. $^{\circ}$ C		K Temp. rise	
A	105	Embedding thermometer method	65	Resistivity method
E	120		70	
B	130		75	
F	155		95	

(3) Reactance deviation:

At rated frequency and voltage, reactance allowable deviation of reactor is $\pm 5\%$ of rated reactance.

Three-phase reactor or three-phase group composed by single phase, the reactance of each phase measured in symmetrical voltage, meet $\pm 5\%$ deviation and the deviation of three-phase reactance average value also shouldn't exceed $\pm 2\%$.

(4) Loss deviation:

The loss of reactor after adjusted shouldn't exceed +10% of specified value.

(5) Creepage distance:

According to GB/T 26218.1-2010, IEC/TS 60815-1-2008.

(6) Electrical distance:

Rated voltage (kV)	10.5	36.5	66	115	230	525
Minimum distance (m)	0.2	0.4	0.65	1.1	2.0	4.3

Except meet above requirements, in order to reduce leakage flux influence, the distance from windings to ground or to support foot metal support is more than 1/2 of winding diameter; it can small if the metal support is non-magnetic material.

Chapter VI Maintenance, repair cycle and items

Section I Maintenance items and cycle

1. Maintenance items and cycle when energized

No.	Items	Method	Cycle	Remark
1	Check any pollution and foreign matter on surface	Visual	Monthly	
2	Check any discolor obvious on surface	Visual	Monthly	
3	The voice is normal or not	Listen	Weekly	
4	Each part any overheating	Infrared temp. measurement	Weekly	

2. Maintenance items and cycle when power cut

No.	Items	Method	Cycle	Remark
1	Check any crack on conductive arms	Visual	Yearly	
2	Check any crack or loose on welding leads	Visual	Yearly	
3	Check any loose on terminal connection	Visual	Yearly	
4	Check any loose on each fastening bolts	With wrench	Yearly	
5	Check any overheating on outside and inside surface	Visual	Yearly	
6	Check any loose on protective cover	With wrench	Yearly	
7	Check cleanliness of air path and active part	Visual	Yearly	
8	Check any loose for supports in air path	Manual	Yearly	
9	Check any crack or drop for surface painting, RTV paint	Visual	3~5 years	
10	Check insulator whether complete and clean	Visual	Yearly	
11	Check insulation whether good	Visual	Yearly	
12	Check surface hydrophobicity	Visual	Yearly	

No.	Items
1	Before operation in high temperature and low temperature weather
2	After the wind, fog, snow, hail and thunderstorm
3	After equipment changed
4	After equipment put into operation
5	Put into operation again after repair, rebuilt or long period off-the-line
6	Abnormal conditions inspection main include equipment heat, system voltage fluctuation, abnormal vibration and noise for main body.
7	After rebuilt of grounding body

3.2 Tour inspection items and requirements

No.	Items
1	Except normal tour inspection items, also note other abnormal conditions.
2	Check the heat of inside reactor and lead connector by infrared thermometer during operation
3	External insulation whether flashover and surface any discharge in high wind raise dust, fog, rain weather
4	Any damage for external insulation in snow and hail weather, main body no incline and deformation, and no foreign matter
5	Grounding body, fence and enclosure whether abnormal heating, can check compared with other equipment, snow melt faster, water vapor is obvious and etc.
6	Reactor has common defects and changes recently

3. Special tour inspection

3.1 Tour cycle

7	Prior to find out the reason of failure after trip, shall not be put into operation again, should check whether the protective device is normal, any deformation and burning-out on turn-to-turn and support parts
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4. Minor repair items and cycle

No.	Items	Method	Cycle	Remark
1	Check any deformation or crack on conductive arms	No deformation and crack	Yearly	
2	Check any crack or loose on welding leads	No crack	Yearly	
3	Check any loose on terminal connection	No loose	Yearly	
4	Check any loose each fastening bolts	No loose and good contact	Yearly	
5	Check any overheating on outside and inside surface	No discolor and overheating	Yearly	
6	Check any loose for protective cover	No loose	Yearly	
7	Check cleanliness of air path and active part	Unblocked, clean	Yearly	
8	Check any loose for supports in air path	Fastness	Yearly	
9	Check any crack or drop on surface painting and RTV paint	No crack	3~5 years	
10	Check insulator whether complete and clean	No abnormalities and clean	Yearly	

5. Major repair items and cycle

No.	Items	Method	Cycle	Remark
-----	-------	--------	-------	--------

1	Clean reactor surface and air path	Ventilate and water washed, make it clean	Yearly	
2	Painting again each 5 years/RTV coating	Painting on time if fall off	5~6 years	
3	Complete check fastening bolts	Tighten each one by spanner	Yearly	

6. Temporary repair

No.	Items	Method	Cycle	Remark
1	Current and voltage fluctuate during operation	Must find the reason of power cut	Any time	

Section II Maintenance and repair preparation

1. Tools, materials and personnel allocation

1.1 Tool requirements

No.	Name	Type (Accuracy)	Unit	Qty.	Remark
1	Torque spanner	Various	Set	1	
2	Welding equipment	Argon arc welding machine	Set	1	
3	Washing equipment	1.2-2.0Mpa	Set	1	
4	Safety belt	1T	Set	Some	
5	Ladder	6M	Set	2	
6	Grounding wire	10mm ²	M	Some	
7	DC resistance tester	0.001mΩ-20kΩ	Set	1	
8	Insulation resistance meter	Digital display 2500kΩ	Set	1	
9	Power frequency withstand voltage equipment	250kV	Set	1	

10	Spare bolts	304 stainless steel	Set	Some	
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1.2 Consumable list

No.	Name	Type (Accuracy)	Unit	Qty.	Remark
1	Gasoline	90#	Litre	1	
2	Gauze	0.04mmThickness	M	Some	
3	White colth	0.04mmThickness	M	Some	
4	Brush	50/100mmWidth	Set	Some	
5	Alcohol		Litre	0.5	
6	Conductive paste		KG	Some	
7	Welding material	Aluminum alloy welding material	Pcs	Some	
8	Epoxy resin glue	Normal temperature solidify	KG	Some	
9	Paint	Anti-UV paint/RTV	Litre	Some	

1.3 Personnel requirements

Personnel qualification	Personnel requirements		Labor-hour requirements	
	Maintainer	Factory staff	Maintainer	Factory staff
HV electrician	3~4	1	2 working days	2 working days

2. Preparation requirement of maintenance and repair when power cut

2.1 Technical preparation

It should make perfect maintenance repair operation instructions before repair, including organization measures of maintenance, safety measures and technical measures. The main contents are as follows:

2.1.1 Working preparation, including power cut application and work ticket.

2.1.2 Personnel requirement and division the

work.

2.1.3 Operation flow chart should reflect the project and schedule.

2.1.4 Eliminating project, repair project and quality standards.

2.1.5 Construction scheme of special items

2.1.6 Test items and standards

2.1.7 Risk analysis, safety measures and notes.

2.1.8 Construction tool list, spare parts list and material list.

2.1.9 Drawings (included main technical parameters of equipment) .

2.1.10 All kinds of record forms.

2.2 Tool preparation

Tool and material preparation see First Section of Chapter Four.

2.3 Personnel preparation

Confirm the maintenance time, inform relevant personnel and equipment manufacturers that the working staff should arrive on site one day earlier and make personnel safety protective measures.

3. Workflow of maintenance and repair when power cut

3.1 Maintenance workflow when power cut

3.1.1 Cut power

3.1.2 Check power

3.1.3 Hang ground wire

3.1.4 Hang mark plates and set temporary shelter

3.2 Minor repair workflow

3.2.1 Use gauze to wipe the post insulator surface. If serious smudgy, swab with gauzes dipped in alcohol or gasoline. Check whether there is any crack, breakage, discharge and porcelain glaze stripping phenomena, if the stripping not exceeds specified area, can paste with epoxy resin adhesive glue.

3.2.2 Check whether the coil has any deformation, crack, breakage, insulation layer stripping phenomena. If the stripping not

exceeds specified area, can paste epoxy resin adhesive glue.

3.2.3 Check the wire connection. Wire should be connected firmly, contact well, no overheating phenomenon, tighten loose. Check the tension of the wire.

3.2.4 Check the regulating connection plate of dry type air-core reactor upper and lower part is normal or not. Connecting bolts should be connected and firmly, and the distance between the upper and lower part conform to the requirements.

3.2.5 Check whether the insulation for base of dry type air-core reactor is firm, grounding wire should be connected firmly, grounding is good.

3.2.6 Smear dry butter on the thread part of connecting bolts, and paint metal support with rust paint.

Section III Defect management and exception handling

1. Defect management

1.1 The management and treatment of defect and abnormal should be strictly implement according to relevant provisions of DL408.

1.2 Once find defects, should dispose them timely. Implement closed-loop management for defects.

1.3 Defects often is referred to damage of any parts of dry type reactor, defective insulation or abnormal running state, divided into critical flaws, serious defect and general defect.

1.4 Once find critical and serious defects, the operator must report to relevant authorities immediately. Closely monitoring developments, if necessary, can withdraw the defective equipment by scheduling command.

1.5 Once find general defects, operator should record the defects and report monthly by the principal.

1.6 Defects found on the new equipment within a year, shall assist the relevant units to dispose.

2. Equipment defect classification

2.1 Critical defects: Equipment happened direct threat to the safe operation and need be disposed immediately, otherwise may cause damage at any time, personal injury or fire accident, such as the following situations.

2.1.1 Dry type reactor appears sudden abnormal sound or vibration.

2.1.2 Joints and coating surface are abnormal overheating or smoking.

2.1.3 Dry type reactor appears surface discharge.

2.1.4 Insulator has obvious crack.

2.1.5 Shunt reactor coating surface has serious cracking phenomenon.

2.1.6 Equipment can't keep continue running if key test indicators exceeds stipulation

2.2 Serious defects: defects have development trend, but still can continue running if take steps and wouldn't cause accidents, then list on monthly plan to dispose, like following situations:

2.2.1 Equipment has a little overheating, grounding body heat; fence and enclosure are abnormal heat.

2.2.2 Coating surface has creepage mark and crack phenomenon.

2.2.3 Post insulators have inclination on deformation (or displacement), temporarily wouldn't make any influence on continue running.

2.2.4 Support bar loose or fall off.

2.3 General defects: Except above critical and serious defects. Refers to the general, the situation is lighter, affects the safe operation not big, such as the following situations.

2.3.1 There is lack of not important parts on equipment.

2.3.2 Secondary test items missed or result is

unqualified.

2.3.3 Coating surface is not obvious discolor or slight vibration.

2.3.4 Insulator or coating is dirty, metal part has corrosion phenomenon.

2.3.5 Dry type reactor has bird nest or foreign matter inside, affects ventilation and heat dissipation.

2.3.6 Leading wire is loose.

2.3.7 Others are not belong to critical and serious defects.

3. Others

The personnel on duty should do analysis or prediction failure for defects or abnormal, and take corresponding measures according to the regulations.

Section IV Accident handling plan

1. Dry type reactor body appears smoking, fire and surface discharge.

1.1 Disconnect instantly.

1.2 Switch off disconnecting switch (Series reactor must close the grounding switch on capacitor side).

1.3 Extinguishment

2. Dry type reactor stop operation caused by tripping, cannot energized before finding out the tripping reasons.

3. Dry type reactor trip because of faults, the principle of treatment and procedure is:

3.1 Check the position signal of dry type reactor breaker, meter indicates, and check whether there is any change on system voltage ripple effect, if any, shall report the dispatcher immediately.

3.2 Completely check reactor body, inter-phase situation, and find out the fault point.

3.3 Check dry type reactor protective action situation.

3.4 Check the actual position of breaker,

mechanism situation, and whether the shunt arrester has any abnormal.

3.5 Report the details of inspection to dispatcher, apply switch off the dry type reactor or maintain, and do next treatment.

4. If there no voltage on the busbar due to main breaker tripping, please open each set shunt reactor manually. During normal operation process, please don't use main breaker to switch on the shunt reactor.

