Rotary Kiln

Installation and Operation Instruction

SINORAN MINING & METALLURGY EQUIPMENT CO., LTD.

Contents

Ⅰ. Technical performance

See details in installation general drawing

This installation and operation instruction manual is applied to the rotary kiln of diameter 2.5～5.2m, with 3 supporting chassis and above. If the diameter of rotary kiln exceeds above specification, you can also refer to it.

Ⅱ. Working principles and structural features

1. Working principles

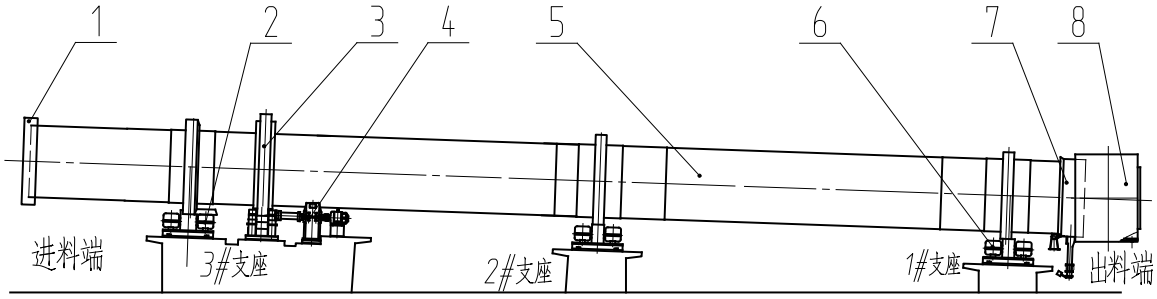
rotary kiln is used as main equipment to cement, lime, zinc, chrome production field.

Raw material is charged from high-end of kiln tail shell to the inner kiln shell for calcination. The inclination and slow rotation of kiln shell makes material rolling along circumferential direction and along axial direction from high end to low end. Through decomposition, calcination or volatilization, cooling and other technical process, the raw material is burnt to product or tail and then discharged from the low end of kiln shell and entered cooler.

The fuel is introduced from kiln head, burnt inside the kiln, used to heat the raw material, to make raw material calcine or volatilize. The hot air formed during the process of material heating exchange enters from kiln feeding end to kiln tail system, and then discharge the gas by chimney.

2. Structural features

The rotary kiln mainly consists of kiln shell, driving device, supporting device, catch wheel device, kiln head sealing device, kiln tail sealing device, kiln hood and so on. Please refer to structural diagram of rotary kiln.



1.窑尾密封装置 2.带挡轮支承装置 3.大齿圈装置 4.传动装置
5.窑筒体部分 6.支承装置 7.窑头密封装置 8.窑头罩

回转窑结构简图

（1）Kiln shell part

Kiln shell is the main body of rotary kiln, and it is rolled and welded by steel plate. Kiln tail is obliquely installed many pairs of supporting rollers. The lower end of the kiln shell is equipped with high temperature and abrasion resistant guard plate and form sleeve space, and there is also air fan to cool this part. Several riding rings have been set along the direction of kiln shell length, which bears the weight of kiln shell, kiln liner, material and other rotate parts, and transmit its weight to supporting device. There are bed plates under the riding ring which can be adjusted to be in accordance with clearance after operation, to reach the best clearance. The bed plates are used to enhance the rigidity of kiln shell, to avoid kiln shell suffering abrasion due to relative sliding between riding rings and kiln shell along circumferential direction.

（2）Girth gear device

Girth gear is fixed near the end part of kiln shell to transmit torque. The girth gear is connected with kiln shell by spring plate, because this connecting structure can

make enough heat dissipation space between gear ring and kiln shell, and can also reduce kiln shell bending deflection, besides it can damp and buffer, which is good to prolong the life of kiln liner.

（3）Driving device

3.1 Driving mode：

a) Single drive：The driving system adopts single drive, and it is driven by a set of main driving motor.

b) Double drive：The driving system adopts double drive, and they are driven two sets of main driving motor. Two sets of transmission of the synchronization are achieved by adjusting the electrical equipment, so two systems can bear even stress.

3.2 Motor

Except the small-scale rotary kiln can select Z2 series small-scale DC motor, the other specifications select ZSN4 DC motor - specialized for rotary kiln. ZSN4 DC motor is designed as per rotary kiln main drive working condition, with small size, light weight, high efficiency, and good performance.

