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The Application of MSVC Reactive Power Compensation Device to the High Voltage Power Supply of Coal Mine

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Abstract

Through the introduction and technical comparative analysis of the SVC reactive power compensation device of the magnetic controlled reactor (MCR) type (it is abbreviated as MSVC), this article measures the working condition of the electrical power distribution system for the Zhaizhen colliery, and confirm the application project of MSVC in the high voltage power supply of Zhaizhen colliery. This device has many obvious advantages such as small output harmonic, low power consumption, maintenance free, simple structure, high reliability, cheap price and small floor area, and it is an ideal dynamic reactive power compensation and voltage regulation device.

Keywords: SVC of MCR type, Coal mine, High voltage power supply, Application

The Zhaizhen colliery of Xinwen Mining Group is the modern mine with year output of 2.1 million ton coals, and its dropping station was established in September of 1989, which is the power supply hinge of whole mine. In the coal industry, most loads on the dropping station are inductive loads, and if proper compensation method is not adopted, the system power factor must be too low, and the low side voltage will correspondingly reduce, which will reduce the rotate speed of the motor, increase the current and heat consumption, and if the compensation is not proper, the over compensation and deficient compensation will occur. When over compensation happens, the capacitive reactive power will be transferred reversely to the system, which can not reduce the consumption, but will increase the reactive power consumption of the system. The high voltage load of the mine mainly includes ventilator and lift, and the ventilator is the equipment which can continually run, so the change is partly embodied in the lift which has quick change cycle and large harmonic content. The traditional switching technology can not simultaneously effectively solve the reactive power compensation and harmonic governance, so we can adopt MSVC to fulfill the requirement of quick load change, and this device can smoothly adjust the reactive power, possess high reliability and small harmonic, make the power factor keep in the high level, better improve the power supply quality and enhance the economic benefit of the whole power supply system of the mine.

1. Introduction of MSVC

At present, the main devices of reactive power compensation include capacitor, reactor and few dynamic reactive power compensation devices. The regulation mode of the switching capacitor group is discrete, which can not get ideal compensation effect. The flow and over voltage induced by the switching capacitor are very harmful to the system the equipment itself. The present static compensation devices such as the SVC of the phase controlled reactor (TCR) type not only have expensive price, but have large floor area and complex structure, and can not be extended. The MSVC has many obvious advantages such as small output harmonic, low power consumption, maintenance free, simple structure, high reliability, cheap price and small floor area, and it is an ideal dynamic reactive power compensation and voltage regulation device. The MSVC device is composed by compensation (wave filtering) branch and the shunt-wound branch of MCR, and the compensation branch is fixedly connected with the bus bar through the insulation switch, and realizes the soft compensation of the reactive power through regulating the output capacitance (inductive reactive power) of the MCR.

2. Typical technical comparison of the compensation

The compensation results are shown in Table 1.

3. Characters of MSVC

(1) The controlled silicon of the control part of MCR generally works on the level of few percent of the system rating voltage, and because it is to control the saturation of the magnetic valve, so it needs not large control power, and the thyristor works on the working condition of low voltage and small current, which can fully enhance the stable operation parameter of the system.

(2) The MCR device likes a transformer, which can adopt different cooling methods. Under the voltages less than 35kv, two natural cooling modes including wind cooling and oil cooling both can be adopted, so there is no assistant cooling equipment, and it can be used combining the change power distribution system without watchers.

(3) Because the controlled part works under the mode of direct current, the harmonic voltage can not happen. The harmonic which is almost equal to half harmonics induced by the TCR type is induced by the magnetized nonlinear process.

(4) The shortcoming of MCR is that its reactive speed is lower that the TCR type's, which is above 0.3 seconds, and reverse proportional with the saturation speed. At present, the product with quicker active speed is developing.

(5) MCR has many advantages such as maintenance free, small floor area and convenient fixing.

4. Working condition measurement of Zhaizhen colliery power supply

To better know the power supply reactive power change and harmonic of the mine, we measure the power distribution system of Zhaizhen colliery, and confirm the application project of MSVC in the high voltage power supply system of Zhaizehn colliery based on that.

4.1 Reactive power

The change of bus bar reactive power has not obvious time rule, and its fluctuation range is very large. The maximum value can achieve 8200kvar and the minimum value is 2200kvar. This value is even smaller in the start moment of the lift, and the change cycle is very short. The reactive change curve of the bus bar is seen in Figure 1. The change is mainly induced by the lift, and when the lift starts, the power factor goes to zero, and this value is only 0.5 when the lift normally runs (seen in Figure 2). The reactive power change of the lift presents periodic changes (seen in Figure 3).