Chapter VII After-sales service

1. Service commitment

Generally, our product warranty period is one year (unless the contract has other stated, normally the date is from the user received product date). Besides, we provide lifelong maintenance service. To make continuous improvement, every year we will visit customers regularly, listen to customers' suggestion and establish callback file.

Regard the fault and problems caused by customers' improper operation and storage, we will clarify the reason from the facts, clear the responsibility, and actively provide customers troubleshoot, maintain the credibility of our company and products.

When the product occurs quality problems, if in the warranty period, our company will deal with charge free; if over the warranty period, our company will deal with charged any cost.

2. Service process at site

2.1 According to the contract, technical agreement and the customer asked us to assign personnel to site service, our company will dispatch competent professional service engineers according to working content and

arrive at site on time, provide installation, commissioning, maintenance, and guidance services.

2.2 After received customer service requirements, after-sales staff fills in the after-sales service record sheet. When come back, take the customer signed sheet regarding to the service attitude and service quality of the after-sales staff before his back.

2.3 Customers problems are disposed properly, complete the service and with the customers permit, the after-sales staff can return. The selling assistant will call-back according to the relevant records, track the service condition and quality.

3. Acceptance & Handling for the customer complaints

3.1 All department (or person) received customer feedback information for quality after products leave factory, first to fill in the customer information process sheet, transmit to after-sales service team.

3.2 After-sales service team will check and verify according to the customer information process sheet, fill in the temporary measures.

3.3 For the project do not need site service, due to the responsibility department to deal with and fill in root cause analysis sheet and take correct and preventive actions. After-sales service team track and confirm the treatment until problems be disposed properly.

3.4 For the project need on-site service, will dispatch service engineers to site based on-site condition, do services for maintenance, debugging or other services.

3.5 Customers problems are disposed properly, complete the service and with the customers permit, the after-sales staff can return. The selling assistant will call-back according to the customer information process sheet, track the service condition and quality.

3.6 Product quality problems, in the warranty period, our company will handle free; if over the warranty period, our company will charge the cost of materials and service properly.

Acceptance sheet of reactor unpacking

Table 1 Executive standards: IEC60076-6:2007,JB5346-2014,JB/10775-2007

Type	Series <input type="checkbox"/> Filter <input type="checkbox"/> Current-limiting <input type="checkbox"/> Parallel <input type="checkbox"/> Phase control <input type="checkbox"/>	Structure	Dry type air-core <input type="checkbox"/> Dry type core <input type="checkbox"/>	Service condition	Outdoor <input type="checkbox"/> Indoor <input type="checkbox"/>
Supplier		Qty.			
Type		Dimension	Depth() Width() Height()		
No.	Inspect Item	Technical Requirements	Inspect Method	Inspect Plans	Results
1	Quality certificate	Quality warranty or certificate of quality	Verify	Full check	Refuse to check if no certificates
2	Pillar insulator inspection	1)Each insulator has its manufacture number; 2)No damage and serious scratch on insulator umbrella skirt;	Visual check	Full check	
3	Inspection of coil body	1) Check the air path: There is no sundries to affect the ventilation in the air path, the supports are firm and without peeling phenomenon. 2) Check coil leads Check all inlet and outlet of coil should be no broken or tripping out from conductive arm at top and bottom; 3) Check the base angle After the outer package be removed, the base angle shouldn't have broken and unsoldering point by visual check; 4) Check the coil body There are no obvious traces of shock and protective paint falls off on coil surface. For filter reactor, there are no any deformation on tuning coil and tuning screw.	Visual check	Full check	
4	Installation accessories inspection	1) The quantity of all installation accessories meet the packing list, no lost; 2) All installation accessories are no obvious quality defects during the transportation	Visual check	Full check	
Unqualified description: Unqualified disposal:					
			Approved by	Date:	

Remarks: This sheet is only for appearance inspection of unpacking, final quality of product should be judged by field test.

Inspector:

Conclusion:

Date:

Table 2

Commissioning Test Report						
Product name		Serial No.				
Product type		A:		B:		
I . Rated parameters						
System rated voltage:	kV	Rated current:	A	Short-time current	kA	
Rated frequency:	Hz	Insulation class	Level	Duration:	S	
Rated capacity	kVar	Insulation level:	kV	Rated inductance	mH	
End rated voltage	kV	Impulse level:	kV	Loss of power frequency value:	kW	
Quality factor:						
II . Test condition						
Ambient temperature:	°C	Relative humidity:				
III. Test items Executive standards: IEC60076-6-2007, JB5346-2014, JB/10775-2007						
Item	Design value	Criterion	Test results			Conclusion
			A	B	C	
Measurement of winding resistance Ω		1. Comparing the test value and design value of each phase change 2% (convert to the same temperature) 2. The difference value of three-phase reactor winding DC resistance value 2% of the average value of three phases (only applicable to the flat put products)				
Insulation resistance MΩ	>1000	>1000				
AC withstand voltage kV		Applied voltage phase to earth, duration 1 minute, no flashover and discharge				
Impulse switching on test		Under the rated voltage impulse switch on three times, no any discharge and structural failures for the reactor				
Infrared temperature measurement		After running 10 hours, measure the temperature of reactor with infrared imager, the temperature rise of hot spot shall not exceed 85K. B:75K F:95K H:120K				
Appearance inspection:	Qualified					
Tested by	Checked by:		Date:			

Testing unit:

Base hidden grounding device construction record

Project name				Construction company			
Constructed by				Construction drawing No.			
Installation site				Hidden date			
1. Grounding body							
No.	Materials	Spec.	Qty.	Set-depth (M)	Inter-pole distance (M)	Distance between pole to building (M)	
1					/	/	
2							
3							
2. Grounding main line							
No.	Materials	Spec.	Length	Preservative treatment	Laying method	Connection method	
1							
2							
3							
3. Grounding resistance							
No.		1	2	3	Measuring method	Climate conditions	
Actual measurement (Ω)					Ohmmeter		
<p>4. The distance from grounding device of independent lightning rod to road is () meter, to entrance of building is () meter.</p> <p>5. The minimum distance underground from grounding line of independent lightning rod to other grounding line is () meter.</p> <p>6. Paint the grounding main line:</p>							
Attached drawing: Test				Comments of construction (supervision) company			
Technical director		Quality inspector		Monitor or group leader			

Acceptance record of reactor installation inspection quality

Company project name				
Branch project name		Acceptance part		
Constructed by		Project manager		
Subcontractor		Subcontracting project manager		
Construction standard name and No.				
Construction quality acceptance items		Construction unit check assessment records	Supervision unit (construction) acceptance records	
1 2 3 4 5 6 7 8	Acceptance the appearance of reactor body and installation accessories			
	Acceptance grounding grid of reactor			
	Acceptance commissioning test of reactor			
	Acceptance assembly quality of reactor			
	Acceptance protective fence of reactor			
	Acceptance protection setting value of reactor			
	Acceptance processing quality of reactor external busbar			
	Acceptance the distance among reactor live part and metal frame, and the fence			
Construction unit check assessment results	Professional master (construction crew)		Team leader	
	Project professional quality inspector: Month Day			Year
Acceptance conclusion from supervision (construction) unit	Supervising engineer: (Project technical director of construction unit) Year Month Day			

Exceptions clause

Our company does not bear the compensation liability if reactor failure or other accidents occurred by following problems.

1. Earthquake, flood, fire and other disasters and secondary disasters beyond the national standard or agreements.
2. War, terrorism, riots, conflict, arson, government compulsory measures and force majeure events.
3. Strong alkali, strong acid, nuclear pollution, radiation, and conductive dust beyond design value.
4. System voltage, current, harmonic content and type, system environment beyond the national standard or agreements.
5. The operation environment such as: altitude, ambient temperature, ambient humidity and etc. are beyond the national standard or agreements.
6. Improper installation, use, maintenance, transportation and storage caused reactor main body damage or other accidents in violation of relevant national standards, enterprise standards and user manual, transport regulations.

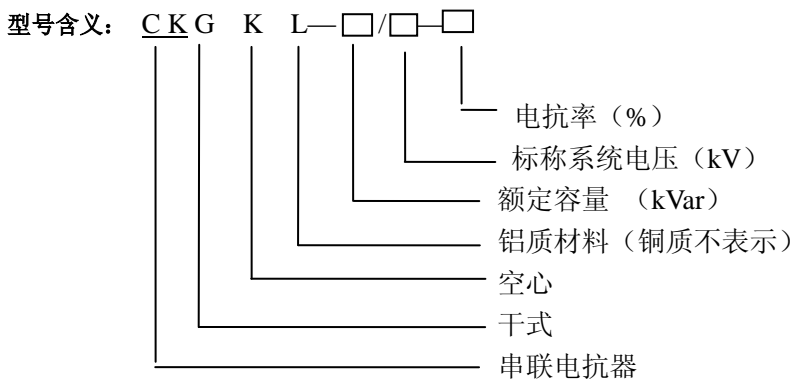
For the equipment failures caused by above reasons, our company will clarify the reasons, clear the responsibility. Besides, we will also actively help customers to troubleshoot the issues, maintain the credibility of our company and products.

Note: All requirements on equipments, materials, technical data and performance data indicated in this manual are based on the latest national standard (GB), IEC and SI. If there have any updated standard, all requirements would get updated automatically according to the latest version.

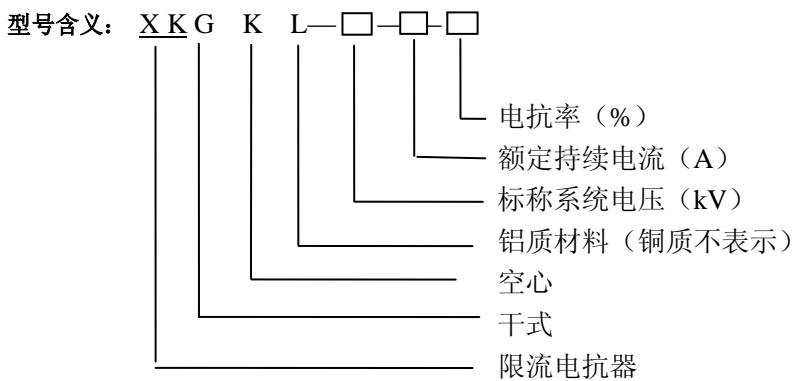
中文版

第一章 电抗器类型及型号表示方法

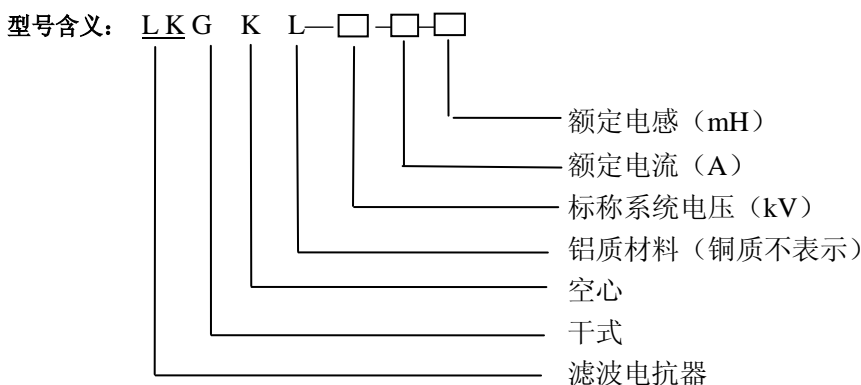
1.干式空心串联电抗器：CKGK(L)系列干式空心串联电抗器，适用于与高压并联电容器组相串联，达到抑制电网电压波形畸变和控制流过电容器组的谐波分量，及限制电容器组投入电网时的浪涌电流。



