

Talking about the Development Status of Mine Frequency Converter

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Abstract: In the past 20 years, the use of frequency converters has become more and more widespread, ranging from air-conditioning fans to large-scale coal mining. From the perspective of mine converter, this article analyzes the background and technical requirements of the mine inverter and the advanced technology used by the inverter. It analyzes the domestic inverter and analyzes the gap with international famous brands. And made some suggestions for the development of mine frequency converters.

Keywords: Frequency converter; development status; explosion protection; variable pressure.

1. INTRODUCTION

The development of power electronics technology has prompted the emergence of many important products, accelerated the pace of industrial development, and has become a promoter of global modernization.

In the 1980s, the commercial production of 4500V gate shut-off thyristors facilitated the development of medium-voltage high-power inverters and transmission industries. Until the late 1990s, high power IGBTs and GCTs appeared, changing the standard power devices used in medium voltage drives. These switching devices have excellent switching characteristics, low power loss, simple gate control, and do not require complex absorption circuit characteristics, making high-power inverters develop rapidly. In general, a variable frequency drive (VFD) is a control device that integrates power electronics technology, automatic control technology, and application control technology, and controls the rotational speed of an AC motor by changing the frequency of the motor supply power. Its small starting current, covering a wide range of power levels, a wide range of voltage levels, easy to switch positive and negative, has been widely used in industrial production, such as lathes, fans, pumps, tower cranes, belt conveyors and so on. At the same time, the inverter provides important technical means in terms of energy saving and consumption reduction in the industry, reducing environmental pollution, improving grid performance, improving control accuracy, etc., and plays an indispensable role in the future industrial development.

2. MINE FREQUENCY CONVERTER TECHNICAL REQUIREMENTS

Compared with general-purpose inverters, mining inverters are used lately, but the development trend is rapid. Faced with the objective of social development with respect to energy saving and consumption reduction and low carbon emissions, combined with the special features of mining equipment, the application of mine explosion-proof inverters is becoming increasingly widespread. In summary, explosion-proof inverters have the following features:

- (1) It must be explosion-proof. Because there are flammable and explosive gas and dust under the mine, and the environment is wet, the products of common structure cannot be applied. Only the common components are placed in a special box that meets the explosion-proof standard. In order to ensure the normal operation of explosion-proof inverter
- (2) Inverters and motors are usually far away from the power supply than the general products. If the power consumption of the 380V power supply line is too large, the voltage levels are generally 660V, 1140V and 3300V. Its specific power is related to the power of the power equipment.
- (3) The anti-jamming requirements are strict, and harmonic interference cannot affect other electrical equipment after the inverter is used, nor can high-frequency electromagnetic interference affect the normal use of other electronic equipment.
- (4) The special needs of the mining equipment itself, such as long life, reliable performance, and other needs of the electrical transmission industry.

The main equipments for mining inverters are as follows:

- (1) Drainage pumps, water supply pumps, etc.
- (2) Exhaust fans, fans, etc.
- (3) Belt conveyors are generally one-kilometre or even two-kilometre long with a bandwidth of one metre or more; flat belts or inclined or trough type; single-motor or multi-motor driven.
- (4) Some need to use four-quadrant inverters with energy feedback, such as inclined belt conveyor, when the material is transported under high drop; the material bucket elevator; oblique well truck.
- (5) Air compressor.
- (6) High-pressure hydraulic oil pumps, etc. used for roofing mines.

3. DOMESTIC AND FOREIGN MINING INVERTER TECHNOLOGY ANALYSIS

In foreign countries, most of the early inverters were open loop constant voltage ratio control methods, such as Toshiba TOSVERT-130 series, FUJIFVRG5/P5 series, and SANKEN SVF series. Later, in 1991, Fuji Electric released the well-known FVR and FRNG7/P7 series designs. Mitsubishi, Hitachi, and Toshiba also had similar products. With the in-depth study of vector control, since 1992, Siemens has developed 6SE70 general-purpose series, which can realize frequency control, vector control and servo control through FC, VC and SC boards respectively. Then the theory of direct torque control makes the inverter control method further. In 1995, ABB first introduced the ACS600 direct torque control series, which has reached a

torque response speed of <2ms. The accuracy of static speed with PG can reach 0.01%. Even without the PG, it is subject to the input voltage. The effect of change or load mutation can also reach 0.1% speed control accuracy. The most representative foreign products are Siemens IGBT direct series three-level mode; ROBICON's IGBT unit series multi-level mode; AB's SGCT current type and GTO current type; ABB's IGBT directly connected in three levels the way.

