

# 树脂绝缘干式空心并联电抗器 安装使用说明书

## Installation Operation and Maintenance Manual Dry-type Air Core Shunt Reactor

BK4000SM

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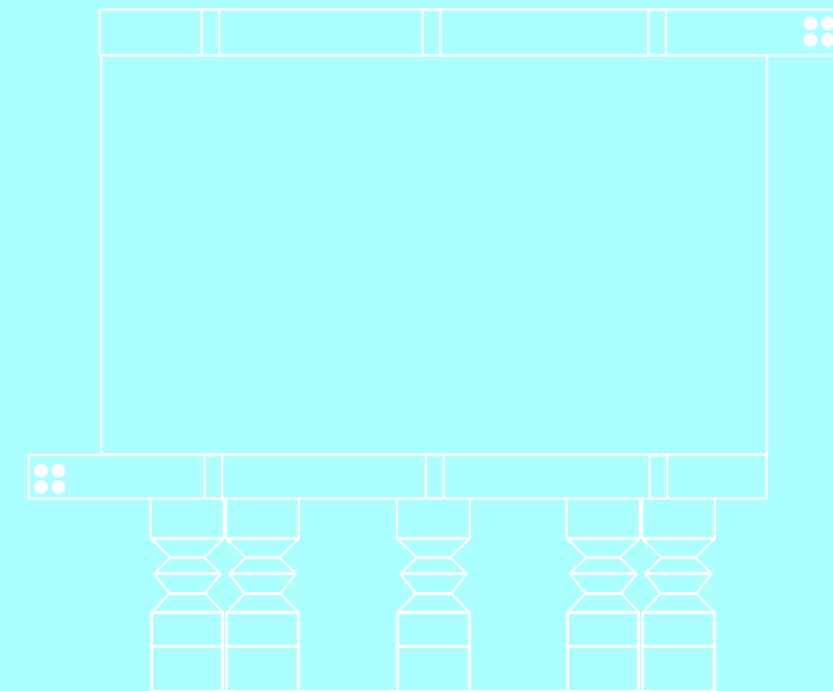
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顺特电气设备有限公司  
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本说明书适用于额定容量40000kvar及以下、电压等级66KV及以下环氧树脂绝缘干式空心并联电抗器的安装和使用。

This manual applies to the installation and operation of cast resin dry-type air core shunt reactor with the rated capacity equal to 40000kvar and below, the voltage class equal to 66kV and below.

