

## Application of ALPHA6000 Inverter in the Cement Industry

### I. Introduction

The emergence of the frequency-conversion governor has brought a revolution to the regulation method for AC (alternating current) asynchronous motor. With the continuous improvement and development of the inverter technology in past over one decade, it has been widely used in speed regulation in different fields by the engineering technicians in different disciplines and industries, which has generated significant economic benefits for the enterprises and promoted the automation process of industrial production.

Cement manufacturing is a major energy consumption industry in the building materials industry, and it is an important measure to reduce energy consumption and improve product quality in order to increase the competitiveness of the enterprise. Energy conservation and consumption reduction has become a major concern for various enterprise managers.

In accordance with the kiln air supply system, the kiln unloading system and the cement powder selecting system of small cement plant, the engineering technicians of our company has conducted long-term special research and developed the frequency-conversion speed regulation and control unit, which has been used in dozens of cement production lines. It has won wide acclaim with its various advantages such as reasonable design, compact structure, convenient installation and debugging, complete protection functions, smart and reliable operation, energy conservation effect and production process.

### II. Frequency-Conversion Transformation Plan for Shaft Kiln Roots Blower

#### 1. Analysis of the Operating Mode

Take the Enping Juntang Cement Plant for example, this plant has two Roots blowers, one of them has the power of 215KW, rated voltage of 380V and rated current of 415A, and the other has the power of 185KW, rated voltage of 380V and rated current of 367A.

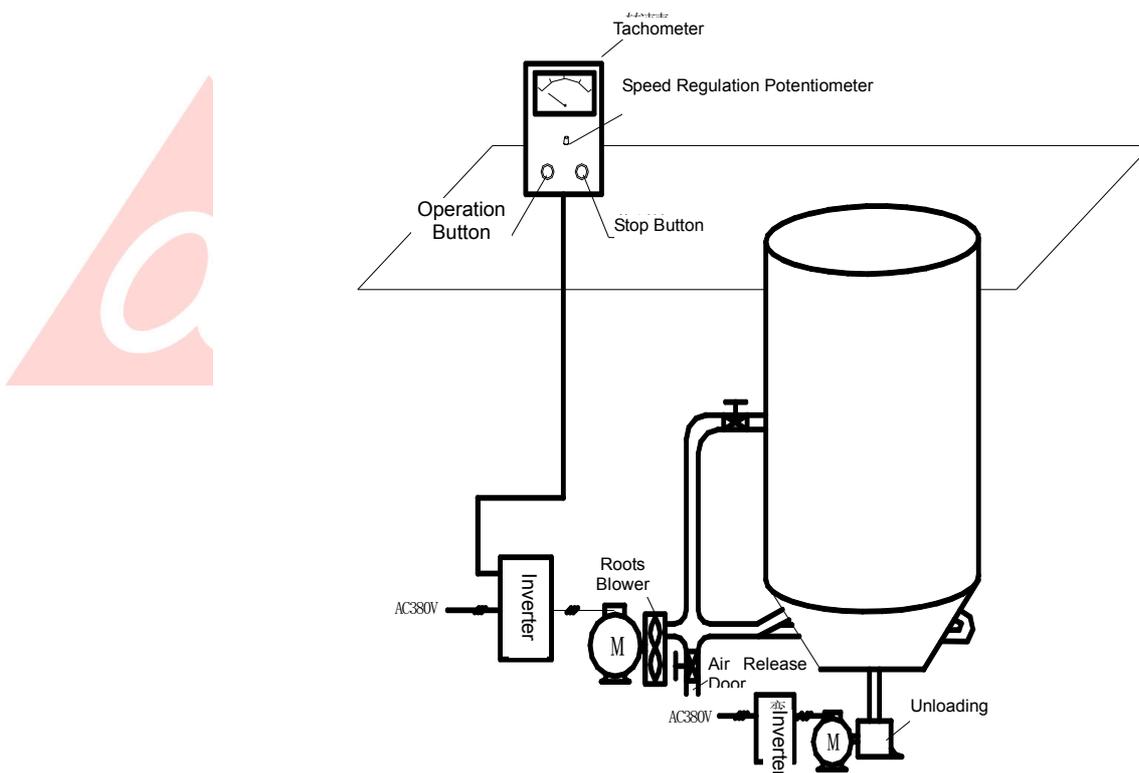
During design of the shaft kiln Roots blower, consideration should be given to the required air volume during maximum production, and certain surplus capacity should also be left, which should be around 20%, in this way increasing the service life of the blower and the motor. In addition, during different stages of the production process, the shaft kiln has different requirements of air supply. Therefore, during production, situations in which the air volume is too big or the air pressure is too high are very common.