2.干式空心限流电抗器：XKGL系列干式空心限流电抗器适用于串联连接在系统线路中，增加系统阻抗，在系统发生故障时限制短路电流，使故障电流降至容许值。

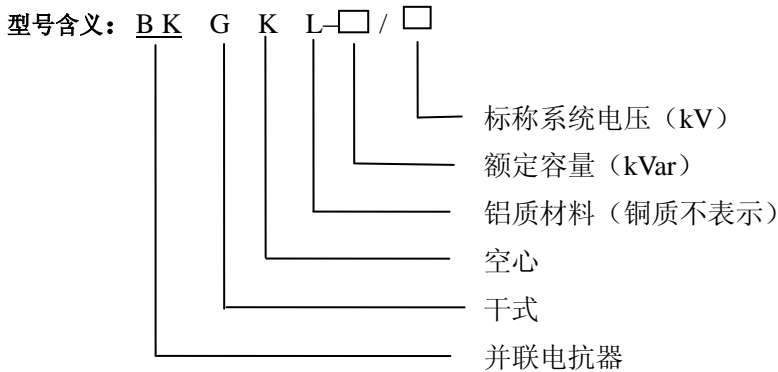


3.干式空心滤波电抗器：LKGKL系列干式空心滤波电抗器与滤波电容器组串联使用，组成谐振电路，使其在某规定频率点上谐振，滤除指定的高次谐波，同时可实现电力系统的无功补偿与限制电容器组投入电网时的浪涌电流。

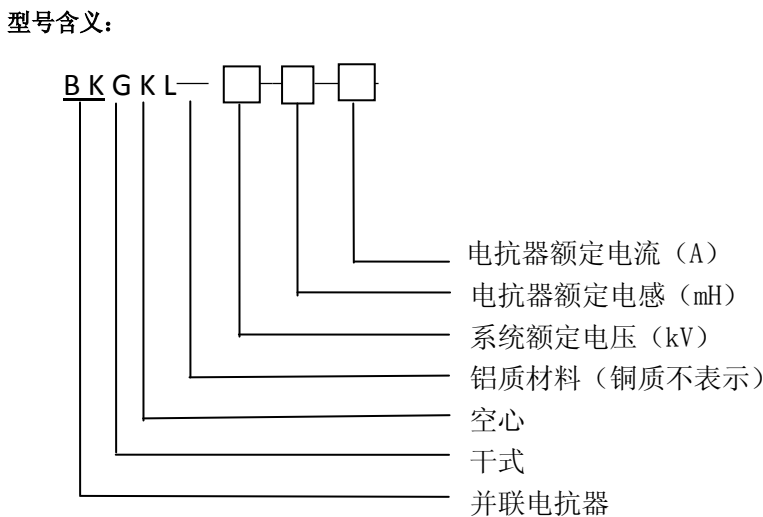


4.干式空心并联电抗器：BKGKL系列干式空心并联电抗器并联连接在 750kV、500kV 或 220kV

变电站低压组侧，用于长距离输电线路的电容无功补偿，使输配电系统电压运行稳定。



5.干式空心 TCR 电抗器: TCR 电抗器用于静止无功补偿器中，通过晶闸管控制流过电抗器中的电流，实现对系统容性无功的补偿。



第二章 干式空心电抗器的使用条件

1.使用地点

干式空心电抗器可以按照设计类型不同，分为户外运行电抗器及户内运行电抗器。户外运行电抗器可以很好的在不大于设计工况标准的户外环境下运行，同时也可兼顾客户内运行环境；户内运行电抗器只能在户内运行和储存。

2.海拔高度

一般不大于 1000 米（超过 1000 米，需在订货时特殊注明）。

3.使用环境温度及温差

-40℃ ~ +40℃，日平均温度不大于 30℃，最大日温差应小于 25K。

4.相对湿度

户内式电抗器，月平均相对湿度不超过 90%，日平均相对湿度不超过 95%（25℃）。

5.最大风速

35m/s（离地面 10m 高，10 分钟平均风速）。

6.抗震能力

8 度（水平：0.3g，垂直：0.15g）。

7.其他

安装场所应无严重影响绝缘的气体、蒸汽、灰尘及其他爆炸性、导电性、腐蚀性介质；电抗器安装周边 1.7 倍电抗器外径范围内，应无强电磁干扰或敏感电气、电子元件。

当使用条件不符合上述正常环境条件时，应按相关国标等规定作必要的调整。如用户对使用条件有特殊要求，应在订货时提出。

第三章 订货须知

感谢您选择我公司产品，为方便我们更好的为您服务，请用户在订货时以书面型式向我方说明以下技术参数及要求：

1. 使用环境

1.1 电抗器运行环境（户内、户外）。

1.2 电抗器运行场所海拔高度。

1.3 电抗器运行场所污秽等级。

1.4 环境最低温度及最高温度。

1.5 电抗器安装排列方式。

1.6 电抗器进出线角度。

1.7 其他需说明的特殊技术条件。

2. 电抗器技术参数。

2.1 电抗器额定容量。

2.2 电抗器额定电压。

2.3 额定频率。

2.4 额定电抗。

2.5 额定电抗器率（串联、限流电抗器）。

2.6 最高工作电压。

2.7 长期最大工作电流。

2.8 电抗器外径及总高度。

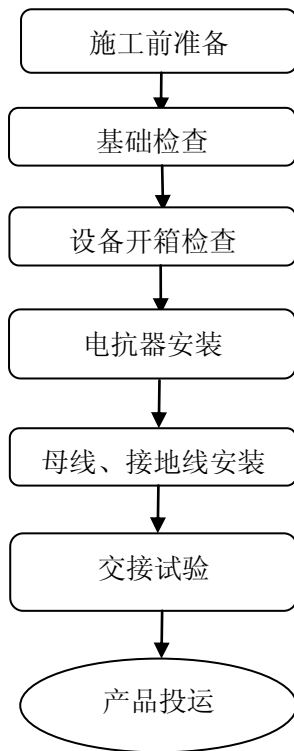
2.9 其他技术要求。

第四章 电抗器的安装

第一节 执行标准

- 1、GB 50303-2002 《建筑电气工程施工质量验收规范》；
- 2、GB 50171-2012 《电气装置安装工程 盘、柜及二次回路接线施工及验收规范》；
- 3、GB 50169-2006 《电气装置安装工程接地装置施工及验收规范》；
- 4、GB 50256-1996 《电气装置安装工程起重机电气装置施工及验收规范》；
- 5、GB 175-2007 《通用硅酸盐水泥》。

第二节 安装作业流程图



第三节 施工前准备

1. 技术准备

根据安装说明书、装配图纸、技术协议要求制定施工方案并对施工人员进行技术交底。

2. 人员组织

施工队伍应有明确的技术负责人、安装负责人、安全质量负责人。

表 1 作业人员配备

工序名称	建议工作人数	负责人数	监护人数
基础检查	3	1	1
设备开箱检查	4	1	1
电抗器安装	6	1	1
母线、接地线安装	4	1	1

注:作业人数根据具体工程量规模配备。

3. 安装器械准备

按施工要求准备安装器械并在施工前进行性能及状态检查和维护;

表 2 主要工器具及仪器仪表配置

序号	名称	规格/编号	单位	数量	备注
1	交流电焊机	380V 20kW	台	2	
2	水平仪	DS05	套	1	
3	力矩扳手	8.8-274.6Nm	套	1	
4	尼龙吊带	10T 8m	条	4	
5	吊车	25T	台	1	
6	电力复合脂	/	千克	2	
7	木方	/	批	1	

注:工器具及仪器仪表根据具体工程量规模配备;木方规格根据电抗器实际重量配备。

4. 施工材料准备

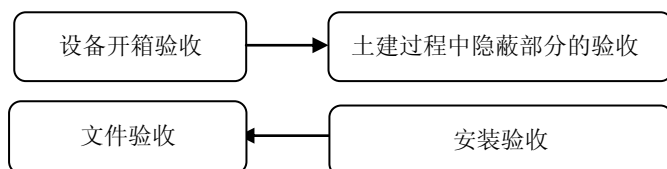
序号	名称	规格/编号	单位	数量	备注
1	槽钢	/	件	2	
2	垫铁	/	件	/	
3	焊丝/焊条	E4303	根	1	
4	水泥	C20 以上	kg	10	
5	银粉	/	kg	1	
6	接地扁铁	/	米	/	

7	螺栓	/	套	/	
8	钢筋		米		

注:施工材料应根据具体工程量规模及电抗器类型配备。

第四节 设备验收

1. 验收作业流程图



2. 设备贮存

设备运到现场后，应按其用途放在室内或室外平整、无积水的场地保管；电抗器保管时应有防雨措施。

3. 设备开箱检查

3.1 开箱检查的主要内容：设备的型号，参数与设计图纸是否相符，如产品型号、额定容量、额定电压、额定电抗率等。产品合格证、产品使用说明书、设备试验数据、图纸、以及产品的备品备件、专用工器具是否齐全。

3.2 检查产品运输过程中有无损伤和变形，检查电抗器的线圈夹缝中是否有异物，所有接缝和连接线是否有松动、断裂，绝缘是否有破损，表面是否有脏物等。

3.3 检查结果要如实记录在开箱记录上，并经三方代表签名确认。设备开箱检查后，所有资料要统一由专职资料员收集，所有附件由物资人员管理，以待工程竣工移交。记录格式见附表 1。

4. 土建过程中隐蔽部分的验收检查

4.1 用水平仪测试预埋钢板水平度，标出基础最高点和最低点位置，并将所有预埋钢板进行水平度调整，核对基础及基础中预埋的金属构件是否与图纸相符。

4.2 干式电抗器的金属围网、预埋钢板、支架、基础内钢筋、接地导体应开环连接且一点与主接地网相连，不应形成闭合回路；

4.3 干式电抗器接地电阻不大于 0.5Ω；

4.4 干式电抗器的开环式接地网与干式电抗器的垂直距离应大于干式电抗器的 0.5 倍直径。

4.5 干式空心电抗器水泥基础应采用 C20 以上混凝土，基础中应视电抗器重量搭配钢筋，

钢筋不应形成闭合回路。

5. 安装验收

5.1 设备安装符合有关设备安装规范和厂家的说明书中所提出的要求。

5.2 电抗器应按其编号进行安装，并应符合厂家技术要求。

5.3 电抗器重量应均匀地分配于所有支柱绝缘子上，并固定牢靠。

5.4 设备接线端子与母线的连接，应符合现行 GB 50149-2010《电气装置安装工程 母线装置施工及验收规范》的规定，其额定电流为 1500A 及以上时，应采用非磁性金属材料制成的螺栓。

5.5 电抗器间隔内，所有组件的零部件，必须选用不锈钢螺栓。

5.6 电抗器线圈的支柱绝缘子的接地应符合下列要求：

- (1) 上下重叠安装时，底层的所有支柱绝缘子均应接地，其余支柱绝缘子不接地。
- (2) 每相单独安装时，每相支柱绝缘子均应接地。
- (3) 支柱绝缘子的接地线不得构成闭合环路。