## 一、产品特点 Product features

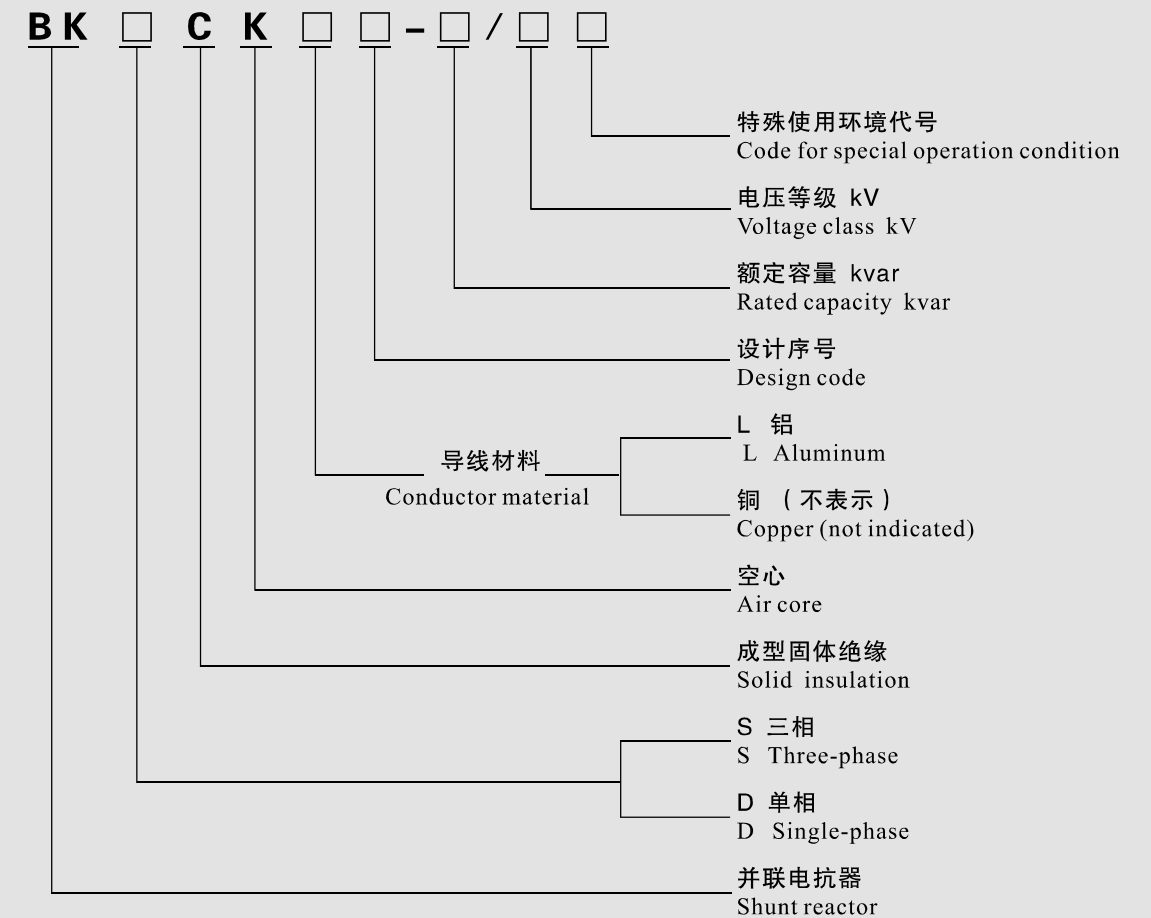
并联电抗器应用于电力系统，通常安装在高压长距离输电线的始端升压站、中间联络站以及高压直流输电的换流站中，并联连接于变电站的66KV及以下的低压回路。具有补偿电网无功功率、降低电网损耗、提高输电能力以及抑制电网谐振过电压、防止发电机自励磁、消除空载长线电容效应和高压电缆电容效应、抑制工频过电压等众多功能，可节约能源、提高电力系统的运行稳定性和可靠性。并联电抗器与并联电容器、大功率晶闸管和微机控制系统组成静止无功补偿装置，可对电力系统的无功功率进行适时动态调节。产品符合GB10229《电抗器》、IEC60076-6《电抗器》等标准的要求。

Shunt reactor is applied to power system. It is usually installed in the step-up stations of long distance and high voltage transmission, middle connection station and HVDC convertor station. It is connected in parallel to low-voltage circuit of 66kV and below. It has multi-functions, for instance, compensating reactive power of power grid, reducing loss of power grid, improving transmission capability, controlling overvoltage due to resonance, prevent self-excitation of generator, eliminating capacity effect of no-load long line and high-voltage cable, controlling power frequency overvoltage and so on. In addition, it also can save power energy and improve stability and reliability of power system. Static Var compensator system is made up of shunt reactor, shunt capacitor, high-power thyristor and microcomputer-controlling system. It can dynamically adjust the reactive power of power system. The product complies with standards of GB10229 Reactor and IEC60076-6 Reactor etc.