4.2 Harmonic level

The main harmonic source of the system is the 12 pulsation direct current motor (lift), and the main harmonic components are divided into 11 times (2.31%), 13 times (2.26%), 23 times (0.95%) and 25 times (0.98%), which make the current wave seriously irregular.

The harmonic situation on the bus bar is that because the variator adopts star connection, so the system has quantitive single phase load, which induces the unbalance of three phases and produces three times harmonic (seen in Figure 5).

Therefore, the main harmonics of the bus bar include 3 times, 11 times and 13 times. So when designing the wave filtering equipment, we consider adopting four wave filter branches, i.e. 3 times branch, 5 times branch, 7 times branch, 11 times branch and high pass branch.

5. Wave filtering project of reactive power compensation

Based on above analysis, the reactive power compensation capacitance is changed to 5400kvar, the fixing capacitance is 7200kvar, four wave filter branches are set up, where, the 3 times branch, 11 times branches and high pass capacitance are 2400kvar, and adopt fixed switching mode, and the 5 times branch and the 7 times branches adopt vacuum contactor to realize automatic switching. So the continual compensation of 2000kvar- 5400kvar can be realized. In addition, comprehensively considering the wave filtering effect and the cost of equipment, we advise putting the lifts on the same bus bar, which can fix a set of MSVC on the bus bar with lifts, and fix a set of automatic compensation on the other bus bar to fulfill the requirements.

5.1 Main arrangement

The capacitor group adopts the tank installation, and it is mainly composed by capacitor, reactor, spurt fuse, vacuum contactor, insulation switch, high voltage fuse, discharge loop, DWK/BR automatic controller and so on.

The MCR branch mainly includes MCR, automatic controller and thyristor valve tank.

5.2 Merits of the project

(1) Comparing with pure automatic switching, this project adopts the method of MCR technology combining with the automatic compensation, which completely can achieve continual smooth compensation of reactive power, and avoid over compensation and deficient compensation.

(2) The project can fully reduce the switching times of vacuum contactor, avoid the impact to the system and prolong the use life of the compensation equipment at the same time.

(3) The project can fully reduce the investment of the equipment when ensuring the compensation effect.

6. Conclusions

Since the MSVC reactive power device is fixed and operated in January of 2007, it presents reliable technology and obvious energy saving effect. It effectively enhances the power factor of the high voltage side of the dropping station to above 0.9, which can not only enhance the using rate of the power supply equipment, but can fully reduce the power loss of the power supply network. Therefore, the device has wide application foreground in the high voltage power supply system of the colliery.

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Table 1. Typical technical comparison of the compensation

Comparative item	SVC of MCR type	SVC of TCR type	Switching	TSC
Investment	Middle size	Large size	Middle size	Large size
Running mode	Stepless regulation (continual)	Stepless regulation (continual)	Step switching (discrete)	Step switching (discrete)
Reliability	Maintenance free, use life of 25 years	Large maintenances	Very large maintenances	Large maintenances
Harmonic level	Less 50% than TCR type	5 times: 6.5% and 7times: 3.7%	null	small
Switching flow	null	null	Above 7 times	null
Power consumption	Less 50% than TCR type	Average 0.5%-0.8%	Very small	small
Floor area	1/10 of TCR type	Very big, difficult arrangement	big	big
Regulation time	0.3s	40ms	0.8s	40ms
Over loading ability	150%	null	null	null
Electromagnetic pollution	null	Eradiating large of power frequency magnetic field, harmful to human	null	null