5.7 吊装及安装过程中，支柱绝缘子或线圈不应遭受损伤和变形。

6. 文件验收

6.1 收集完整的竣工图纸、变更设计证明文件。

6.2 设备说明书、试验报告、合格证、安装图纸等技术文件。

6.3 现场调试记录、安装记录等。

6.4 备品备件清单。

第五节 电抗器安装

1. 电抗器的起吊方式

1.1 对于导电臂配有吊装孔的电抗器起吊时，须用 U 型吊环挂吊全部导电臂吊装孔，然后用铁链或钢丝绳起吊吊环即可；

1.2 对于导电臂没有配吊装孔的电抗器起吊时，需用带销孔的长吊杆，穿入电抗器中心孔后，穿上销栓方可起吊，吊完后取出吊杆；

1.3 严禁采用钢丝绳直接起吊电抗器导电臂端部，直接采用钢丝绳吊装容易损伤电抗器线圈从而对电抗器性能造成破坏。

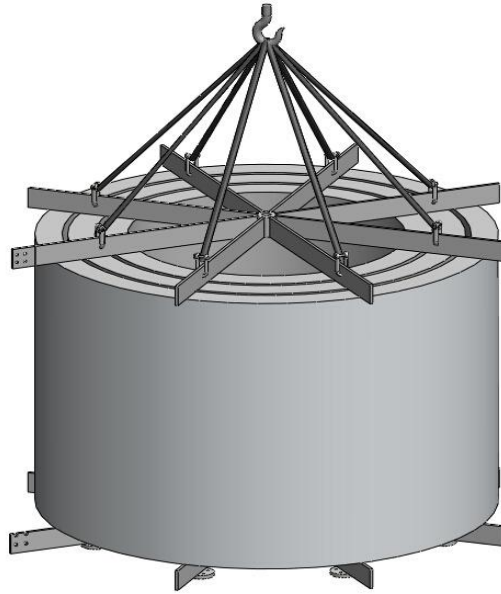


图 1 采用吊装孔吊装示意图

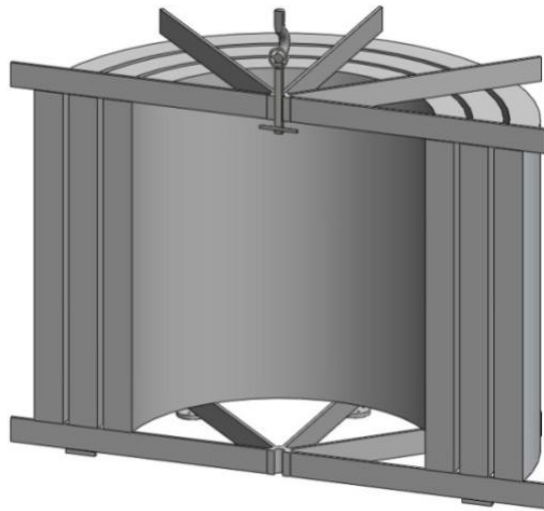


图 2 采用吊杠吊装示意图

2. 电抗器的安装类型

干式空心电抗器的安装类型通常有三相叠装、两叠一平安装、三相平放品字型安装、三相平放一字型安装四种基本方式。

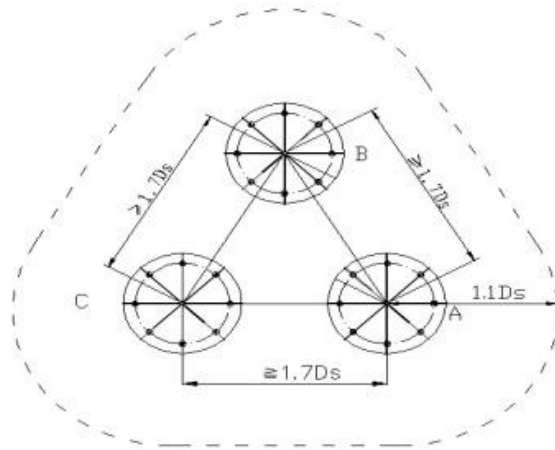


图 3 三相平放—品字型安装

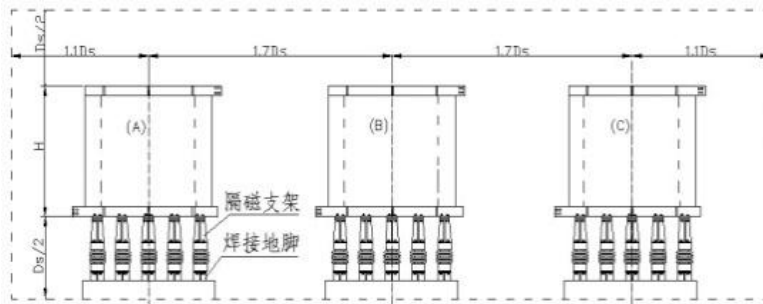


图 4 三相平放—一字型安装

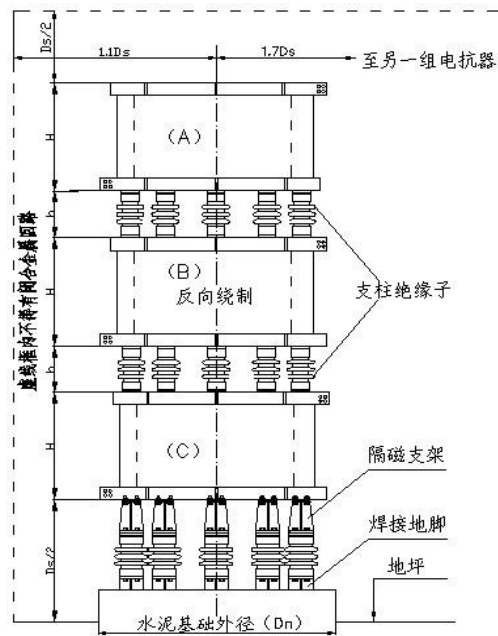


图 5 三相叠装

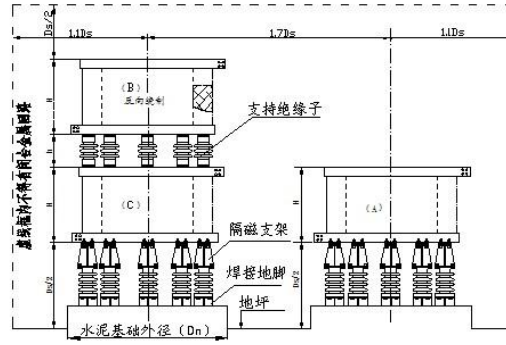


图 6 两相叠装一相水平安装

3. 电抗器安装注意事项

3.1 电抗器安装时，电抗器与天棚、地面、墙壁、围栏以及临近电抗器之间的距离应该满足图 3 至图 6 中虚线框内给出的距离要求。

3.2 电抗器安装于楼层户内时，应有防止发生共振的措施，避免电抗器与建筑物结构发生共振。

3.3 应严格按照订货技术协议及产品安装图纸要求对产品相序及进出线进行安装，电抗器的安装方式及进出线相序不能随意改变。

3.4 电抗器水泥基础内采用钢筋加强时，钢筋之间不能形成闭合金属回路，必要时应在钢筋搭接位置采取足够的绝缘措施或适当增加电抗器距地面高度。

3.5 用户安装电抗器前，应按电抗器产品图纸提供的地脚尺寸预先在水泥基础中埋入预埋件，并进行水平校正。






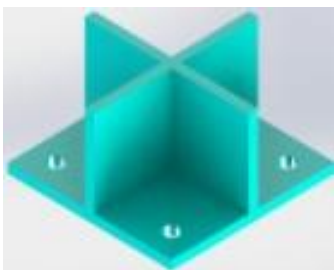
3.6 电抗器安装过程中，如有金属异物（如螺栓、螺母、平垫等）掉入电抗器气道内，应及时清除。

3.7 电抗器安装过程中，所有操作人员均应佩戴手套、安全帽等防护用品，吊运操作人员应配备 2 人以上。在底面无保护时，任何情况下不允许操作人员将胳膊等身体部位伸入底部操作。

3.8 电抗器安装完成后，应检查并去除起吊时用的 U 型吊环、吊杠、电抗器外包装物。

3.9 支撑附件安装完成后，应检验支撑附件的垂直度，其垂直度误差应小于 10mm。

4. 电抗器的安装相关附件

序号	附件名称	常用型号	附件作用	示意图	
1	橡胶垫	XJD-106 XJD-122	一般作为电抗器支撑附件应用，起到减震降低噪音的作用		
2	绝缘子	FZSW-72.5/10 ZSW-35/4L ZSW-35/8L TR205 TR220	绝缘子是用来支持和固定电抗器，以及使电抗器之间或电抗器与大地之间有足够的绝缘距离的配件。		
3	隔磁支架	CJ-200 CJ-400 CJ-400/140-F	隔磁支架一般由 6061 铝材制成，主要用来支撑电抗器，增加电抗器对地电磁距离。		
4	铁地脚	TJ-8 DXTJ-8	铁地脚一般由 Q235A 钢板经剪裁、镀锌加工而成，一般作为电抗器支撑附件，用于与用户预埋附件焊接固定。		

5. 干式空心电抗器的安装

5.1 安装准备工作

根据施工要求及电抗器安装图纸，核对支撑附件型号、支撑附件数量以及螺栓型号、螺栓数量；

仔细核对现场进出线位置及预埋件对应电抗器位置，确保电抗器接线端子安装方向；

5.2 三相叠装产品的安装

安装顺序

工步一、根据安装图纸，选择支撑类型，并将支撑配件组合成一组合体，如图 7-9。



图 7 双隔磁支架安装



图 8 单隔磁支架的安装



图 9 绝缘子直接安装

工步二、将电抗器吊起，逐个将组合体与电抗器下端底脚用螺栓连接，但螺栓不能完全紧固，预留 2-3 丝，如图 10-11。

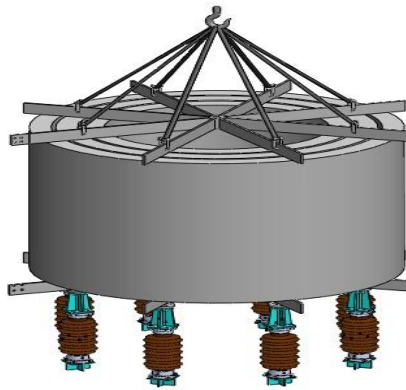


图 10

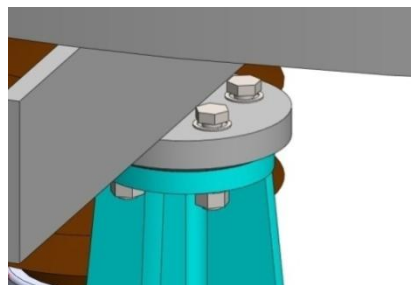
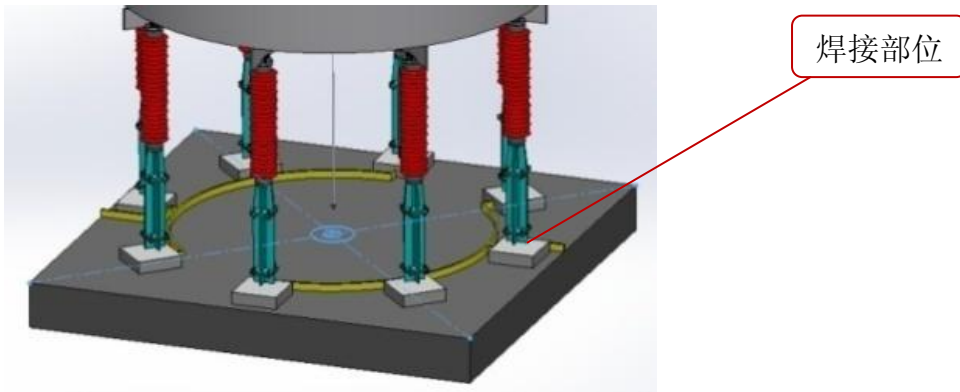


图 11

工步三、将电抗器底脚螺栓紧固后将电抗器圆心与基础圆心对齐，落下电抗器，将所有铁地脚与预埋件间的空隙用平铁填实，再将铁地脚与预埋平铁焊成一体，如图 12。



◇ 注：电抗器落下时应注意电抗器进出线位置符合相关图纸要求。

工步四、将中间相电抗器吊起并将相间绝缘子用螺栓连接到下部底脚上，螺栓不要完全紧固，缓慢落下中间相，再用螺栓将相间绝缘子与下相电抗器上部底脚连接，最后将绝缘子两端所有螺栓完全紧固，如图 13。