该产品应用计算机进行电磁优化计算和空间三维结构设计，采用环氧玻纤增强的多包封并联结构，使用先进的工艺技术和微机控制的生产设备及引进的检验设备进行产品生产和检验。该产品具有电感线性度好、损耗低、温度分布均匀、绝缘强度高、机械强度高、局放小、噪音低、体积小、重量轻、防潮、阻燃、过载能力强、可靠性高、无污染、免维护、环保效果好等优点，可广泛应用于输变电系统、电气化铁道、冶金、石化等领域，既可以户外安装运行，也可以户内安装运行，特别是要求具有较高的动热稳定性、防火性能和需要户外运行的场所，更能充分发挥其优越性。

The electromagnetic computation and structure design of the product are conducted with computer. It is made of multi-envelope parallel connection structure reinforced with glass-epoxy fiber and its production and check are done with advanced technique, microcomputer-controlled production equipment and imported inspection equipment. The product features good inductance linearity, low loss, uniform temperature distribution, high insulation strength, high mechanical strength, low partial discharge, low noise, small size, light weight, damp proof, fire retardation, high overload capacity, high reliability, pollution free, maintenance free and other advantages. It can extensively apply in the fields such as power transmission and transformation system, electric railway, metallurgy and petrochemical industry, etc. It can be installed and operated both indoors and outdoors, especially for the location required high dynamic thermal stability, fire resistance performance and outdoor site, in which its advantages can more fully play.

## 二、产品型号说明 Product Type Specification



### 三、使用条件 Operation Conditions

- 3.1 安装地点：户内(或户外)。  
Installation location: indoors (or outdoors)
- 3.2 环境温度：-40℃~+40℃。  
Ambient temperature: -40℃ to +40℃
- 3.3 海拔高度：不超过2000m。  
Altitude: Under 2000m
- 3.4 最大风速：35m/s(离地面10m高处10分钟内平均值)。  
Maximum wind speed: 35m/s (average value in 10 minutes at the place 10m higher than the ground)
- 3.5 地震强度：水平0.3g，垂直0.15g。  
Earthquake intensity: horizontal 0.3g; vertical 0.15g
- 3.6 绝缘等级：F级。  
Insulation class: Class F
- 3.7 安装地点应清洁，无有害腐蚀性气体及蒸气，无导电性或爆炸性尘埃。  
The installation location shall be clean without any harmful corrosive gas or vapor, conductive or explosive dust.
- 3.8 当产品用于户内时，应安装在场地清洁、通风良好和具有合适的大气条件的场所。如果电抗器安装在地下室或其它空间受限制的地方时，应有足够的通风，一般每1kw损耗应有2~4米<sup>3</sup>/分钟的空气通风。  
When product is used indoors, it shall be installed in clean and well-ventilated location with suitable atmosphere. When the reactor is installed in basement or other location with limited space, it shall be adequately ventilated. There shall have 2 ~ 4 m<sup>3</sup>/min ventilation for 1kW loss.

### 四、产品运输 Product Transportation

- 4.1 电抗器本体与支柱绝缘子和支持底座等应分箱包装，电抗器连接座与包装底座应可靠紧固定位。  
The reactors, post insulators and support bases shall be packaged in separate boxes. The reactor connection bases and package base shall be reliably and firmly fixed and positioned.

- 4.2 产品运输过程中，如无包装或仅有简易包装，应注意天气，如遇下雨下雪，应采取措施，避免雨雪侵入其内。  
During the transportation of product, if there is no package or just there is simple package, the weather shall be considered. Measures shall be taken in rain or snow condition to prevent the rain or snow entering.
- 4.3 电抗器及包装箱应按规定方向放置，产品运输过程中，其倾斜度不得大于30°。  
The reactor and package box shall be placed with specified direction. During transportation of product, its inclination shall be no more than 30°.
- 4.4 起吊并联电抗器时，如有包装箱，应在包装箱的四下角垫木处挂钢丝绳起吊，如没有包装箱或并联电抗器从包装箱中吊出时，应同时使用器身上的所有吊孔(板)垂直起吊，起吊钢丝绳之间的夹角不得大于60°。  
When hoisting the shunt reactor, if there is package box, steel wire ropes shall be hanged at the bed timbers at four bottom of package box. If there is no package box or the shunt reactor has been hoisted from the package box, it shall be vertically hoisted with all lifting eyes (plates) on body of reactor. The included angle between steel wire ropes shall be no more than 60°.

