

On Study of Application of Power Electronical Technology in Field of Energy Conservation

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Abstract: aiming at achieving the sustainable development in economy and improving living standard of the residents, the government departments in China have strengthened the promotion of green, low-carbon and sustainable development concepts. Under this context, the energy conservation concept is implemented during the implementation of social production and life activities. Currently, in order to ensure the improvement in social energy conservation benefits, the advanced technologies are applied by China's enterprises and residents. This paper, based on this, discusses the development situations of energy conservation in China, and analyzes the application of power electronical technology in the field of energy conservation, hoping to realize the sustainable development of energy conservation cause in China and to gain high yield.

1. Introduction

Serving as a technology type integrating control, power and electronical technology, the power electronical technology tends to effectively transform energy output by virtue of high power electronic devices in the process of promotion, which saves various energies at maximization and realizes the social sustainable development in China. The recent years see the implementation of low-carbon and green development concepts in China, and the application of power electronical technology is strengthened during the process of social production and life activities implementation, facilitating benefits in various aspects.

2. Introduction of Power Electronical Technology

2.1 Definition of Power Electronical Technology

The so-called power electronical technology refers a science which solves practical problems through designing and applying various electronic components according to principle of electronics. Generally speaking, the research of power electronical technology has gone through three eras (rectifier era, inverter era and inverter era), and is widely applied in various fields in social production and life.

Actually, with the wide application of power electronical technology, China's social production and life will gradually develop towards the digital, green, intelligent, humanity and network orientation, and promote higher benefits.

2.2 Reasons for Application of Power Electronical Technology in Energy Conservation Field

With the continuous improvement of urbanization and industrialization in China, the scale of cities in China is expanding day by day, and an irrational situation occurs in industrial structure. Under such a background, China faces severe environmental pollution gradually, and our ecological environment is further damaged by garbage, sewage and gas produced by industrial production.



Considering this situation, relevant departments in China strengthen call on green and low-carbon economy, and consolidate promotion of energy-saving work. In this process, in order to avoid the waste of power resources as well as pollution caused by electricity resources production, the relevant departments strengthen the application of power electronical technology in order to improve energy efficiency of power systems, avoiding power resources waste and facilitating the environmental improvement.

3. Key Technologies of Power Electronical Energy Conservation

In order to make the further improvement in energy efficiency in China's power system, the relevant units and persons enhance application of power electronical energy-saving technology. In terms of commonly used power electronical energy conservation technologies, the author draws relevant conclusions as follows.

3.1 Switching Frequency Conversion Technology

The so-called switching frequency conversion technology refers to the energy conservation technology which adjusts fixed frequencies. Currently, China's power equipment faces low efficiency and low power factors in the process of running, further reducing power consumption. It is reported that about 2/3 of annual total energy consumption is wasted caused by power equipments in the non-optimal efficiency.

Actually, the promotion of frequency conversion technology guarantees that the power equipment is in the best operating efficiency state to a large extent, improves electricity efficiency, avoids line loss and reduces pollutant emissions. Here is an example about testing frequency conversion and speed regulation of three 300kW water pumps in one 400kVA transformer frequency conversion device, and we have to ensure that three pumps mentioned above will save 600kW electricity or so during running in the process of test implementation.

Relevant research shows that the traditional switching power supply only utilizes 65% to 70% of energy in the design and application, however, with the promotion and application of frequency conversion technology, the utilization of power resources reaches as high as 85 %. The changes of these data show that: frequency switching technology is characterized by high efficiency, good performance and small size in the running, and is able to reduce energy consumption in the process of promotion and application.

3.2 Soft Switching Technology

Actually, in the application of switch, energy consumption will occur during the process of opening and closing, which will result in low energy conservation efficiency of power systems. In order to avoid this problem, the technical persons strengthen development, promotion and application of soft switching technology. It is said that soft-switching technology is capable of reducing switch energy consumption and noise in the process of running, and of upgrading frequency of switches.

The so-called soft-switching technology is a relative speaking to hard switching technology. Generally speaking, the hard switching technology refers to one that, in the switching process of switch operation, will avoid no-voltage and zero current switch which will lead to overlap various indexes. In general, the soft-switching technology will cause noise caused by rapid changes in voltage and current in the implementation process. However this technology means that inductance, capacitance and other resonant components should be added in hard switching technology circuits in order to avoid voltage and current overlap situations.

Generally speaking, the promotion of such technology is able to ensure components to switch under no-voltage and zero current state and to greatly reduce energy consumption, upgrading utilization of power efficiency and realizing energy conservation.

3.3 High Frequency Technology

High-frequency technology develops on the basis of frequency conversion technology. It aims at

improving frequency on the basis of frequency conversion, and making full use of energy and materials. In fact, the technical persons find that there is an inverse relation between volume and weight of transformers, inductors and capacitors of product with the square root of power supply frequency when analyzing relevant experiments

Guided by such study, the technical persons raise frequency of electrical equipment from 80Hz to 20kHz, and the volume and weight of power equipment will be lightened to a large extent, besides, the decline ranges are between 5% and 10%. Actually, according to this principle, the technical members are able to transform power supply in electrical processing industry, which shall save electricity with the minimum rate of 30%. A conclusion can be drawn from such result that the promotion application of high-frequency technology is capable of improving the maximum energy utilization and its operating result is better than that of frequency conversion technology.