3.3 Reduction gear box

It often selects hardened tooth-surface reducer for the reducer, because it has advanced technology, small size and light weight.

3.4 Assembled spring coupler

Assembled spring coupler is used between pinion device and main gear box, because it has good flexibility, can absorb impact and also compensate for the larger radial and axial expansion.

（4）Supporting device

Supporting device is an important part of rotary kiln. It carries the whole weight of the rotating part of kiln shell, and has the positioning function on shell to make shell and supporting roller rotate stably. Supporting device is self-aligning sliding bearings structure, with compacts structure and light weight. It also configured lubricating oil automatic heating and temperature control devices and measuring devices, which is reliable and adaptable.

（5）Catch wheel device(Thrust roller)

According to the stress condition and action principle of catch wheel, it is divided into mechanical catch wheel and hydraulic catch wheel.

a) Mechanical catch wheel: It is installed in pairs on the two sides of riding ring near girth gear, to restrict kiln shell movement in axial direction.

b) Hydraulic catch wheel：it is set on lower side of riding ring near girth gear. Thrust roller is to force riding ring and kiln shell reciprocate in certain speed and stroke along kiln centerline direction on the supporting roller, which can make the riding ring and supporting roller wear evenly on the whole width to prolong lifetime.

（6）Kiln head sealing device

Kiln head sealing device is the SM-type kiln head sealing device or the GP-type kiln head sealing device, which can meet the working condition and the user’s requirements.

a) SM-type kiln head sealing device SM graphite is block radial contact and labyrinth assembly sealing mode. It can compensate runout during kiln shell operation automatically, and it has good sealing performance.

b) GP-type kiln head sealing device is steel sheet radial contact sealing mode. It can compensate runout during kiln shell operation automatically, and it has good sealing performance.

（7）Kiln tail sealing device

a) QD-type kiln tail sealing device adopts cylinder compress end face contact, and the whole sealing rings can bear the even stress and eliminate harmful effect caused by installation and kiln shell flexibility. Besides, lubricating grease is fed into friction ring contact surface to lubricate by electrical dry oil pump, with little friction, little abrasion and good sealing.

（8）Kiln head cover

Kiln head cover is welded by steel plate. It is located on kiln head operation platform by the supporting legs on the two sides. Its lower part is connected with cooler. Inside the kiln head cover, there should be refractory brick or heat resistant

concrete. Two suspension movable kiln door are set at outer end face of kiln head cover, so as to easily get into kiln for repairing and building kiln liner.

Ⅲ. Installation instructions

1. Preparatory work before installation

Before installation, please get familiar with drawing and the relative technical documents from the suppliers and acquire information of structure of the equipment and technical requirements for erection. Decide procedures and ways of mounting according to detailed on-site condition. Prepare necessary mounting tool and equipments. Draw up working and erection program, carefully design and construct so as to accomplish the erection task quickly with high quality.

During equipment inspection and acceptance, the company in charge of installation works shall check completeness and quality of equipment. If it is found that the quality is not enough or has defects caused by transportation or storage, the installation company should inform the relevant company to try to make repair or replace work first. For those important dimensions might affect installation quality, check according to drawings and make records patiently, also in the meantime discuss with design party for modification.

Before being installed, components shall be cleaned and removed from rust. Drawings shall be checked carefully by the engineers so as to avoid damaging components. Check and make up serial numbers and marks for those joined parts in advance to prevent them from being mixed up and lost and affect assembly. Dismantling and cleaning shall be done under clean circumstances. After cleaning, fresh anti-rust oil shall be smashed onto those parts. Quality of used oil shall be conformed to stipulations on drawings. Then they shall be sealed properly so as to prevent them from being polluted and rusted.

In the course of hauling and transporting components, all hauling equipments, wire ropes, lifting hooks and other tools must have enough coefficient safety. Wire rope

is not allowed to have direct contact with working surfaces of parts and components. Hauling hook or eye screw on gear box and upper cover of bearing and lift hole on supporting roller shaft end shall be only used to lift themselves and not be permitted to be used to lift the whole assembly unit. Special attention shall be paid on these relevant cases. While horizontally transport parts and components must be kept to be balanced. It is not allowed to place them upside down or set upright. For sections of shell body, riding ring, supporting roller and other cylindrical parts and components, they shall be tightly fixed onto the crosstie support, then underneath support with rolling rod, and then haul with cable winch. It is forbidden to haul it directly on the ground or on rolling rod.