At present, the operator generally regulates the air volume in accordance with different stages of the production process. The measure to regulate the air volume is to open a ventilation door on the air outlet duct of the fan to release air, and the volume of air supply can be regulated by regulating the opening of the air release ventilation door. In this way, extra air volume will be released, which does not only cause waste of energy, but also generates big noise during the air releasing process.

#### 2. Solution

In accordance with the operating mode mentioned above, our company recommends the following transformation plan:

- a. The original drive system is transformed into a frequency-conversion speed regulation system. The two frequency-conversion speed regulation systems have chosen the ALPHA6000 3220G inverter and ALPHA6000 3200G inverter respectively, and the two systems have the same principle. After frequency-conversion transformation, in addition to preserving the original reduced-voltage start and control system, the air supply system has also added a frequency-conversion speed regulation system in parallel with the original control system, in this way forming the two-circuit control system. Its characteristics are that the two control circuits can compensate each other to provide high reliability, and the machine does not need to be stopped during overhauling of the equipment, which can ensure continuous operation. The air releasing door is closed, and the system air supply volume is regulated through change of the rotation speed of the motor to realize the purpose of energy conservation. The system diagram is as the following:



Frequency-Conversion Speed-Regulation Diagram of the Shaft Kiln Air Supply and Unloading System

- b. For the convenience of the kiln surface operator to control the air volume, the inverter is set with terminal control. The control signal is led to the kiln surface, an operation panel is installed on the kiln surface through which start/stop of the blower can be controlled and the air supply volume can be regulated, and the operator can regulate the air volume in accordance with the calcinations situation. The operation panel is also installed with a

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tachometer to indicate the rotation speed of the fan and motor.

3. Benefits to the users after the transformation

a. Improved production process

After the transformation, the air supply volume can be smoothly regulated in accordance with different stages to ensure the product quality.

b. Improved production environment

Because the rotation speed of the fan and motor can be regulated freely through the inverter, the air volume can be accurately regulated in accordance with the requirement without the need of air release through bypass, which can significantly reduce the noise caused by air release and dust pollution of cement.

c. Reduced maintenance work amount of the equipment

Because the inverter has the soft start function, during the start of the motor, there is no big current impact, which can increase the service life of the equipment and reduce the maintenance work amount.

d. Energy conservation and reduced consumption

After the transformation, it has significant effect of energy conservation. In accordance with the situation of the previous equipment and production process, its energy conservation rate can reach 15%-40%, and it generally takes about 6~12 months to recover all investment. The investment recovery cycle is short, and the comprehensive benefits are impressive.

4. Parameter setting of the inverter in the Roots blower

Function Code	Function Name	Date of Setting and Indication	Factory Default Value	Set Value
P0.04	Control Mode	0: keyboard, 1: terminal, 2: terminal	0	1
P0.01	Frequency Setting	1: keyboard, 2: terminal AI1, 3: terminal AI2	0	2
P0.21	Acceleration Time	0.1-3600 seconds	10.0	50
P0.22	Deceleration Time	0.1-3600 seconds	10.0	60
P2.06	Regulation of Carrier Frequency	0.5-12HZ	3.0	Carrier frequency of the 2-3 high-power inverters should be smaller than 3KHZ.

