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The Automatic Control System of Air Compressor for Saving Energy

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Abstract—Air compressors are key equipments with high energy consumption in the railway maintenance departments. But they work mostly in manual mode and cost much more electrical energy. Also the service life of air compressors is shortening. On the basis of the analysis about the practical working process of air compressor system, remolding control system is put forward concerned with frequency conversion driving 2 electrical motors of air compressors. The air pressure and the change of air pressure are the close-loop control referenced objects. By applying frequency converters, the electrical motors of air compressors can start and stop softly. This control system can greatly improve the security and automation of air compressors and decrease energy consumption.

Keywords-air compressor; frequency converter; close-loop control

1. Introduction

The air compressor is the key equipment of the railway maintenance departments. It mainly provides a breeze source for experimenting of locomotive, rolling stock brake. Also it provides a motive source for pneumatic equipments. The air compressor that used mostly in the railway maintenance departments currently is the piston type air compressor. Figure 1 shows the working sketch of the air compressor system.

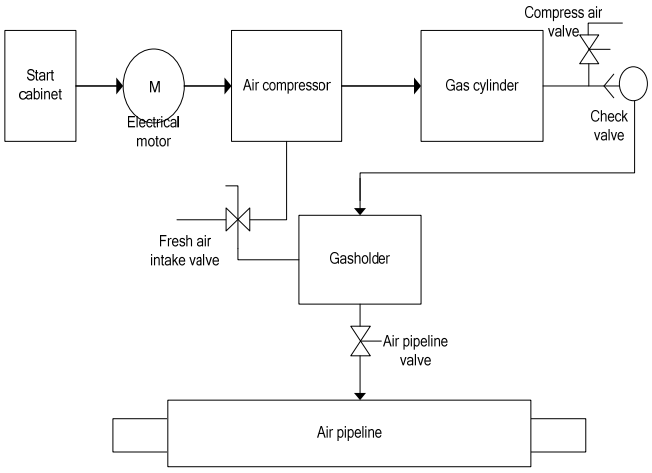

Fig.1. Working sketch of air compressor system.

The fresh air outside is drew into the compressor by opening the intake valve. And the air is compressed up to 0.65-0.75Mpa by the cylinder. Then the compressed air is cooled down by water and is pushed into the gasholder by the check valve. When the air pipeline needs compressed air the compressed air intake valve is opened. The traditional air compressor works in manual mode. First the compressed air intake valve is closed

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and the electrical motor of air compressor starts to work. Then the fresh air intake valve is opened and the electrical motor runs with heavy load. When the air pressure of the gasholder reaches upper limit the unloading valve acts and the fresh air intake valve is closed. The electrical motor runs with light load. When the air pressure of the gasholder reaches the lower limit the unloading valve acts and the fresh air intake valve is opened. The electrical motor runs with heavy load again. And so on, over and over again in an endless spiral, the air pressure of gasholder can be kept within the prescribed limits.

For require breeze of the railway maintenance departments at any time the air compressor normally is in work state all the time. About 30%-50% of time the electrical motor of air compressor runs without load or with light load. 30% electrical energy is wasted,

2. Improvement of the air compressor system

When the electrical motor runs without load or with light load the air compressor don't produce compressed air. But the electrical energy is wasted. Therefore the motor should stop when no load or light load. As air compressor is concerned, frequent starts-stops is not allowed for the air compressor is supplied by WYE-DELTA services.

The electrical motor power rating of railway air compressor is 65kW-130kW. So two 65kW motors is chosen in the improvement system. Also two corresponding air compressors and two cylinders are used. The total power rating is equal as before. One frequency converter and a microcontroller module are added in the new system. The frequency converter can control and drive the electrical motor starting and stopping softly. Figure 2 shows the new working sketch of the improved air compressor system.

The electrical motors of air compressor are AC asynchronous motors. Two motors droved by the frequency converter in a sequential manner can start with low frequency, small current and enough pull-in torque. The frequency converter power rating is 65kW for matching the motor. The air compressor system controlled by the microcontroller module has two work states.

a) One motor works. One motor droved by the frequency converter works and the other motor stops.

b) Two motor work. One motor is droved by the frequency converter when starting. After that the started motor supllied by the AC power. And then the other motor is drovd by the frequency converter starting and working.