### 五、检查验收 Check and Acceptance

- 用户收到并联电抗器后，应立即进行检查。  
Please check the shunt reactor immediately after received it.
- 5.1 检查产品的铭牌数据与订货合同是否相符，如产品型号、额定容量、额定电压、额定电流等。  
Check whether the data on the nameplate are consistent with those on the purchase order, such as product model, rated capacity, rated voltage, rated current, etc.
- 5.2 检查出厂文件是否齐全。  
Check whether the delivery documents are complete.
- 5.3 检查包装箱内零部件是否与装箱单相符。  
Check whether the parts and components in package box are in consistence with the packing list.
- 5.4 检查产品运输过程中有无损伤，产品的零部件是否损伤和移位，接线是否松动、断裂，绝缘是否有破损，是否有脏物或异物等。同时，如有运输所使用的垫木等物，必须把它们挪开。  
Check whether the product is damaged, whether the product parts are damaged or moved, whether the wiring is loose or broken, whether the insulating layer is damaged, whether there are contaminants or impurities during transportation, and so on. Meanwhile, objects such as stow-wood used in the transportation must be moved away.

- 5.5 产品开箱检查完毕后，如不立即投入运行，则必须重新包装好，并把它放在户内安全的地方，以防损防盗。

Product should be packed again and placed at safe place after the unpacking check if it is not put into operation immediately in case of damage or theft.

## 六、运行前试验 Test before Operation

- 6.1 检查所有零部件安装是否妥当、齐全，紧固件、连接件是否可靠紧固。

Check whether all the parts and components are installed properly and completely. Check whether the fastener and connection parts are reliably fixed

- 6.2 检查电抗器上是否有异物

Check whether there is foreign material on reactor.

- 6.3 绕组直流电阻的测试

Test DC resistance of the winding.

- 6.4 绝缘电阻测试。一般情况下，绝缘电阻可满足如下值：

Test insulation resistance . Under normal conditions, the insulation resistance can meet following requirements:

相-相 $\geq 200M\Omega$ ， 相-地 $\geq 200M\Omega$ 。

Phase-phase:  $\geq 200M\Omega$ ， Phase-ground  $\geq 200M\Omega$

如果是在比较潮湿的环境条件下，电抗器的绝缘电阻值会有所下降。一般地，若每1000V额定电压，其绝缘电阻值不小于 $2M\Omega$ （一分钟 $25^{\circ}C$ 时的读数），就能满足运行要求。

The insulation resistance value of reactor will slightly decrease under damp environment conditions.

Generally, if the insulation resistance value is no less than  $2M\Omega$  per 1000V rated voltage (readings for 1 minute at  $25^{\circ}C$ ), it can meet the operation requirements.

- 6.5 外施工频耐压试验。试验电压为出厂试验电压的85%，历时1分钟。

Applied power frequency withstand voltage test. The test voltage is 85% of ex-factory test voltage and it shall be applied for 1 minute.

- 6.6 电抗值测量。

Measure reactance value.

## 七、安装与运行 Installation and Operation

- 7.1 建议采用实心水泥平台基础，水泥平台高出地面约2米。水泥基础内要避免出现金属短路环。

Proposed to adopt solid cement platform foundation, cement platform above the ground about 2 meters and avoid metallic short-circuit rings in the cement foundation.

- 7.2 电抗器安装时请先准备规格为1mm、2mm的薄钢板各若干块，数量等于底座数量，每块长50mm、宽20mm，用来调节产品底座与安装基础间的配合，

Please prepare several block steels of 1mm and 2mm thick, 50mm long and 20mm wide to adjust the adaptation between product bases and installation foundation. The quantity of the steels should be equal to that of product bases.