In order to align girth gear ring and shell body, it would be necessary to rotate the kiln. Wire rope shall be up to being leaded out through pulley which is suspended on the hoist or ridge lifting support. As friction to supporting roller bearing and bending moment born by shell body would be minimum when pulling force is up. It would be better to use temporarily installed kiln drive device to rotate the kiln, and it would be good help to keep the speed even and shorten the work time while auto-welding interfaces of shell body.

2．Check the foundation and mark the line

2.1 Amend the drawing first

Measure the length of shell section, plus with jointing clearance and consider that shrinkage of every couple joint welding will be about 2mm, then it will be the real size between every two tires of kiln shell. Added with heat expansion, it will be the slope distance between every two neighboring supporting units. Then calculate the horizontal distance. After that amend sizes on the drawing.

2.2 According to the amended drawing to check the foundation:

According to the amended drawing to check the size of kiln foundation, particularly the center distance of foundation. If it is not conformed to the drawing, the following measures should be adopted. There would be no need to take any steps: if the error between distance of two supporting units on the amended drawing and the

center distances between the relative two foundations is less than 5mm; if the error is 5～10mm, it could be adjusted by enlarging or shrinking the joint surface clearance between shell sections while assembling the kiln shell body; when the tolerance is more than 10mm, besides adjusting joint surface clearance of shell sections, positions of supporting units should be adjusted while fitting. According to the real size of shell body after adjustment, re-amend oblique spacing dimension of all supporting device and calculate the horizontal distance. Re-measure the dimensions of supporting roller and its bearings, correct the elevation size or the supporting roller surface.

2.3 Mark the line of foundation

Firstly, draw the axial centerline of kiln foundation on the foundation surface, and its tolerance should be no more than 0.5mm. And draw the level datum line on the side of foundation (it would be best if it is 1m above the ground level), and its tolerance should be no more than 0.5mm.

According to the measured and amended sizes, start from the foundation which has supporting unit to the two ends, in order to get the horizontal central distance of all foundations. Horizontal central distance tolerance of neighboring foundations should be not more than 1.5mm; but the central distance of the head and end foundations for supporting Ⅲ is 3mm, for supporting ⅣⅤⅥ are 6mm.

2.4 Set elevation marks

In order to make it easy for settlement and inclination of foundation later, elevation boards supplied with equipment shall be embedded with the height about 1m to the ground during casting the foundation. As illustrated in Fig.1 and Fig.2, four marks shall be embedded for one foundation. Their positions should be as close as they can to four angular and layout to corresponding positions. After casting, mark the level and vertical line of the same elevation on the board, then weld elevation iron onto it. Be sure to keep the up edge of elevation iron to be pressed on the level mark line.

As far as possible to file or turning head of elevation bolt so as to keep head up surfaces of elevation bolts every foundation to be totally on the same level. To minimum, 4 elevation bolt heads up surfaces of same foundation shall be kept to have same level. Then fill values of these elevation and height of bolt head into the table as illustrated in Fig.1 for keeping as file for reference. Last verification on elevation shall be done including brick and fill the table to give the owner. After that the owner could periodically or when it is necessary to check changing conditions of these elevations. With calculation of shell body to know settlement and inclination of every foundation so that it would be good for alignment and adjustment of kiln.