The technology and reliability of the above foreign products have been at the leading stage in the world, and China's inverter technology started relatively late, and there is not a small gap in technology and reliability compared with international famous brands. At present, most domestic inverter manufacturers can only produce AC380V medium and small power products, and relatively few technologies are used in high-voltage and high-power inverter products, and high-voltage inverter technology and capital requirements are much higher than those of low-voltage inverters. . In particular, mine inverters also need to take anti-explosion treatment, which undoubtedly increases the technical difficulty. Since the voltage level in foreign countries is less than 1140V, this type of inverter is not easy to import. The inverters with other voltage levels have high import cost and low cost performance. Therefore, it is very important for China to independently develop safe and reliable mine explosion-proof inverters. However, at present, there are few mine explosion-proof inverter manufacturers that can develop, produce, and provide services in China. Major domestic mine explosion-proof inverter company's products have achieved 660V, 1140V and 3300V frequency converters commonly used in three mines, most of them adopt AC-DC-AC direct power supply mode, and use IGBT as power device. It is a voltage source inverter. Commonly used types include two-level, series-connected H-bridge multi-level, diode-clamped multi-level and other connection methods. In terms of control technology, it is basically the same as foreign technology. There are constant voltage and frequency ratio control technologies for fan pump loads, voltage space vector control technology for high torque loads, and vector control technology for high-accuracy loads. The direct torque control technology has not yet been widely used, and it is still in the test or small-scale test stage.

Because of the demand on the mine, some frequency converters have also joined the four-quadrant energy recovery function, such as on high-drop belt conveyors, to return the generated energy to the power grid and save resources. In terms of heat dissipation, heat pipe heat dissipation and water cooling heat dissipation are used, of which high power is mainly water-cooled heat dissipation and has good heat dissipation performance.

4. FORWARD-LOOKING DEVELOPMENT OF DOMESTIC MINE INVERTER

From the perspective of the overall development of mining explosion-proof inverters at home and abroad, there are certain gaps in the performance and stability of domestic mining explosion-proof inverter products, which are not unattainable. Many advanced technologies are also being used in domestic inverters. Compared with the integrated inverters of

well-known foreign companies, domestic mine inverters should be more in line with China's national conditions. To this end, the following suggestions are proposed:

(1) Mine frequency converters are differentiated, that is, they are industrialized. Different application places have different requirements for frequency converters. If a mine inverter is to satisfy multiple functions, it will increase the technical cost of the inverter and cause the waste of other functions. It is advisable to specialize in frequency converters, such as dedicated frequency converters for fan pump loads. This equipment requires low accuracy and can effectively reduce production costs.

(2) Lightweight mine inverter. The current mining inverter is a one-piece product, namely a steel explosion-proof enclosure, which is filled with various components, making the mine inverter quite cumbersome. Especially when used under a mine, disassembly and installation are bothersome. Lightweight production reduces the weight while reducing the volume, which is easy to install and easy to maintain.

(3) Intelligent mine inverter. This intelligentization does not allow the inverter to have its own thinking logic, but it reduces the obstacles in the human-computer interaction, and makes the expression of the inverter more inclined to the human way of thinking, which makes the operation easier and more convenient.

5. CONCLUDING REMARKS

At present, China-made frequency converters are at a peak period of development. The gap between products from well-known foreign companies is gradually shrinking, and mining inverters are developing steadily in light of the current state of the country. Various international advanced technologies are being applied. Supporting and developing mine explosion-proof inverter products has great significance for the development of China's power industry, not only improving the product's own performance and application, but also has important significance for China's energy conservation and high efficiency development.

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