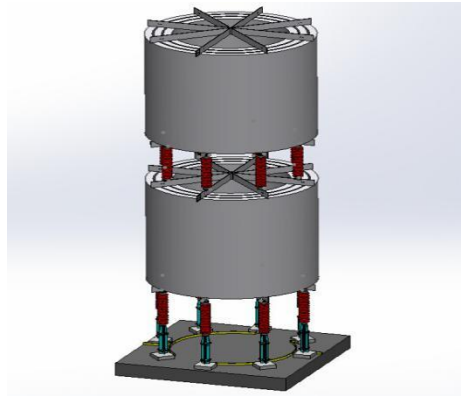


图 13

工步五、采用如第 4 步相同的方法，将上相电抗器安装到中间相电抗器上，如图 14。

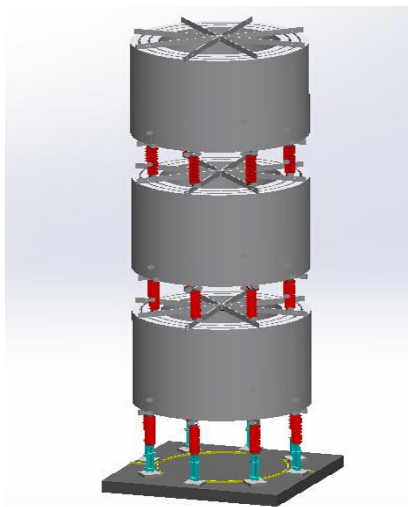


图 14

工步六、电抗器整体安装就位后，对电抗器与预埋平铁处的焊接部位进行防腐处理、即对焊接部位清理焊渣、涂刷防锈漆后再涂一层银粉。

注：平放及两叠一平结构的产品可参照上述步骤进行安装。

6. 母线安装

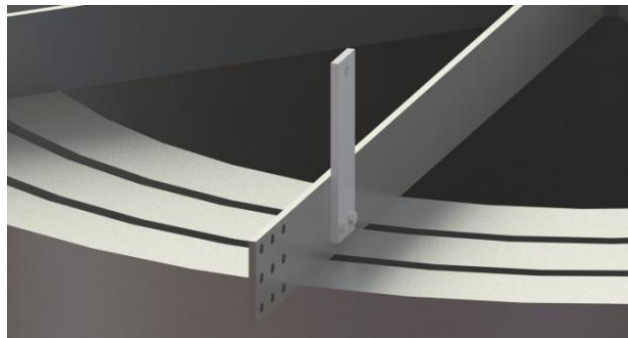
母线经放样确定长度，按母线压接工艺要求进行压接好，母线安装要走向美观，并保证足够的电气距离，相—地及相—相间距离符合相关规范要求；母线与电抗器接线板搭接面涂电力复合脂；电抗器侧要用不锈钢螺丝连接。

7. 接地线安装

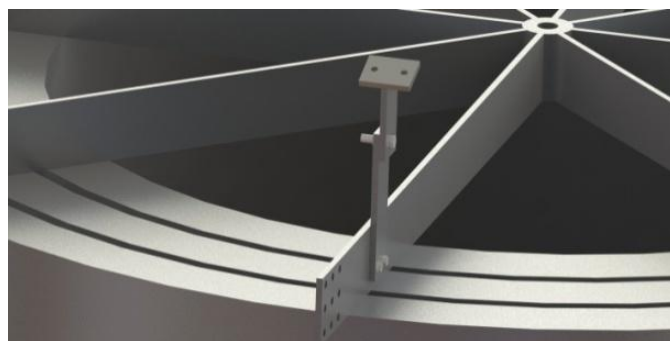
将电抗器的基础槽钢焊牢，并在预埋钢板上焊上镀锌接地圆钢（或其他防锈接地线），但不能形成闭合磁路。电抗器重叠安装时，底层的支柱绝缘子底座均应接地，其余的支柱绝缘子不接地。

8. 防护罩的安装

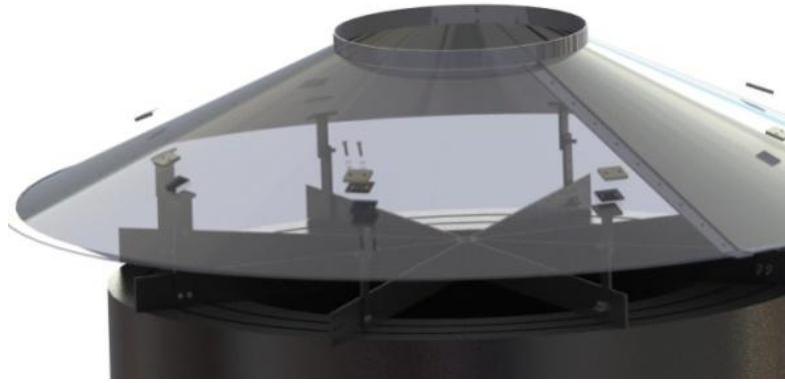
8.1 首先用 M12×55 螺栓将防护罩长支架与电抗器最上方导电臂固定。



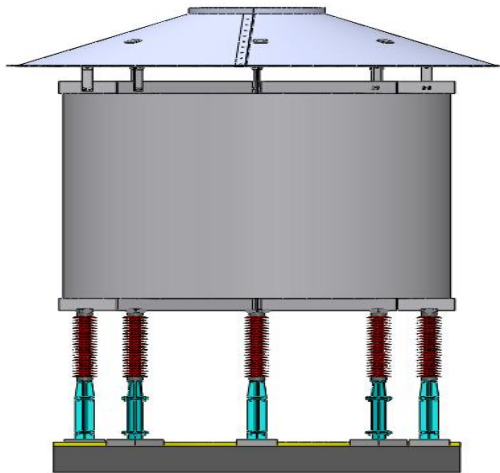
8.2 用 M16×50 螺栓将防护罩短支架与长支架固定。



8.3 用吊车将弧形防护罩吊至最上方防护罩支架上，并使用 M12×55 螺栓将铝压板、减震橡胶垫和防护罩连接固定。



8.4 防护罩组装完成



*注：安装完成后，应将防护罩吊母去除，并将吊母位置用 M12×55 螺栓拧紧。

9. 质量控制

9.1 电抗器安装场所应无严重影响绝缘的气体、蒸汽、化学性沉积、金属漂浮物、重度灰尘污染及其他爆炸性和腐蚀性介质。

9.2 支柱及线圈绝缘等应无严重损伤和裂纹，线圈应无变形，支柱绝缘子及附件应齐全。

9.3 垂直安装时，各相中心线应一致。电抗器上、下重叠安装时，应在其绝缘子顶帽上，放置与顶帽同样大小且厚度不超过 4mm 的橡胶垫片。

9.4 电抗器上、下重叠安装时，底层的所有支柱绝缘子均应接地，其余的支柱绝缘子不接地。每相单独安装时，每相支柱绝缘子均应接地。支柱绝缘子的接地线不应成闭合回路。

9.5 三相安装位置不得调换，必须按出厂相序及设计图的安装位置安装，连接线采用伸缩节并符合设计要求。

9.6 电抗器绕组圆心与预埋基础中心圆圆心应对正，两者在水平方向上的偏离不能大于 5mm。

9.7 母排间隔棒按规范要求错开。

9.8 引线、接头、接线端子等连接牢固完整。

9.9 安装完后用力矩扳手校验检查，力矩大小可参见下表。所有螺栓、双头螺栓、螺纹、管螺纹、螺栓夹及螺母均应遵守国际标准化组织（ISO）和国际单位制（SI）的标准，使用不锈钢等不导磁材质，且螺丝长度宜漏出螺丝帽 2~3 道螺纹。

表 3 螺栓规格及相应力矩值

螺栓规格(mm)	力矩值 (N.m)	螺栓规格(mm)	力矩值 (N.m)
M8	8.8--10.8	M10	17.7—22.6
M12	31.4--39.2	M14	51.0—60.8
M16	78.5--98.1	M18	98.0--127.4
M20	156.9--196.2	M24	274.6--343.2

9.10 户外电抗器的防雨罩安装牢固。

9.11 安全围栏安装牢固，接地良好，围栏门应可靠闭锁，金属围栏不能形成闭合回路。

9.12 干式电抗器的出厂和现场交接试验数据合格。

9.13 交接资料和技术文件齐全。

10. 交接试验检查项目

电抗器在安装检查完毕后，还应该做下列验收试验，试验结果应与出厂试验报告相符。

10.1 直流电阻测量

在现场测量直流电阻时，应采用双臂直流电桥，测量时电抗器绕组温度与环境温度应基本平衡，并将电阻测量值换算至 75℃。

10.2 绝缘电阻测量

绝缘电阻测量应采用 2500V 兆欧表进行测量，测量值应符合相关标准及技术协议规定。

10.3 直流泄漏试验。

10.4 交流耐压试验。

10.5 绝缘子探伤。

10.6 RTV 涂料憎水性能检查。

10.7 额定电压下的冲击合闸试验。

11. 安健环控制措施

11.1 控制措施

11.1.1 吊装作业必须有专人指挥，吊装过程中指挥人员不得离开岗位。

11.1.2 电抗器到位时要防止设备碰撞，设备就位时人力应足够，指挥应统一，以防倾倒伤人，狭窄处应防止挤伤。

11.1.3 安装支柱瓷瓶时，要均匀上紧螺栓，避免产生应力而发生瓷瓶破裂。

11.1.4 进入施工现场注意成品保护。施工中始终保持现场文明施工，做到设备、材料、工具摆放整齐。

11.1.5 在高温或低温等恶劣环境下工作时，施工人员应有足够的防护设施；使用打磨机具和火焊时应正确佩戴防护眼镜；使用电焊施工人员应有防护目镜的面罩。

11.1.6 夜间施工必须配备足够的照明设备，施工作业人员有充足的精力。

11.1.7 吊装吊具必须检验合格，符合安全要求才能使用。吊装尼龙绳等必须按检验周期进行检验，不合格的不得使用。吊装作业必须有专人指挥，吊装过程中，施工负责人、指挥人员不得离开岗位。

11.1.8 设备加垫时不得将手伸入基础底面，设备连接时应防止设备挤伤手。

11.2 危险点辨识

表 13-1 危险点辨识及预控措施

序号	危险点	预控措施
1	起重作业指挥不当	(1) 指挥人员发出的指挥信号必须清晰、准确。 (2) 指挥人员应站在使操作人员能看清指挥信号的安全位置上。当跟随负载进行指挥时，应随时指挥负载避开人及障碍物。
2	吊装工具使用不当	吊装使用的链条葫芦必须是完好，操作顺畅的；吊装绳无破损及断口驳接，承重负荷满足小于破断拉力总和的 75%。
3	焊接作业	(1) 电焊机的外壳必须可靠接地，接地电阻不应大于 4Ω。 (2) 不得多台串联接地电焊机，各电路对机壳热态绝缘电阻不得低于 0.4M。 (3) 电焊机裸露的导电部位和转动部分必须装设防护罩。 (4) 焊钳及电焊导线的绝缘必须良好；导线截面应与工作参数相适应。焊钳、割炬应具有良好的隔热能力。
4	高空作业	(1) 高处作业必须系好安全带，安全带应挂在上方的牢固可靠处；高处作业人员应衣着灵便，衣袖、裤脚应扎紧，穿软底鞋。 (2) 高处作业地点、各层平台、走道及脚手架上不得

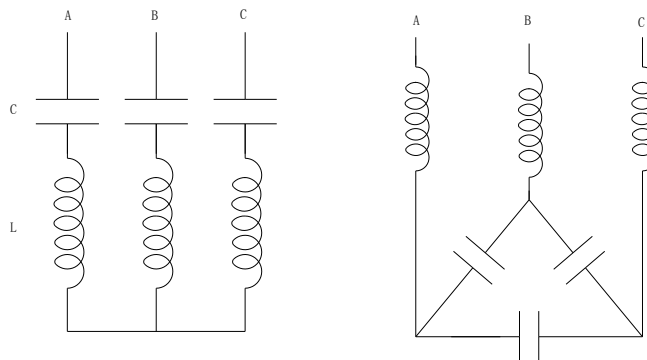
		堆放超过允许载荷的物件，施工用料应随用随吊。 (3) 高处作业人员应配带工具袋，较大的工具应系保险绳；传递物品时，严禁抛掷。
5	拼装设备倾倒伤人	拼装过程中注意上下交叉作业，设备支撑平稳，牢固。拼装时设监护人。