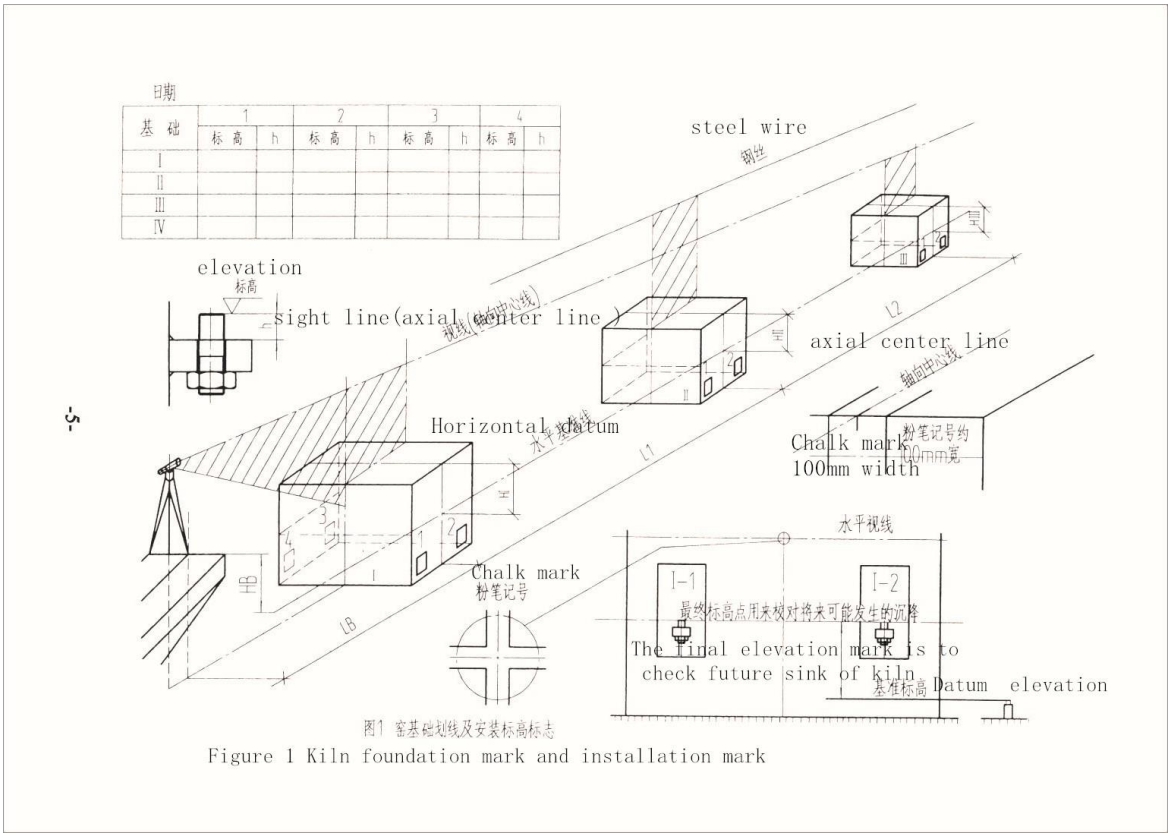
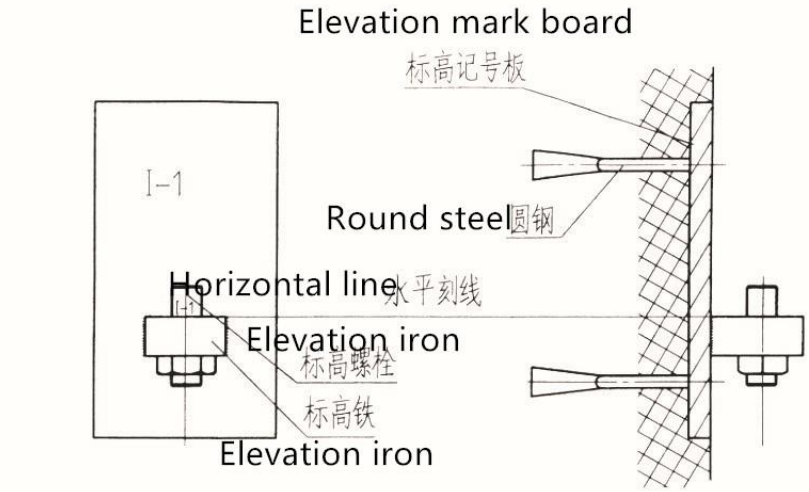


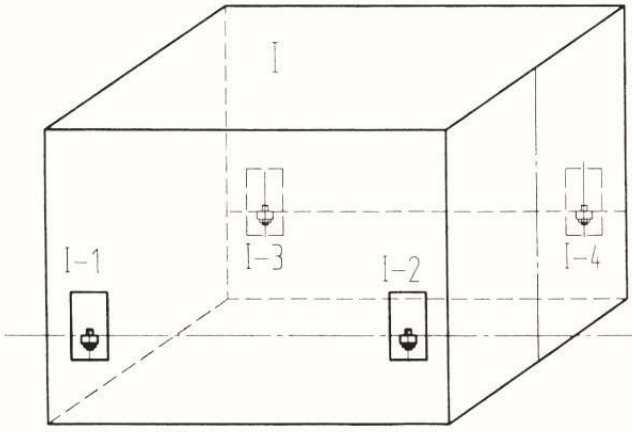
图1 窑基础划线及安装标高标志

Figure 1 Kiln foundation mark and installation mark



在为了调整取出标高螺栓以前每个基础上的标高记号板和标高螺栓上应做好配合记号

Cooperation marks should be made on elevation mark board and elevation bolt before adjusting elevation bolt



The final mark is used t
check future sink
最终标高用来核对将
来可能出现的沉降

出料

图2 窑基础标高标志的安装

Figure 2 Installation of Kiln foundation elevation mark

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3．Installation of supporting device

Erection of the supporting units decides whether the kiln shell body centerline is

kept in one straight line or not.