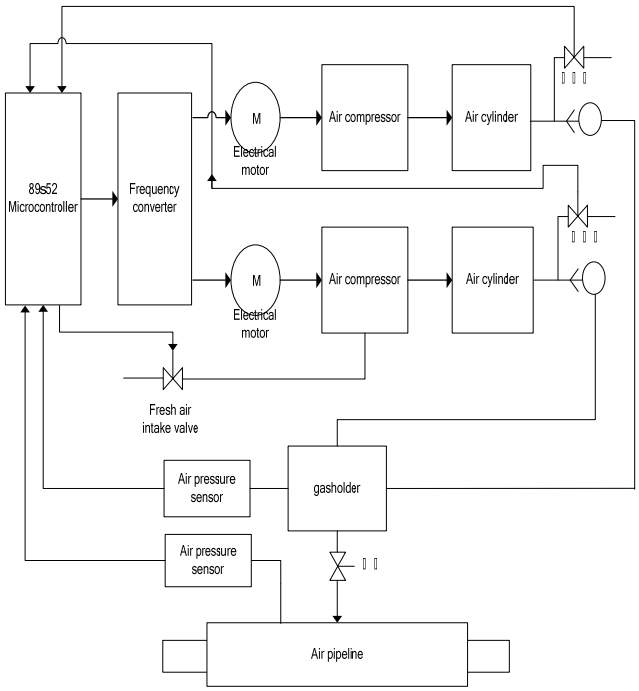

Fig.2. The improving working sketch of air compressor system.

3. Control Strategy of Air Compressor system

Figure 3 is the air compressor system control diagram. The microcontroller module 89s52 is the control core. Two electrical motor are droved by one frequency converter. The control reference objects are air pressure and changing rate of air pressure. The air pressure of gasholder and air pipeline determines which state the air compressor should choose.

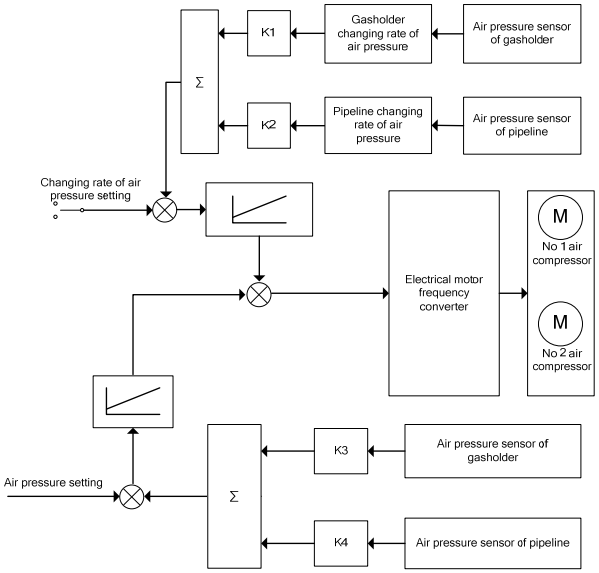

Fig.3. Control diagram of air compressor system.

3.1. Air pressure close-loop control

Two electrical motors stop by the frequency converter when the air pressure of gasholder or air pipeline is higher than the upper limit or the pressure setting. One electrical motor stop by the frequency converter and the other is supplied by the frequency converter when the air pressure of gasholder or air pipeline is higher than the pressure setting. When the air pressure of gasholder or air pipeline is lower than the low limit or the pressure setting, two motors start one by one droved by the frequency converter. Then one started motor supplied by the AC power, the other motor is supplied by the frequency converter.

3.2. Changing rate of air pressure close-loop control

The air pressure of gasholder and air pipeline is sampled every second. The difference between two data sampled is the changing rate. It reflects that how much air breeze is need. If the changing rate is positive and higher than the setting, two motors run, one supplied by AC power, the other supplied by frequency converter. If the absolute changing rate is low than the setting, only one motor is supplied by frequency converter. If the changing rate is negative and high than the setting, two motors stop to work.

4. Advantage of the control system

That improvement system has already used in the railway air compressor system. It runs in a good condition. The energy–saving result is apparent.

4.1. Saving eletrical energy

The electrical motors can stop to work when no load or light load. About 25%-40% electrical energy is saved.

4.2. Decreasing niose

The motors droved by the frequency converter can run with low speed or stop to run when no load. About 25%-40% running time of air compressors is reduced. The work noise of the equipments is reduced.

4.3. Reducing maintenance of equipments

The motors running time is reduced. The mechanical tear of equipments is reduced. The service life of the equipments is prolonged.

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