- 7.3 并联电抗器安装布置方式应符合电抗器的安装外形图的要求。在产品订货和设计中通常选用的安装布置方式见图1、2、3；通常选用的端子出线方向见图4。安装布置方式一经确定，则不允许再行变更。

The installation and arrangement of reactor shall meet the requirements of the shunt reactor mounting dimensions. The installation and arrangement normally selected during product order and design refer to figure 1, 2 and 3. The terminal outlet direction normally selected refers to figure 4. The installation and arrangement must not be altered after confirmed.

- 7.4 按照安装外形图首先将支柱绝缘子与电抗器下出线臂上的连接座相连接，注意螺栓不要拧紧，以便给后装配留下活动裕度。

According to installation outline drawing, firstly connect the post insulators with connection bases on lower outgoing line arm of reactor. Notice that the bolts shall not be tightened to reserve moving margin.

- 7.5 将支持底座与安装于最下层的电抗器的支柱绝缘子相连接。

Connect the supporting bases with the post insulators of reactor installed at lowest layer.

- 7.6 将装有支持底座的电抗器吊装于预置有支承钢板或连接螺栓的混凝土基础上定位并固定。

Lift the reactor with supporting bases on concrete foundation embedded with support steel plates or connection bolts and fix it.

- 7.7 出线端子方向和相间夹角按外形图。

The outlet terminal direction and phase-to-phase included angle shall refer to the outline drawing.

- 7.8 电抗器安装完毕并经检验合格后，将电抗器支持底座与底座支承钢板焊接牢固。

After the installation of reactor is completed and it is verified as qualified, firmly weld the reactor supporting bases with base support steel plates.

7.9 电抗器与电抗器之间、电抗器与周围金属物体之间需保持足够的磁间距，一般情况下，各种布置方式的电抗器的最小磁间距应不小于图1、2、3的规定。

Adequate magnetic spacing shall be remained between reactor and reactor, reactor and surrounding metal article. Under normal conditions, the minimum magnetic spacing of reactor with various arrangement shall be no less than the specification in figure 1, 2 and 3.

7.10 电抗器安装前应按电抗器总装配图中底座位置及尺寸图预制混凝土基础，在基础内预埋支承钢板和接地保护极，各支承钢板应可靠接地。基础应水平，其倾斜度应 $\leq 2/1000$ 。基础除应能承受电抗器的重力、运行振动和短路电动力的冲击外，对于户外安装的电抗器，还应能承受电抗器遭受正面35m/s的风袭时所产生的破坏力的作用。

It is necessary to prefabricate the concrete foundation according to base position and dimension drawing in reactor general assembly drawing before emplacement of reactor, embed support steel plates and grounding protection pole in the foundation. All support steel plates shall be reliably grounded. The foundation shall be horizontal, of which the gradient shall be less than or equal to 2/1000. The foundation shall be able to bear the gravity of reactor and impact by operation vibration and short-circuit electric dynamic force, furthermore, the reactor installed outdoors shall also be able to bear the destructive force resulted from 35m/s wind applied on outdoor of reactor.

7.11 在电抗器周围有影响的区域内(如图1、2、3)及水泥基础内的金属件，不得有大的封闭金属环网，以免形成环流而增加电抗器的损耗，造成局部过热。

In the surrounding affective areas of reactor (see figure 1, 2 and 3) and metal piece in cement foundation, there shall have no large closed metal ring so as not to generate circulation flow and add the loss of reactor which may lead to partial overheating.

7.12 电抗器出线端子与外部母线或其它电器的连接最好采用电缆连接。如果必须采用硬母线连接时，母线应有缓冲的过渡性弯头，以保证电抗器本体在受到电动力冲击时有适当的振动自由度。

It is preferable to use cable to connect the outgoing line terminal of reactor with outside bus or other electric appliance. If it is necessary to connect with hard bus, the bus shall have buffering transition bend to ensure proper vibrational degree of freedom of reactor body when impacted by electric force.

