Design and Research of Thyristor Rectifier Based on Polarization Technology

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Abstract. The thyristor rectifier has the advantages of simple operation, fast response, good steady flow accuracy and high rectification efficiency. In this paper, the system structure design and parameter design of the thyristor rectifier are carried out, and the main technical measures of the rectifier cabinet are analyzed. Through the research of the thyristor rectifier system, the system can obtain high stability DC current, which can basically meet the actual production needs.

1. Introduction
With the continuous improvement and improvement of high-powered crystal tube distillation technology, thyristor rectifiers have been widely used in the chemical industry. The thyristor rectifier device has the advantages of simple operation, quick response, good steady flow precision, and high rectification efficiency. The output DC current regulation relies on the coarse adjustment of the on-load switch of the transformer, and the phase shift of the thyristor is fine-tuned, so that the system can obtain a high-stability DC current, which fully meets the requirements of the chemical electrolysis process.

2. System structure design
The rectification system consists of 2 sets of rectifier units. Each set of rectifier unit adopts the structure of a rectifier transformer zes20ka/340v rectifier. The main circuit of the rectifier cabinet adopts three-phase bridge type in-phase anti-parallel type, 12 pulses of single cabinet, and the transformer network side. The phase shift is rectified and composed of 24 pulses. Each rectifier independently supplies power to a series of cells and requires independent operation.

Each rectifier machine is equipped with a local control cabinet, which is installed side by side with the ballast. Each control cabinet installation unit controls the plc locally. Its function is the data acquisition of the rectifier cabinet and the auxiliary machine system. All the local manual control functions of the control cabinet can be transmitted from the unit plc to the upper computer to realize remote machine control.

The steady flow regulation control trigger system of the control cabinet adopts the digital dual-channel digital control trigger of the single-chip microcomputer. The two channels are hot standby for each other. The two channels can operate independently and have automatic diagnosis function, which can be easily operated online without disturbance. Switch. The trigger system is controlled by a single-chip microcomputer to ensure stable and reliable trigger pulses. Normal operation is controlled by a line angle between 5 and 25 degrees. When the current feedback is dropped due to a fault, the control system can automatically recognize that the current does not suddenly increase or decrease.
A central console is arranged in the central control room to correspond to the remote operation of the two sets of units, and the remote manual control function keys are installed, including remote series current manual adjustment, on-load switch operation, series current, voltage display, and the like.

3. Rectifier device parameter design

The rectification efficiency of any rectifying device can be expressed by its power conversion efficiency, namely:

$$
\eta = \frac{P_{av}}{P_N + \Sigma P}
$$

In the formula, $P_{av}$ indicates the DC rated output power of the rectifier cabinet, which is equal to the product of the rated DC voltage and DC current, i.e:

$$
P_{av} = U_{av} \times I_{av}
$$

$\Sigma P$ is the sum of the losses of the rectifier cabinet itself, including rectifier component loss, fast-melting loss, fast-fed and component busbar loss, busbar busbar loss, connection row loss, absorption and protection device loss.

The element arm busbar adopts a cold drawn or formed oxygen-free copper double-hole busbar. The specifications are as follows:

$$
K_1 S_{bD} = \Delta t_{bD} + \alpha t_{bD}\rho
$$

In the formula: $\rho$ is the resistivity, copper is $0.0175$ at $20\,^\circ\text{C}$; $\alpha$ is the temperature coefficient of resistance, copper is $0.0043$; $\Delta t_{bD}$ is the temperature rise of the double-hole busbar, take $\Delta t_{bD}=15\,^\circ\text{C}$; $K_1$ is the skin effect coefficient, $K_2$ is the proximity coefficient; $L_{bD}$ is the length of the double row busbar; $S_{bD}$ is a double-hole busbar cross section.

4. Main technical measures of rectifier cabinet

4.1. Technical measures

(1) Rectifier In addition to the 1800V withstand voltage selection measures, the surface of the rectifier device is also specially designed, which is one of the key measures for manufacturing high voltage devices.

(2) The same anti-parallel branch is separated from the same row of epoxy glass cloth board, and there is no connection and connection in the middle, which avoids the fear of breakdown of the electrical equipment, reduces the volume of the device, and reduces the size of the casing. The eddy current loss caused by the variable magnetic field. According to the relevant national standards and electrical requirements and according to the requirements of the specification, for non-contaminated insulators such as rectified silicon insulation supports, the insulation creepage distance between AC and DC and between the positive and negative tributaries and between DC and ground is ensured to be greater than 80. In millimeters, this is one of the key measures to manufacture high voltage rectifiers.

(3) The secondary circuit of the distillation unit uses the insulated wire of 500v withstand voltage. The relevant external lead wire adopts the high quality terminal of Germany Wago Company, and the direct measurement circuit adopts voltage isolator to take out to ensure the reliability of the control measurement circuit. Sex.

4.2. Component arm current sharing guarantee measures

(1) All devices gradually pass the thermal aging and electric aging screening of the field. The basic process is: the tens of originals are heated in the aging box to heat the sub-elements at a temperature of 120 degrees Celsius, and then the rated DC reverse voltage is applied. Failure is acceptable. After the
aging test, the component is tested for the forward peak voltage. The tested components are grouped with each arm component according to the peak voltage error of not more than 0.05v, which is one of the key technologies to ensure high current sharing coefficient.

(2) Rectifier original clamping is made of high-quality automotive leaf spring. Under high temperature and high pressure, the pressure is stable. For three-inch components, the pressure in the silicon component is about five tons, which ensures reliable and balanced pressure. It is the second key technology to ensure a high current sharing coefficient.

(3) In order to obtain better current sharing and reduce eddy current loss, the main circuit adopts the same phase anti-parallel structure, and the rectifying elements of the parallel branch are distributed symmetrically according to the circumference, and each branch is completely symmetrical, all conductive. The contact surfaces are all processed by milling machine with a finish of 6 or more. All of them adopt the crimping structure. The pressure variation range is small, the contact resistance is low, and the uniformity is good. This is the third technology to ensure the current sharing coefficient.

5. Conclusion
The thyristor rectifier device has been widely used in the chemical industry. The device has the advantages of simple operation, fast response, and good steady flow precision and high rectification efficiency. According to the design, the DC current regulation of the output of the thyristor rectifier device relies on the coarse adjustment of the on-load switch of the transformer, and the phase shift of the thyristor is fine-tuned, so that the system can obtain a high-stability DC current, which can meet the requirements of the chemical electrolysis process.

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