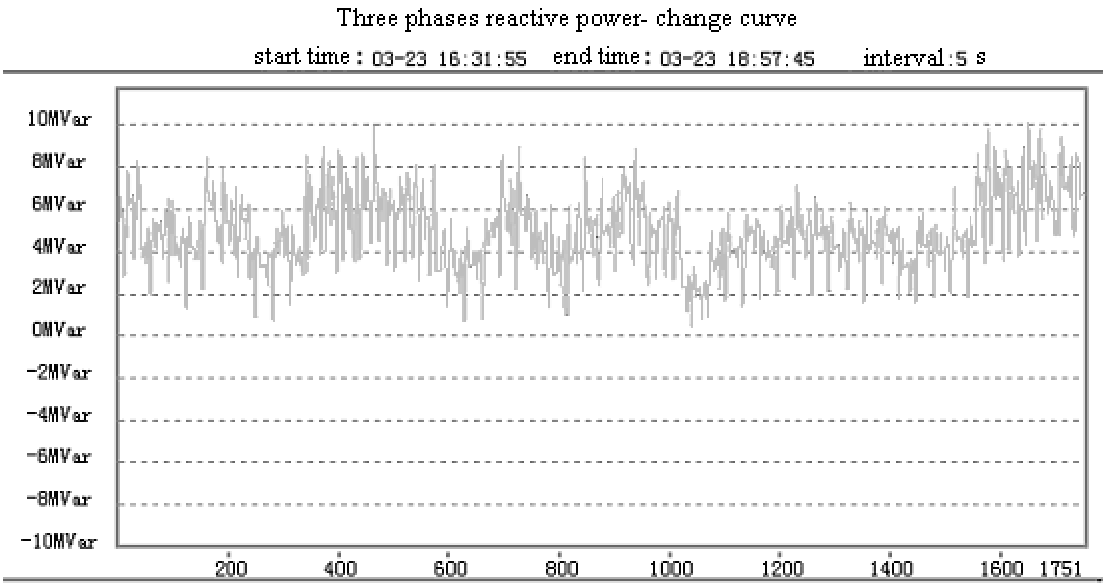

Figure 1. The Reactive Power Change of Bus Bar

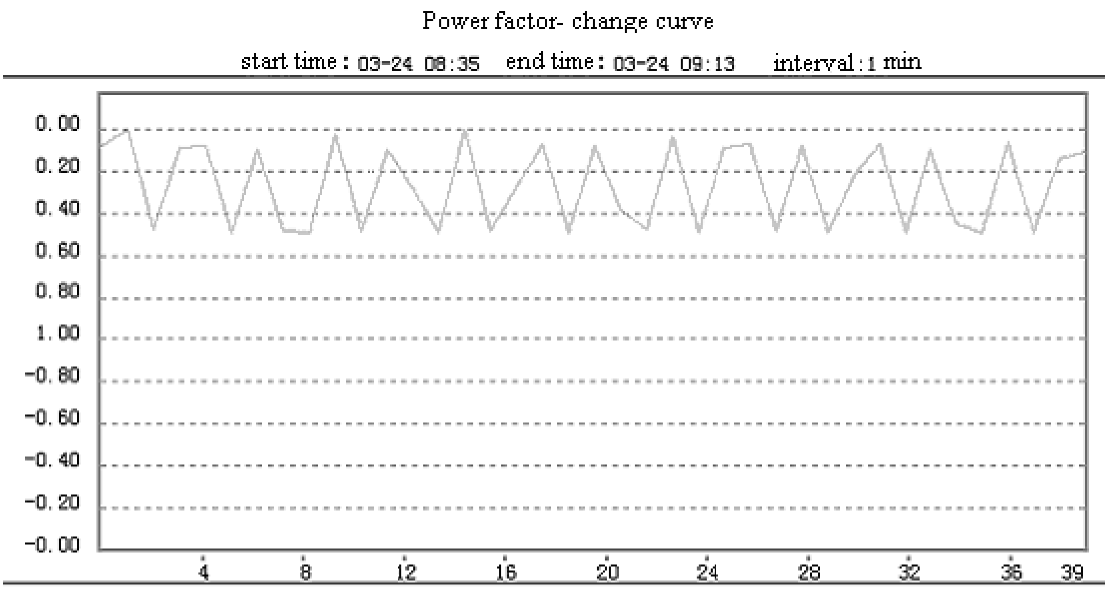

Figure 2. The Power Factor Change Curve of Lift