3.4 Active Power Factor Correction Technology

The so-called power factor refers to the cosine produced by voltage at two ends of two-port network and the current. In general, the power factors are significant for researching utilization rate of power equipments.

There is a certain rated voltage and current generally in the operation of power equipments, and once they exceed a rated value in operation, safety loopholes tend to occur in working state of equipments. Taking this into consideration, operators need to improve power factors in order to realize a perfect energy conservation property of power equipments, to strengthen output of active power, to reduce the reactive power and to fully make use of electricity.

3.5 Other Energy Utilization Technologies

Actually, with the continuous development and wide application of science and technology, many ways for energy conservation are adopted in China's power electronical technology in the promotion and application. At present, there are other energy utilization technologies like new magnetic components, new transformers and smart power. In fact, these technologies are able to greatly utilize energies and further improve energy conservation in the extensive promotion process.

4. Energy Conservation Results of Power Electronical Technology

In order to further verify outstanding contribution of power electronical technology in energy conservation aspect, the author summarizes achievements of various power electronical technologies in the process of promotion and application. The specific content about energy conservation results of power electronical technologies is as follows.

Currently, with the promotion and application of power electronical technology as well as the implementation of transformation of traditional electric power equipments, the electricity-saving rate of relevant equipments has reached about 20%. If the data are introduced into the field of national electricity, about 50 billion kwh of electricity will be saved annually.

In this process, the power technical persons strengthen the promotion and application of AC highly efficient speed regulation device based on power integrated devices such as the giant transistor, and such equipment is able to regulate speed of fan and pump equipment as well as save energy during promotion, besides, it has to ensure that its operating power consumption must save energy as 30% as that in traditional ways. Currently, over 20 million units of fans and pump equipments are adopted in first-tier and about 15 billion kwh of electricity will be saved after such energy-saving device is adopted.

Besides, the technical persons also develop and promote the carrier wave device with DC high-efficiency regulation way through grid thyristor. It is said that the equipment tends to replace resistors in the process of application and the energy efficiency shall up to 20% when it is used in fields like urban trams, industrial and mining electric locomotives. Here is an example about Shenyang, about 500 trolleybuses are modified to cater to the call of developing green transport, besides, the carrier wave device with DC high-efficiency speed regulation way. In such a circumstance, 4 million kwh of electricity will be saved by vehicles above and at least 103 billion kwh of electricity will be saved if such

technology is introduced nationally.

Besides, the application of electrostatic induction thyristors and field effect transistors tends to replace power frequency inductance ballast and about 20% electricity will be saved in its operation. Moreover, the promotion and application of rare earth three-band fluorescent lamp and inductive ballast will save over a half electricity in power system. Currently, 8% electricity in China power generation is used for lighting. In this context, if technical persons transform 2/3 lighting systems with such technology, about 13 billion kwh electricity will be saved in the running of power system.

Besides, the technical persons strengthen the application of asymmetric thyristor in the promotion of power electronical technology, realizing high frequency processing to intermediate frequency power. The measure not only improves efficiency of electric-thermal conversion to a large extent, but also guarantees the application of such technology. Currently, there are 12,000 standard high-frequency electric furnaces (with 100 kilowatts as the standard) operated by China's production system, but these devices still adopt tube-shaped high-frequency oscillator for operation, so the operating efficiency is only 50% or so. However, if the electric power technical persons transform equipments by adopting electrostatic induction transistor, the operating efficiency will be maintained as high as 80% of equipments and about 1 billion kwh electricity will be saved at the macro level.

5. Prospect of Application of power Electronical Technology

It shows from previous analysis that: with the promotion of power electronical technology, China's power system equipment is capable of improving energy efficiency benefits in operation. Actually, with the implementation of China's scientific outlook on development, the power electronical technology will experience a permanent development and usher in a promising prospect in the future. Besides, with the continuous development of science and technology in China, the improvement of power electronics theories as well as development and application of new power materials, the technical persons in China are capable of developing and applying high-performance circuit topologies so as to save more energy resources, and obtain economic and social benefits widely, realizing the sustainable development of national economy.

6. Conclusions

Aiming at achieving steady improvement in energy conservation efficiency in China, our technical persons strengthen development and application of power electronical technology, obtaining benefits in various aspects. This paper, based on such situation, analyzes the connotation of power electronical technology (definition of power electronical technology and application reasons of it in energy conservation field), and discusses key technologies of power electronical energy conservation (switching frequency conversion technology, soft switching technology, high frequency technology, active power factor correction technology and other energy utilization technologies); finally, the energy conservation effects and application prospect of power electronical technology are mentioned. The author believes that with the implementation of relevant measures in place and development of technology, permanent and steady progress will be made in our energy conservation cause, which shall bring economic profits and social benefits, and is conducive to the implementation of sustainable development.

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