第五章 干式空心电抗器的使用

第一节 干式空心串联电抗器

1. 产品用途

CKGKL 系列干式空心串联电抗器，适用于与高压并联电容器组相串联，达到抑制电网电压波形畸变和控制流过电容器组的谐波分量，及限制电容器组投入电网时的浪涌电流。



串联电抗器与匹配电容器组的接线图

2. 执行标准

JB/T 5346-2014 《高压并联电容器用串联电抗器》；

GB/T 1094.6-2011 《电力变压器 第 6 部分:电抗器》；

IEC 60076-6-2007 《电力变压器 第 6 部分:电抗器》

3. 结构特征

(1) 干式空心串联电抗器由线圈主体、支柱绝缘子、非导磁金属支撑件、焊接地脚等构成，用非磁性螺栓连接成一整体。

(2) 电抗器线圈主体均采用多层并联筒式铝（铜）质结构，内部分若干个包封，每个包封有数层线圈。这种结构将导体截面分成许多相互绝缘的小截面导线平行绕制，可以降低线圈匝间电压，使匝间绝缘安全可靠，涡流损耗小。由于每层导线并联绕制，线圈匝间电压低，适于户外运行。

(3) 电抗器线圈内外均用绝缘胶浸渍的玻璃丝包绕，经高温固化成一个整体，机械强度高，可耐受很大的短路电流冲击，噪音很小。包封之间设有通风道，以利空气对流和散热。

(4) 电抗器线圈所有导线的引出线，均引至星状导电臂骨架上，这种结构可满足线圈分数匝的要求。

4. 主要技术参数

(1) 绝缘水平，符合相关标准，具体参数如表：

系统额定电压（方均根值）kV	工频耐受电压（干试）（方均根值）kV	冲击耐受电压（峰值）kV
6	32	60
10	42	75
35	100	200
66	165	325

(2) 绝缘耐热等级，符合国家标准,具体参数如表：

部分	绝缘系统温度 °C	温升限值 K
绕组（电阻法）	120 (E)	70
	130 (B)	75
	155 (F)	95
	180 (H)	120
	220 (C)	145

(3) 在额定电流下，电抗器的声级水平不超过下表的规定：

电抗器额定容量 kVar	声级水平 dB
<80	48
80~125	50
125~200	52
200~315	54
315~500	56
500~800	58
800~1250	60
1250~2000	63
2000~3150	66

(4) 过负荷能力：电抗器可在工频电流为 1.35 倍额定电流的最大工作电流下连续运行。

(5) 热稳定：能承受额定电抗器率倒数倍额定电流的最大短时电流作用，持续 2 秒钟。

(6) 动稳定：动稳定电流为热稳定电流的 2.55 倍，持续时间 0.5 秒，而无任何机械损伤。

第二节 干式空心限流电抗器

1. 产品用途

XKGL 系列限流电抗器适用于串联连接在系统线路中，增加系统阻抗，在系统发生故障时限制短路电流，使故障电流降至容许值。

2. 执行标准

GB/T 1094.6-2011 《电力变压器 第 6 部分:电抗器》;

IEC 60076-6-2007 《电力变压器 第 6 部分:电抗器》

3. 结构特征

(1) 干式空心限流电抗器由线圈主体、支柱绝缘子、非导磁金属支撑件、焊接地脚等构成，用非磁性螺栓连接成一整体。

(2) 电抗器线圈主体均采用多层并联筒式铝（铜）质结构，内部分若干个包封，每个包封有数层线圈。这种结构将导体截面分成许多相互绝缘的小截面导线平行绕制，可以降低线圈匝间电压，使匝间绝缘安全可靠，涡流损耗小。由于每层导线并联绕制，线圈匝间电压低，适于户外运行。

(3) 电抗器线圈内外均用绝缘胶浸渍的玻璃丝包绕，经高温固化成一个整体，机械强度高，可耐受很大的短路电流冲击，噪音很小。包封之间设有通风道，以利空气对流和散热。

(4) 电抗器线圈所有导线的引出线，均引至星状导电臂骨架上，这种结构可满足线圈分数匝的要求。

4.主要技术参数

(1) 绝缘水平，符合国家标准，具体参数如表：

系统额定电压 (方均根值) kV	工频耐受电压 (干试)(方均 根值) 1min kV	冲击耐受电 压(峰值) 1.2/50μs kV
6	32	60
10	42	75
35	100	200
66	165	325

(2) 绝缘耐热等级，符合国家标准，具体参数如表：

部分	绝缘系统温度 °C	温升限值 K
绕组 (电阻法)	120 (E)	70
	130 (B)	75
	155 (F)	95
	180 (H)	120
	220 (C)	145

(3) 在额定电流下，电抗器的声级水平不超过下表的规定：

电抗器额定容量 kVar	声级水平 dB
<80	48
80~125	50
125~200	52
200~315	54
315~500	56
500~800	58
800~1250	60
1250~2000	63
2000~3150	66

(4) 热稳定：能承受电抗率倒数倍额定电流的最大短时电流的作用，持续 2 秒钟。

(5) 动稳定：动稳定电流为热稳定电流的 2.55 倍，持续时间 0.5 秒，而无任何机械损伤。

第三节 干式空心滤波电抗器

1. 产品用途

LKGL 系列滤波电抗器与滤波电容器组串联使用，组成谐振电路，使其在某规定频率点上谐振，滤除指定的高次谐波，同时可实现电力系统的无功补偿与限制电容器组投入电网时的浪涌电流。

2. 执行标准

GB/T 1094.6-2011 《电力变压器 第 6 部分:电抗器》;

IEC 60076-6-2007 《电力变压器 第 6 部分:电抗器》

3. 滤波电抗器的工作原理

(1) 滤波电抗器的调感形式

我公司现有滤波电抗器的调感形式分为两种，即调匝调感的滤波电抗器和调距调感的滤波电抗器。两种滤波电抗器的结构形式见图 1、图 2。

(2) 调匝型滤波电抗器的工作原理

调匝型滤波电抗器由主线圈和调匝线圈共同构成，调匝线圈通过绝缘垫块安装于主线圈的外侧，整台电抗器的电感量由主线圈和调匝线圈共同构成。主线圈的电感量一般占整台电抗器电感量的 95%左右，而调匝线圈的电感量占整台电抗器电感量的 5%左右。通过改变调匝线圈的匝数即可平滑调节电抗器的电感量，而改变调匝线圈中电流的方向，可以正负两个方向来调节主线圈的电感量，即 $L=L_{主}+L_{调}$ 。

(3)调距型滤波电抗器的工作原理

调距型滤波电抗器每相电抗器由两个绕制方向相同、匝数相等的两台等结构电抗器构成，两台电抗器通过可调不锈钢螺杆上下支持，构成一台电抗器。调整不锈钢螺杆改变两台电抗器中心距离，即改变两台电抗器之间的互感，从而达到对电抗器电感量的平滑调整，即 $L=2L_1+M$ 。

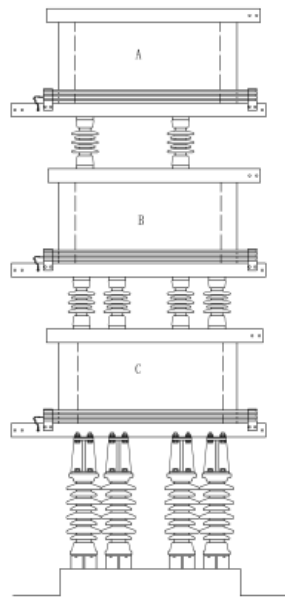


图 18

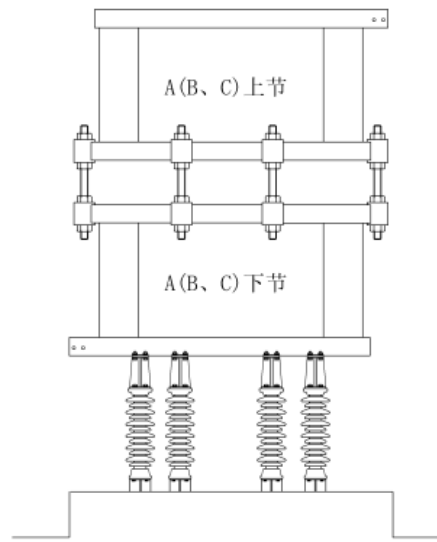


图 19

4. 滤波电抗器的整体结构特点

4.1 滤波电抗器由主线圈、调整线圈、支柱绝缘子、非导磁金属支撑件等构成，用非磁性螺栓连接成一整体。

4.2 电抗器主线圈采用多层并联筒式铝（铜）质结构，内部分若干个包封，每个包封有数层线圈。这种结构将导体截面分成许多相互绝缘的小截面导线平行绕制，可以降低线圈匝间电压，使匝间绝缘安全可靠，涡流损耗小。由于每层导线并联绕制，匝间电压低，故适于户外运行。

调匝线圈采用专用绝缘导线绕制，并通过特制的环氧支架及固定架固定，有效降低了电抗器的运行噪声。

4.3 电抗器主线圈包封内外均用绝缘胶浸渍的玻璃丝包绕，经高温固化成一个整体，机械强度高，可耐受很大的短路电流冲击，噪音小。包封之间设有通风道，以利空气对流和散热。

3.4 电抗器线圈所有导线的引出线，均引至星状导电臂吊架上，这种结构可满足线圈小数匝的要求。

5. 滤波电抗器的调谐

5.1 调匝型滤波电抗器调谐

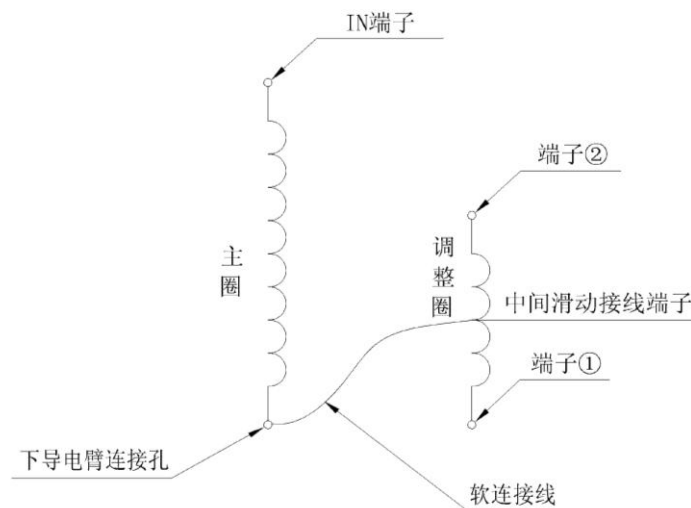
5.1.1 电抗器出线端为下导电臂 OUT 端子，将环氧板、铝连接板依次固定于此。

5.1.2 当电抗器需要正向电感值时，请用软连接将电抗器出线端子（下导电臂）与调整圈最下端接线端子 1 相连，将调整圈最上端接线端子 2 用另一根软连接线连接在铝连接板上，外界安装铝排（或电缆）接于铝连接板，这时调整圈为正向电感，电感值为额定值的正接最大值。

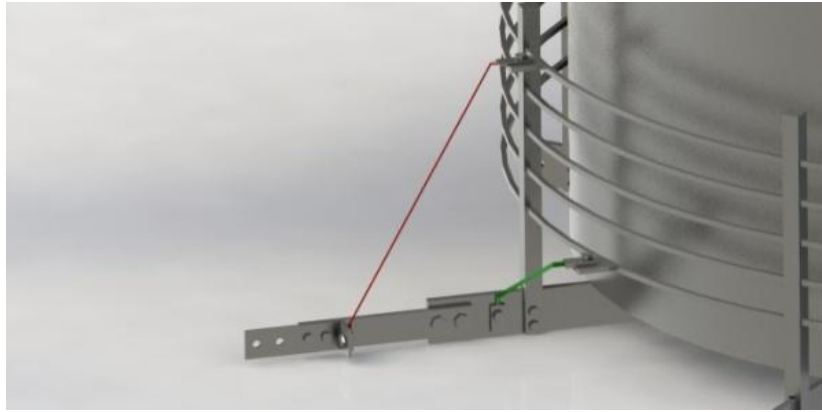
5.1.3 当电抗器需要负向电感值时，请用软连接线将电抗器出线端子（下导电臂）与调整圈接线端子 2 相连，将调整圈接线端子 1 用另一根软连接线连接在铝连接板上，外界安装铝排（或电缆）接于铝连接板，这时调整圈为负向电感，电感值为额定值的反接最少值。