7.13 连接端子排应平整光滑，清洁无污物，用螺栓紧固，建议在接触部分涂导电膏。

The connection terminals shall be flat, smooth and clean without dirt, and be fixed with bolts. It is recommended to apply conductive paste onto the contact part.

7.14 检查上述操作完全正确、并联电抗器整体无其它异常、所有异物均彻底清除后，并联电抗器可投入试运行。

Check the completely correctness of above operation. The shunt reactor can be put into operation if the shunt reactor has no other abnormality and all foreign materials have thoroughly been cleared.

7.15 试运行60分钟无异常后，并联电抗器可投入正式运行。

The shunt reactor can be put into formal operation if there is no abnormality after test run for 60 minutes.

7.16 并联电抗器具有在最高运行电压下长期运行的能力，但在通常情况下，并联电抗器的运行电压最好为额定电压。

Shunt reactor can operate for a long time under the highest operating voltage, but as a rule, it is recommended to run at rated voltage.

## 八、维护与保养 Maintenance

为了保证并联电抗器能正常运行，需对它进行定期检查和维护。

To ensure normal operation of shunt reactor, it shall be regularly checked and maintained.

8.1 一般地，在干燥清洁的场所，每年或更长一点时间进行一次检查；在其它场所，例如可能有灰尘或化学烟雾污染的空气进入时，每三至六个月应进行一次检查。

Normally, check once every year or a bit more in dry and clean locations. At other locations, such as where the air with dust or chemical smoke pollution possibly enters, it shall be checked once every three to six months.

8.2 检查时，如发现有过多的灰尘聚集，则必须清除，以保证空气流通和绝缘良好，特别要注意清洁并联电抗器的绝缘子、绕组顶部和底部，对通风道中的灰尘，可使用压缩空气吹净。

During check, excess dust conglomeration, if founded, must be removed to ensure the air circulation and good insulation. The insulators and the top and bottom of winding shall be especially cleaned. The dust in ventilating ducts can be blown off with compressed air.

8.3 检查紧固件、连接件是否松动，导电零部件以及其它零部件有无生锈、腐蚀的痕迹，还要观察绝缘表面有无爬电和碳化现象，绑扎拉带有无损伤，必要时应采取相应的措施进行处理。

Check the loose of fastener and connectors, rust or corrosion mark on conductive parts and components and other components. Observe whether there is creepage or carbonization on insulation surface and there is damage on binding belt, corresponding measures shall be taken if necessary.

8.4 电抗器表面漆每2~3年进行一次检查，发现不良时应及时处理或与厂家联系处理。

The surface paint of reactor shall be checked one time every 2 to 3 years. If poor condition is founded, it is necessary to timely treat or contact the factory for treatment.

**九、安全注意事项 Safety precautions**

9.1 并联电抗器安装完毕投入运行之前，一般在并联电抗器的周围安装非金属安全隔离栅栏，以避免人或物进入发生意外事故。

Before shunt reactor is put into operation, non-metal separation fence is normally installed surrounding the shunt reactor to avoid the entering of person or matters, which may lead to accident.

9.2 并联电抗器投入运行以后，禁止触摸电抗器主体，以防事故发生。

After the operation of shunt reactor, prohibit touching the reactor body to prevent from accident.