### III. Frequency-Conversion Transformation of the Shaft Kiln Unloading System

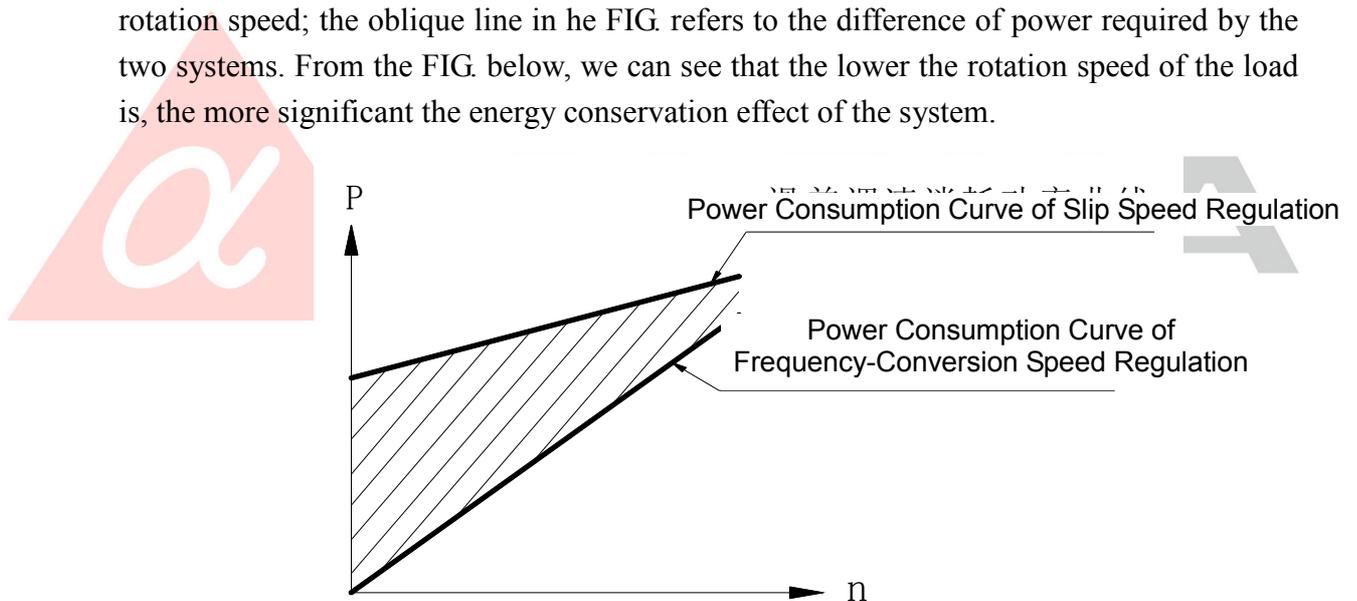
#### 1. Analysis of the operating mode

In order to realize the “three balances” (i.e., the three balances of feeding, air supply and unloading) during the sintering process of cement, the shaft kiln manufacturer generally uses slip motor as the driving force for the plate-type unloading device. Under the same condition of operation, compared with the common Y-series motor, this motor consumes 20% more energy, and it also has soft regulation characteristic and bad load capacity. In its application in the cement industry with severe dust problem, its slip head has frequent failure, which is difficult for maintenance. It also consumes 20% more energy with soft regulation characteristic, which is very inappropriate.

At present, this plant has two unloading machines and a slip motor with a power of 22KW, a rotation speed of 1460 turns/r and a rated current of 45 A, and it has an actual rotation speed of 400 turns/r in operation. The slip motor regulates speeds through the typical method of slip ratio: with decrease of the rotation speed, the slip ratio increases, and it also causes the increase of slip power of the inner rotor, all of which is transferred into heat and gets wasted. The system efficiency has significant decrease.