5.1.4 如果用户在调试过程中需要额定值、最大值、最小值以外的电感值，建议优先选用调整线圈上的其它焊接端子。具体接线方法如下：首先把选中的中间抽头端子与该点最近的下导电臂接线端子相连，出线位置由正接线端子 2（或负接线端子 1）通过软连接线接到铝连接板，由铝连接板接外界安装铝排。

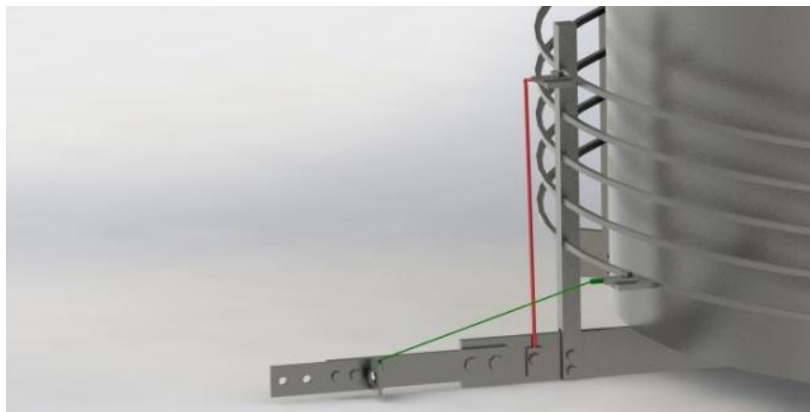
5.1.5 所有电气连接处均要去氧化层并涂敷导电膏，连接螺栓要固定紧。



调整圈调试连接示意图



调匝型滤波电抗器正接（此时电感值为最大值）



调匝型滤波电抗器反接（此时电感值为最小值）图片

5.2 调距型滤波电抗器的调谐

5.2.1 调距型滤波电抗器当上下两节电抗器中心距最大时，电抗器电感值最小；当上下两节电抗器中心距最小时，电抗器电感值最大。为保证运输过程中电抗器的稳定性，出厂时电抗值调在最大值位置。

5.2.2 调距型滤波电抗器的调谐，可在现场配合电感测试仪进行，即将电感测试仪的测试表笔接于电抗器上下接线端子上，用扳手逐一调节调感螺杆的位置，即改变两节电抗器间的中心距，待电感测试仪显示值达到要求时，将所有调感螺杆的紧固螺母拧紧。

5.2.3 调距型滤波电抗器调谐结束后，一定要保证调感螺杆的上下端距电抗器最上和最下星架的距离一致，并保证电气连接铝排同中间星架上的接线部位良好接触，接触部位要去除氧化膜并涂覆导电膏。

第四节 干式空心并联电抗器

1. 产品用途

干式空心并联电抗器，是干式空心电抗器的一种。电抗器并联用于变电站等电力系统内，

其使用目的主要有：

- (1) 吸收电容无功电流，降低输电损耗和抑制轻负载时的过电压。
- (2) 抑制轻负载时发电机的电容性运转，提高稳定度，并防止产生异常电压。
- (3) 补偿 6~35kV 电缆和架空线路对地电容电流。
- (4) 同 SVC 中的 TCR 配合达到跟踪和平衡无功的目的。

2. 执行标准

GB/T 1094.6-2011 《电力变压器 第 6 部分:电抗器》;

IEC 60076-6-2007 《电力变压器 第 6 部分:电抗器》

JB/T 10775-2007 《6kV~35kV 级干式并联电抗器技术参数和要求》

3. 主要技术参数

(1) 绝缘水平:

系统额定电压 (kV)	工频耐受电压 (方均根值) 1min(kV)	冲击耐受电压 (峰值) 1.2/50 μ S(KV)
6	32	60
10	42	75
35	100	200

(2) 温升:

在额定频率和最高运行电压下，电抗器的容许温升不超过下表的规定。

干式空芯电抗器温升限值

绝缘等级	容许最高温度	测温方法	温升限值	测温方法
	温度 $^{\circ}$ C		温升 K	
A	105	埋入温度计法	65	电阻法
E	120		70	
B	130		75	
F	155		95	

(3) 电抗偏差:

在额定频率和额定电压下，电抗器的电抗容许偏差不应超过额定电抗值的 $\pm 5\%$ 。

三相电抗器或由单相电抗器组成三相组时，在对称电压下测得的每相电抗，除满足 $\pm 5\%$ 的容许偏差外，并且每相电抗与三相电抗平均值的偏差不应超过 $\pm 2\%$ 。

(4) 损耗偏差:

电抗器校正后的总损耗不超过损耗规定值的+10%。

(5) 爬电比距:

符合《GB/T 26218.1-2010》、《IEC/TS 60815-1-2008》要求。

(6) 电气距离:

额定电压 (kV)	10.5	36.5	66	115	230	525
最小距离 (米)	0.2	0.4	0.65	1.1	2.0	4.3

干式空心电抗器除满足上述要求外, 为了减少漏磁影响, 线圈对地面或对支柱脚金属支架的距离大于线圈直径的 1/2, 若金属支架为非导磁材料可小些。

第六章 维护、检修周期及项目

第一节 维护项目及周期

1. 不停电维护项目及周期

序号	项目	要求	周期	备注
1	检查表面脏污情况及有无异物	目测	每月	
2	检查表面是否明显变色	目测	每月	
3	声音是否正常	听	每周	
4	各部件有无过热现象	红外测温	每周	

2. 停电维护项目与周期

序号	项目	要求	周期	备注
1	检查电抗器导电臂是否有变形裂纹现象	目测	每年	
2	检查电抗器焊接引线是否断裂或松动	目测	每年	
3	检查电抗器接线端子连接是否良好, 有无松动	目测	每年	
4	检查电抗器各紧固螺栓有无松动	用扳手	每年	
5	检查电抗器外表及内侧表面有无过热现象	目测	每年	
6	检查防护罩安装有无松动	用扳手	每年	
7	检查气道及器身的干净度	目测	每年	
8	检查各气道内引拔撑条有无松动	手动	每年	
9	检查表面油漆、RTV涂料有无龟裂、脱落	目测	3~5年	
10	检查绝缘子是否完好和干净	目测	每年	
11	检查绝缘性能是否良好	目测	每年	
12	检查表面憎水性	目测	每年	

3. 特殊巡视

3.1 巡视周期

序号	项目
1	在高温、低温天气运行前
2	大风、雾天、冰雪、冰雹及雷雨
3	设备变动后
4	设备投入运行后
5	设备经过检修、改造或长期停运后重新投入运行
6	异常情况下的巡视。主要是指设备发热、系统电压波动、本体有异常振动和声响
7	电抗器接地体改造之后

3.2 巡视项目和要求

序号	项目
1	正常巡视项目外，还应注意其他异常情况
2	投运期间用红外测温设备检查电抗器包封内部、引线接头发热情况
3	大风扬尘、雾天、雨天外绝缘有无闪络，表面有无放电痕迹
4	冰雪、冰雹外绝缘有无损伤，本体无倾斜变形，无异物
5	电抗器接地体及围网、围栏有无异常发热，可对比其他设备检查，积雪融化较快、水汽较明显等进行判断
6	电抗器存在一般缺陷且近期有发展变化情况
7	故障跳闸后，未查明原因前不得再次投入运行，应检查保护装置是否正常，干式电抗器线圈匝间及支持部分有无变形、烧坏等现象

4. 小修项目及周期

序号	项目	要求	周期	备注
1	检查电抗器导电臂是否有变形、裂纹现象	无变形和裂纹	每年	
2	检查电抗器焊接引线是否断裂或松动	无断裂	每年	
3	检查电抗器接线端子连接是否良好，有无松动	无松动	每年	
4	检查电抗器各紧固螺栓有无松动	无松动、接触良好	每年	
5	检查电抗器外表及内侧表面有无过热现象	无变色、过热情况	每年	

6	检查防护罩安装有无松动	无松动	每年	
7	检查气道及器身的干净度	通道畅通、表面无脏污，较为干净	每年	
8	检查各气道内引拔撑条有无松动	完好牢固	每年	
9	检查表面油漆、RTV涂料有无龟裂、脱落	完好无龟裂	3~5年	
10	检查绝缘子是否完好和干净	绝缘子无异常，干净	每年	

5. 大修项目及周期

序号	项目	要求	周期	备注
1	清洁电抗器表面及气道内灰尘和污垢	通风吹/水冲保证其干净	每年	
2	电抗器每五年补刷一次油漆/RTV涂料	脱落部位应及时补刷	5~6年	
3	全面排查紧固螺栓	用扳手每个拧紧	每年	

6. 临时检修

序号	项目	要求	周期	备注
1	运行中回路电流电压的波动	必须断电查找原因	实时	

第二节 维护及检修准备工作

1. 工具、耗材、人员需求清单

1.1 工器具要求

序号	名称	型号规格（精度）	单位	数量	备注
1	力矩扳手	各种类型	套	1	
2	焊接设备	氩弧焊机	台	1	
3	冲洗设备	1.2-2.0Mpa	台	1	
4	安全带	1T	副	若干	
5	梯子	6M	副	2	
6	接地线	10mm ²	米	若干	
7	直流电阻测试仪	0.001mΩ-20kΩ	台	1	
8	绝缘电阻表	数显2500 kΩ	台	1	
9	工频试验耐压装置	250kV	台	1	
10	备件螺栓	304不锈钢	套	若干	

1.2 耗材清单

序号	名称	型号规格（精度）	单位	数量	备注
1	汽油	90#	升	1	
2	纱布	0.04mm厚	米	若干	
3	白布	0.04mm厚	米	若干	
4	刷子	50/100mm宽	副	若干	
5	酒精		升	0.5	
6	导电膏		千克	若干	
7	焊接材料	铝合金焊材	根	若干	
8	环氧树脂胶	常温固化	千克	若干	
9	喷涂材料	抗紫外线油漆/RTV	升	若干	

1.3 人员需求

人员资质要求	人员需求		工时需求 -	
	检修人员	厂家人员	检修人员	厂家人员
高压电工	3~4	1	2个工作日	2个工作日

2. 停电维护及检修准备要求

2.1 技术准备工作

检修前应编制完善的检修作业指导书，其中包括检修的组织措施、安全措施和技术措施。主要内容如下：

2.1.1 准备工作安排，包括停电申请、工作票等。

2.1.2 人员要求及分工

2.1.3 作业流程图，应体现施工项目及进度。

2.1.4 消缺项目、检修项目和质量标准。

2.1.5 特殊项目的施工方案

2.1.6 试验项目及标准

2.1.7 危险分析、安全措施及注意事项

2.1.8 施工工具明细表、备品备件明细表、材料表等

2.1.9 图纸资料，包括设备主要技术参数。

2.1.10 各种记录表格。

2.2 工器具准备工作

工器具、材料等准备参见第四章第一节。

2.3 人员准备工作

确定检修时间，通知相关人员及设备制造厂家，人员需要提前一天到达设备运行地，并做好人员安全防护措施。

3. 停电维护及检修工作流程

3.1 停电维护工作流程

3.1.1 停电

3.1.2 验电

3.1.3 挂地线

3.1.4 悬挂标示牌和装设临时遮拦

3.2 小修工作流程

3.2.1 用纱布擦拭电抗器支持绝缘子表面。如脏污严重，可蘸酒精或汽油擦洗。检查绝缘子有无裂纹、破损、放电痕迹、瓷釉剥离现象，如剥离面积未超过规定时，可用环氧树脂粘结剂粘补。