9.3 并联电抗器周围1.1倍直径范围内，不得有封闭的金属短路环，以免引起发热和增加电抗器的损耗。

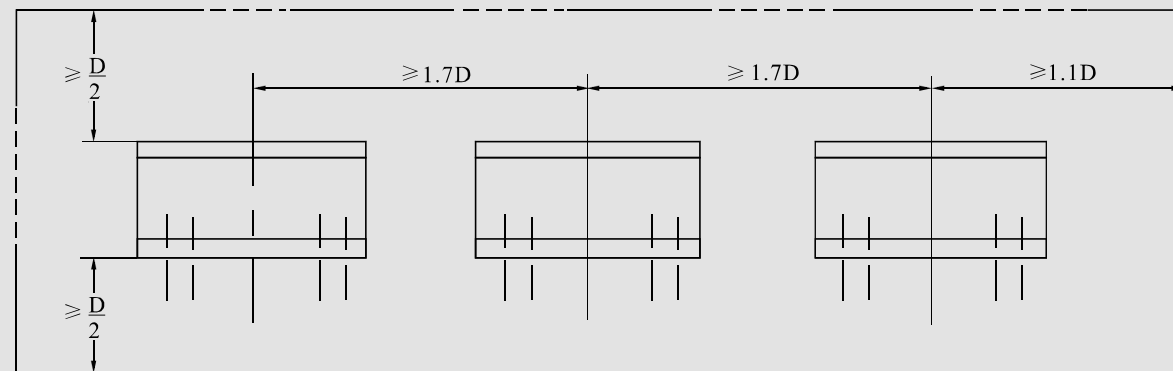
There shall have no closed metallic short-circuit ring within the range of 1.1 times diameter surrounding the shunt reactor to avoid heating and additional reaction loss.

9.4 电抗器应安装良好，以防止产生附加噪声。

The reactor shall be installed well to prevent generation of additional noise.

**图1 三相水平“-”形布置**

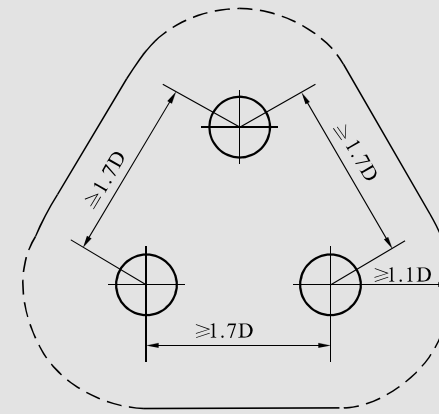
**Figure 1 Horizontal “-” form arrangement**



相对于不形成闭环的金属部件和其它电抗器的最小磁间距  
Minimum magnetic spacing in relation to metal components not forming closed loop with other reactors.

**图2 三相水平“△”形布置**

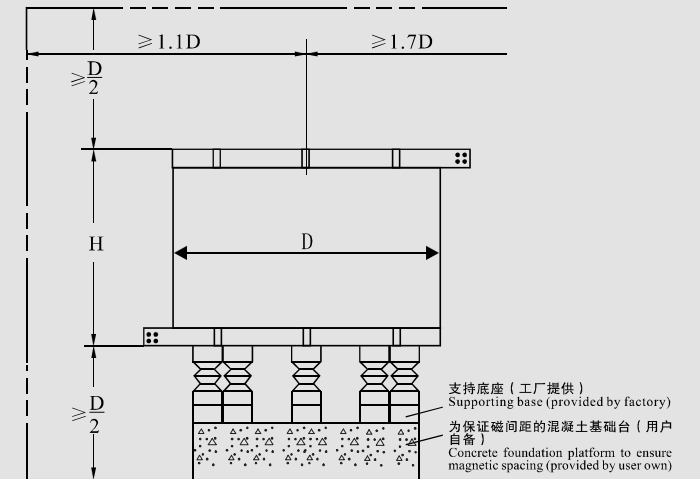
**Figure 2 Horizontal “△” form arrangement**



相对于不形成闭环的金属部件和其它电抗器的最小磁间距  
Minimum magnetic spacing in relation to metal components not forming closed loop with other reactors.

**图3 并联电抗器**

**Figure 3 Shunt reactor**



相对于不形成闭环的金属部件和其它电抗器的最小磁间距  
Minimum magnetic spacing in relation to metal components not forming closed loop with other reactors.

**图4 端子出线方向**

**Figure 3 Outgoing Terminal direction**