## 2. Transformation plan

Drill on the slip head of the 22KW slip speed-regulation motor to install screw, so that rigid connection can be conducted between the motor shaft and load shaft. If the service life of slip motor almost ends, it can be changed into common cage motor. After the transformation, the motor is started and regulated through the inverter. The plate-type unloading device is typical constant-torque load, and after replacing the original slip speed regulation with frequency-conversion speed regulation, the system efficiency has been significantly increased. The following FIG. has shown the curves of the power required by the two AC speed regulation systems to drive the constant-torque load changing with the rotation speed; the oblique line in the FIG. refers to the difference of power required by the two systems. From the FIG. below, we can see that the lower the rotation speed of the load is, the more significant the energy conservation effect of the system.



The oblique line refers to the saved energy after frequency-conversion transformation

## 3. Benefits to the users

- a. After the frequency-conversion transformation, the energy conservation rate can be more than 35% with significant benefits.
- b. It is more convenient to use the system. After the frequency-conversion transformation, its performance is far better than slip speed regulation, the speed regulation has rigid characteristic, and its load capacity is increased as well.

c. Maintenance work amount for the equipment has been significantly reduced, and more than 50% of maintenance cost can be saved, which can ensure continuous production.

4. Parameter setting of the inverter in the unloading machine:

Function Code	Function Name	Date of Setting and Indication	Factory Default Value	Note
P0.04	Control Mode	0: keyboard,1: terminal,2: terminal	0	0
P0.21	Acceleration Time	0.1-3600 seconds	10.0	15
P0.22	Deceleration Time	0.1-3600 seconds	10.0	15

#### IV. Energy Conservation Transformation of Powder Concentrator

1. Analysis of the operating mode

In accordance with different cement marks, there are different requirements for powder concentration. The old powder concentrator requires changing the powder concentration, and the process is very troublesome, which does not only need to stop production, but also to dismantle the powder concentrator to regulate the number and angle of each group of fan blades on the same shaft. There is no fixed standard for this process, it can only be conducted based on experience, and the following process has to be repeated every time: open the unit—regulate the fan blades—install the unit—test selection—check the powder concentration, until the powder concentration has satisfied the requirement.

2. Transformation plan

Use inverter to drive the motor of the powder concentrator, test out the required rotation speed of the motor for each mark in accordance with different cement marks, and preset these rotation speeds as the multi-stage speed of the inverter. Set one number selection panel beside the machine, and the panel should be installed with the start/stop button of the inverter and mark selection buttons of cement. The inverter is controlled by terminal, and the switching value required by the multi-stage speed is given through the buttons on the number selection panel.

3. Parameter setting of the inverter in the powder concentrator

Function Code	Function Name	Date of Setting and Indication	Factory Default Value	Set Value
P0.04	Control Mode	0: keyboard, 1: terminal, 2: : terminal	0	1
P2.11	Multi-stage speed setting 1	0. 5-400HZ	5. 0	15 (in accordance with mark requirement)
P2.12	Multi-stage speed setting 2	0. 5-400HZ	10. 0	25 (in accordance with mark requirement)
P2.13	Multi-stage speed setting 3	0. 5-400HZ	15. 0	32 (in accordance with mark requirement)
P2.14	Multi-stage speed setting 4	0. 5-400HZ	20. 0	40 (in accordance with mark requirement)
P2.15	Multi-stage speed setting 5	0. 5-400HZ	25. 0	45 (in accordance with mark requirement)

#### 4. Benefits to the users

##### a. Increased convenience in use

After the frequency-conversion transformation, you only have to press the preset buttons indicating different powder concentrations for different cement marks, and the powder concentrator will choose the particles with the powder concentration you have required.

##### b. Optimized production process

After the frequency-conversion transformation, the speed can be regulated smoothly. In this way, speed of the motor can be regulated conveniently in accordance with the cement mark and different powder concentration to increase the precision of powder concentration, provide continuous and automatic production, save valuable time and increase the efficiency.

##### c. Increased productivity

After the frequency-conversion transformation, the automation level and production continuity have been increased and labor intensity of the production personnel has been reduced, which has significant comprehensive benefits,