3.2.2 检查电抗器绕组有无变形、裂纹、破损、绝缘层剥离现象。如绝缘层剥离面积未超过规定时，可用环氧树脂粘结剂粘补。

3.2.3 检查引线连接情况。引线应连接牢固，接触良好，无过热现象，松动者应拧紧。检查引线的受力情况。

3.2.4 检查干式空心电抗器上、下节间的调节连板状态是否正常。连接螺栓应连接牢固，上、下层间距离符合参数要求。

3.2.5 检查干式空心电抗器底座安装是否牢固，接地线应连接牢固，接地良好。

3.2.6 对连接螺栓螺纹部位涂干黄油，对金属构架进行除锈涂漆。

第三节 缺陷管理及异常处理

1. 缺陷管理

1.1 缺陷及异常的管理和处理应严格执行 DL408 的有关规定。

1.2 发现缺陷应及时处理，实行对缺陷的闭环管理。

1.3 缺陷常指干式电抗器任何部件的损坏、绝缘不良或不正常的运行状态，分为危急缺陷、严重缺陷和一般缺陷。

1.4 发现危急缺陷和严重缺陷，运行人员必须立即向有关部门汇报。密切监视发展情况，必要时可迅速按调度命令将有缺陷的设备退出运行。

1.5 发现一般缺陷，运行人员将缺陷内容记入相关记录，由负责人汇总按月度汇报。

1.6 投入运行一年内的新设备发生缺陷，应协助有关单位进行处理。

2. 设备缺陷分类

2.1 危急缺陷：设备发生了直接威胁安全运行并需立即处理的缺陷，否则随时可能造成设备损坏、人身伤亡或火灾等事故，例如下列情况等。

2.1.1 干式电抗器出现突发性声音异常或振动。

2.1.2 接头及包封表面异常过热、冒烟。

2.1.3 干式电抗器出现沿面放电。

2.1.4 绝缘子有明显裂纹。

2.1.5 并联电抗器包封表面有严重开裂现象。

2.1.6 设备的试验主要指标超过规定不能继续运行。

2.2 严重缺陷：缺陷有发展的趋势，但可以采取措施继续运行，列入月计划处理，不致造成事故者，例如下列情况等。

2.2.1 设备有过热点，接地体发热，围网、围栏等异常发热

2.2.2 包封表面存在爬电痕迹以及裂纹现象。

2.2.3 支撑绝缘子有倾斜变形（或位移），暂不影响继续运行。

2.2.4 有撑条松动或脱落情况。

2.3 一般缺陷：上述危急、严重缺陷以外的设备缺陷。指性质一般，情况较轻，对安全运行影响不大的缺陷，例如下列情况等。

2.3.1 设备上缺少不重要的部件。

2.3.2 次要试验项目漏试或结果不合格。

2.3.3 包封表面不明显变色或轻微振动。

2.3.4 绝缘支柱绝缘子或包封较脏，金属部分有锈蚀现象。

2.3.5 干式电抗器内有鸟窝或有异物，影响通风散热。

2.3.6 引线散股。

2.3.7 其他不属于危急、严重的设备缺陷。

3. 其他

值班人员应对缺陷或异常进行运行分析或事故预想，并按有关规定采取相应措施。

第四节 事故处理预案

1.干式电抗器本体出现冒烟、起火、沿面放电等情况：

1.1 立即断开电抗器。

1.2 断开干式电抗器隔离开关（串联电抗器必须合上电容器侧接地开关）。

1.3 灭火。

2.干式电抗器因保护跳闸停运，在没有查明跳闸原因之前，不得强送电。

3.干式电抗器因故障跳闸，其处理原则及步骤是：

3.1 检查干式电抗器断路器的位置信号、表计指示，以及检查系统电压有无变化等连锁反应，若有，应立即汇报调度。

3.2 详细检查干式电抗器本体、相间情况，找出故障点。

3.3 检查干式电抗器保护动作情况。

3.4 检查断路器实际位置及本体、机构的情况，并联避雷器有无动作等。

3.5 将检查情况详细汇报调度，申请将干式电抗器转为冷备用或检修状态，以做处理。

4. 因总断路器跳闸使母线失压后，应手动拉开各组并联电抗器。正常操作中不得用总断路器对并联电抗器进行投切。

第七章 售后服务

1.服务承诺

一般情况下，产品质保期为一年（除合同约定外，以用户收到产品之日起算），同时，我公司提供终身维护服务。 我公司将定期回访客户，听取客户意见，并建立回访档案，感谢用户的积极配合以及为提高我公司产品质量的宝贵意见。

属于客户不当操作、保存等造成的故障和问题，我公司将实事求是的讲清问题的性质及原因，并积极为客户排除故障，维护我公司及产品的信誉。

当产品质量出现问题，在保质期内的，由我公司免费进行处理；超过保质期的，我公司将收取成本费用为客户服务。

2.现场服务流程

2.1 根据合同、技术协议或客户要求派人去现场服务的，根据工作内容，公司选派能够胜任的服务人员按客户要求的时间赶到现场，为客户安装、调试、维修或提供其他帮助。

2.2 接到客户服务要求后，售后人员填写《售后服务记录单》，工作结束回厂前，请客户对服务人员的服务态度和服务质量在《售后服务记录单》上签署意见。

2.3 客户问题得到妥善处理，服务完成并得到客户允许后，服务人员返回公司。销售内勤将根据相关记录对客户进行电话回访，了解售服情况及后续质量跟踪。

3. 客户投诉的受理和处理

3.1 产品出厂后，所有接到客户反馈有关产品质量信息的部门（或个人），首先填写《顾客信息处理单》，转交售后服务小组。

3.2 售后服务小组根据《顾客信息处理单》中客户反馈的信息内容，进行调查核实，填写临时处理措施。

3.3 对于不需要进行现场服务的，由相关责任部门负责处理，填写原因分析及纠正预防措施。售后服务小组跟踪确认处理情况直至客户问题得到妥善处理。

3.4 对于需要进行现场服务的，将根据现场情况，派出服务人员到达现场，为客户维修、调试或其他服务。

3.5 客户问题得到妥善处理，服务完成并得到客户允许后，服务人员返回公司，销售内勤将根据《顾客信息处理单》对客户进行电话回访，了解服务情况及后续质量跟踪。

3.6 产品质量出现问题，处于质保期内的，由我公司免费进行处理；超过质保期的，我公司将收取材料成本及适当的服务费用。

电抗器开箱验收单

表 1

执行标准： EC60076-6:2007,JB5346-2014,JB/10775-2007

编号：

电抗器种类	串联 <input type="checkbox"/> 滤波 <input type="checkbox"/> 限流 <input type="checkbox"/> 并联 <input type="checkbox"/> 相控 <input type="checkbox"/>	结构形式	干式空心 <input type="checkbox"/> 干式铁芯 <input type="checkbox"/>	使用场所	户外 <input type="checkbox"/> 户内 <input type="checkbox"/>
供应商		数量			
产品型号		包装尺寸	厚 () × 宽 () × 高 ()		
序号	检验项目	技术要求	检测手段	检验方案	检验结果
1	质量证明	有质保书或合格证	验证	全检	没有时柜检
2	支柱绝缘子检验	1) 每只绝缘子附有出厂编号； 2) 绝缘子伞裙无破损和严重划痕；	目测	全检	
3	电抗器线圈本体检验	1) 通风气道检查 气道内未存留能够影响产品通风的杂物，气道撑条紧固无脱落现象； 2) 绕组引线检查 检查线圈所有绕组进出线应无折断或与从上下导电架脱开； 3) 产品底角检查 产品外包装拆除后，目测底角应无破碎、脱焊现象； 4) 线圈本体检查 线圈表面无明显撞击痕迹、表面防护漆无脱落，滤波电抗器的调谐绕组及上下调谐螺杆不应存在变形	目测	全检	
4	安装附件检验	1) 所有安装附件的数量符合用户提供的装箱清单无丢失； 2) 所有安装附件在运输过程中未形成明显质量缺陷。	目测	全检	
不合格描述： 不合格处置：					
			批准：	日期：	

备注：本表只提供给用户开箱后产品外观检查项目，产品最终质量判定需由现场试验判定

检验员： 检验结论： 检验日期： 年 月 日

表二

交接试验报告						
产品名称		出厂编号				
产品型号		A:			B:	
一、额定参数						
系统额定电压 :	kV	额定电流	A	短时电流-	kA	
额定频率	Hz	绝缘等级	级	持续时间:	S	
额定容量	kVar	绝缘水平	kV	额定电感	mH	
额定端压	kV	冲击水平	kV	工频损耗值 :	kW	
品质因数						
二、试验条件						
环境温度	℃	相对湿度:				
三、试验项目 执行标准 60076-6-2007、5346-2014、/10775-2007						
项目	设计值	判定标准	试验结果			结论
			A	B	C	
绕组电阻测量 (Ω)		1、每相试验值和设计值比较变化<2% (折算至同一温度下) ; 2、三相电抗器绕组直流电阻值相间差值<三相平均值的 2% (仅适用于平放产品)				
绝缘电阻 (MΩ)	大于 1000	大于 1000				
交流耐压 (kV)		相对地施加电压, 时间 1 分钟无闪络、放电				
冲击合闸试验		在额定电压下冲击合闸 3 次, 电抗器未出现任何放电痕迹和结构故障				
红外测温		产品正式运行 10 后, 用红外成像仪对电抗器的线圈温度进行测量, 其最热点温升不超过 85K				
外观检查:		合格				
试验 :		审核 :		日期:		

试验单位 :

基础接地装置施工隐蔽记录

工程名称					建设单位			
施工单位					施工图号			
安装地点					隐蔽日期			
1、接地体:								
序号	材质	规格.	数量.	埋入深度 (米)	极间距离 (米)	极度与建筑物距离 (米)		
1					/	/		
2								
3								
2、接地干线 :								
序号.	材质	规格.	长度	防腐处理	敷设方法	连接方法		
1								
2								
3								
3、接地电阻:								
序号		1	2	3	测量方法	气候条件		
实测阻值 (Ω)					电阻表			
<p>4. 独立避雷针的接地装置与道路距离 () 米, 与建筑物的出入口距离 () 米。</p> <p>5. 独立避雷针的接地线与其它接地线地下最小距离 () 米。</p> <p>6. 明敷接地干线涂漆:</p>								
附图 测试				建 设 (监 理) 单 位 意 见				
专业技术负责人				质量检查员				班 (组) 长

电抗器安装检验质量验收记录表

单位工程名称				
分部工程名称		验收部位		
施工单位		项目经理		
分包单位		分包项目经理		
施工执行标准名称及编号				
施工质量验收项目			施工单位检查评定记录	监理(建设)单位验收记录
1	电抗器本体及安装附件外观完好程度验收			
	2 电抗器接地网验收			
	3 电抗器的交接试验验收			
	4 电抗器装配质量验收			
	5 电抗器防护围栏验收			
	6 电抗器保护整定值验收			
	7 电抗器外接母线加工质量验收			
	8 电抗器带电部分与金属构架、围栏间电气距离验收			
施工单位检查评定结果	专业工长（施工员）		施工班组长	
	项目专业质量检查员： ：			年 月 日
监理（建设）单位验收结论	监理工程师： （建设单位项目专业技术负责人）			年 月 日

免责条款

如发生下列原因导致电抗器发生故障或由此引发的其他事故，我公司不承担赔偿责任：

- 1.遇地震、洪水、火灾等超出国家标准要求或协议要求规定强度的灾害及次生灾害；
- 2.遇战争、恐怖活动、暴乱、冲突、人为纵火、政府强制措施等不可抗拒事件；
- 3.遇强碱、强酸、核污染、核辐射、超出设计值的导电性粉尘等强污染；
- 4.系统电压、电流、谐波含量、谐波类型等系统环境超出国家标准或协议要求强度；
- 5.海拔高度、环境温度、环境湿度等运行环境超出国家标准或协议要求强度；

6.违反相关国家标准、行业标准及本公司使用手册、运输手册等相关规定，对电抗器进行不当安装、使用、维护、运输及贮存，造成的电抗器本体损坏或由此引发的其他事故。

对于以上原因造成的设备故障，我公司将实事求是的确定问题原因、讲清问题性质、划清问题责任。同时，积极主动的协助顾客解决问题，排除故障，维护我公司及产品信誉。

*注：本手册中所有设备、材料、技术参数、性能要求均遵照最新版本的国家标准（GB）、国际电工委员会标准（IEC）及国际单位制（SI），如标准换代，该手册中的要求按最新标准执行。



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