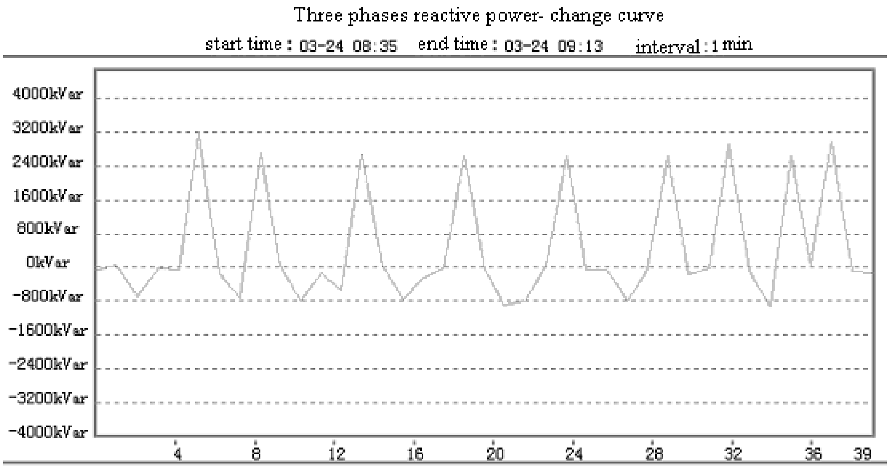

Figure 3. The Reactive Power Change Curve of Lift

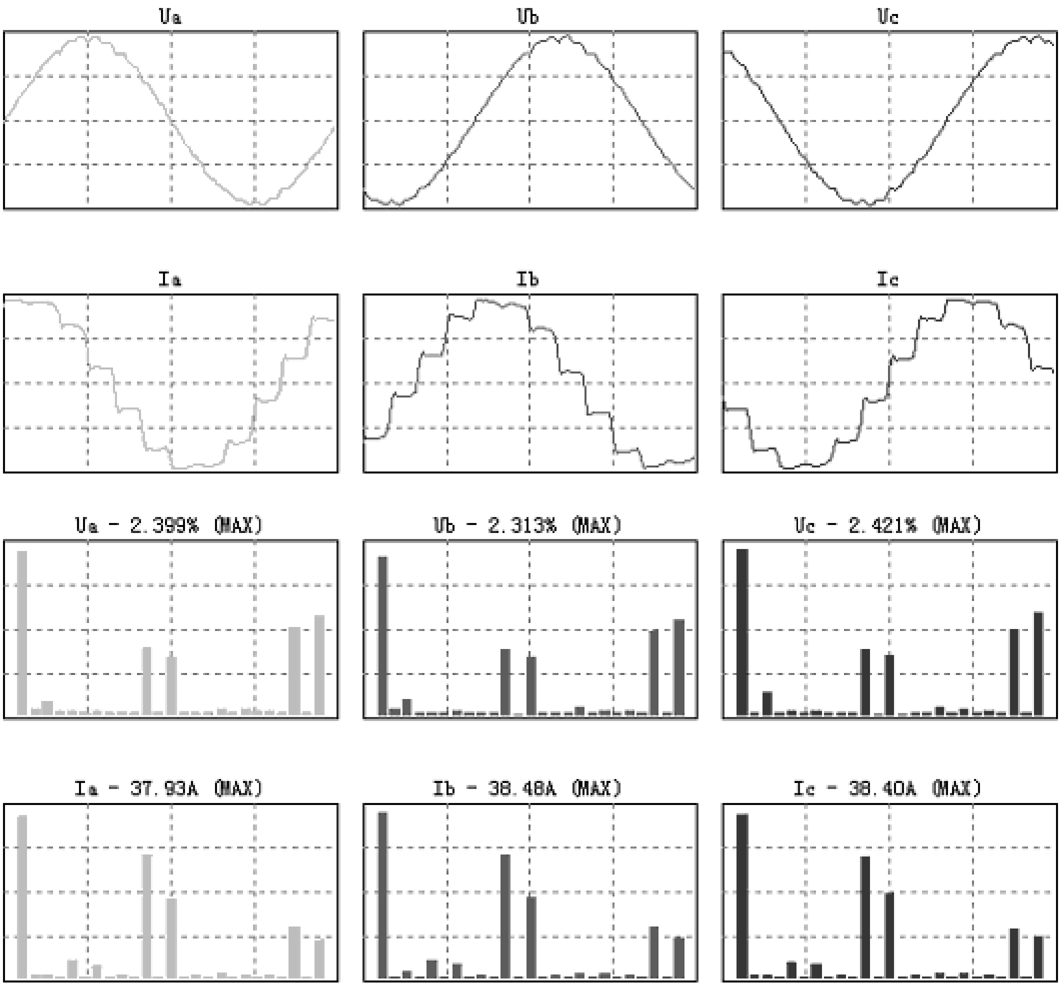

Figure 4. Lift Wave Figure and Frequency Spectrum