3.1 Assembly of supporting rollers

When assembling the sliding bearing of supporting roller, series of bearing seat, spherical bush and lining tile should be checked. Assemble it only after they are proved to be of the same number.

Contact angle between lining bush and journal of supporting roller should be between 60°-75°. By the way of painting with colors to check the contact points between lining bush and supporting roller journal, every square centimeters should be no less than 1-2 points; contact points between spherical bush and bearing base should not be less than 1-2 points per $2.5\times2.5cm^2$; contact points between spherical bush and lining bush should not be less than 1-2 points per $2.5\times2.5cm^2$. Use plug gauge to check the two ends of lining bush and journal, side clearance should be kept between (0.001-0.0015) d (d is shaft diameter). If it doesn't meet the above mentioned requirements, then it should be scrapped. Only when the above work is finished, could start up erection. Roller bearing assembly requirements of JB-ZQ4000.9-36 "General Technology Condition for Assembly" could be used as reference to assembly the supporting roller for roller bearings.

3.2 Mounting of supporting roller couple

3.2.1When mount the supporting roller, first to find out the right center position, center cross line of base should be aimed at that of foundation.

The two supporting rollers longitudinal centerline to the base longitudinal centerline should be equal and conformed to the sizes on the drawing, the permitted tolerance should not be more than 0.5mm. The horizontal centerline should be coincide with that bade and the permitted tolerance is 0.5mm and in the meantime the two sides movement of supporting roller should be kept equal.

3.2.2 Use slope gauge to check the slope of supporting roller surface, slopes of every supporting roller surface should be the same and the allowed error shouldn't be over 0.05mm/m. The top surface center points connecting line of the two rollers on one supporting unit should be in level and the permitted tolerance should not be more than 0.05m/m. If it is over the tolerance then put bearing plate under the

bearing base to adjust it.

3.2.3 Fix bearing couple of supporting roller onto the aligned supporting roller shaft of the seat. Thrust ring of high end (near to the feed end) shall contact with the end of lining tile. 2mm clearance (or according to clearance required on the drawing) shall be left as illustrated on Diagram 3. In the meantime, distances from two supporting roller rim side high ends to horizontal centerline shall be equal and allowed tolerance shall be 0.5mm as illustrated in Diagram 3.

3.3 Carefully re-check the following items after finishing mounting of every couple of each supporting rollers:

3.3.1 Measure the midpoint elevation at top surface of each supporting rollers, all elevation differences of each supporting units should be equal with central height difference on the upper surface of all bases. Allowed error of two neighboring couples of supporting rollers elevation should not be more than 0.5mm. The permitted tolerance of the head and end couples of supporting rollers level shouldn't be more than the following value: For short kiln of support Ⅲ is 1mm, support Ⅳis 1.5m, for support Ⅴ and above this is 2mm.

3.3.2 Check all the supporting rollers top surfaces to see whether they are even and to the level in a slope of sin which is stipulated in the drawing. If there is tolerance with the elevation or the slope, then it should be adjusted by slightly raising up or lowering the base until it meets the requirements of the drawing.

Secondary casting shall be done when all supporting units have been aligned. Before casting, sizing blocks under the base shall be spot welded onto the seat so as to prevent them from losing and coming off. Casting shall be continuous and completed in one time. Inside of the seat shall also be fully cast and tamped with vibrating pump. Those heads of reinforced steel exposed on the foundation shall be spot welded onto the seat so as to make secondary concrete to be well combined with the existing foundation and seat.

4 Shell body welding and mounting

4.1 Preparation：

4.1.1 Clear bur, fin, oil, rust and other contaminants off the joints of kiln shell sections. Preliminary assemble them together on the ground according to the interface codes. Check all the devices on kiln shell, such as: man-hole, suspended position of wet process kiln and other angular positions to see if they meet the requirements of drawing or not.

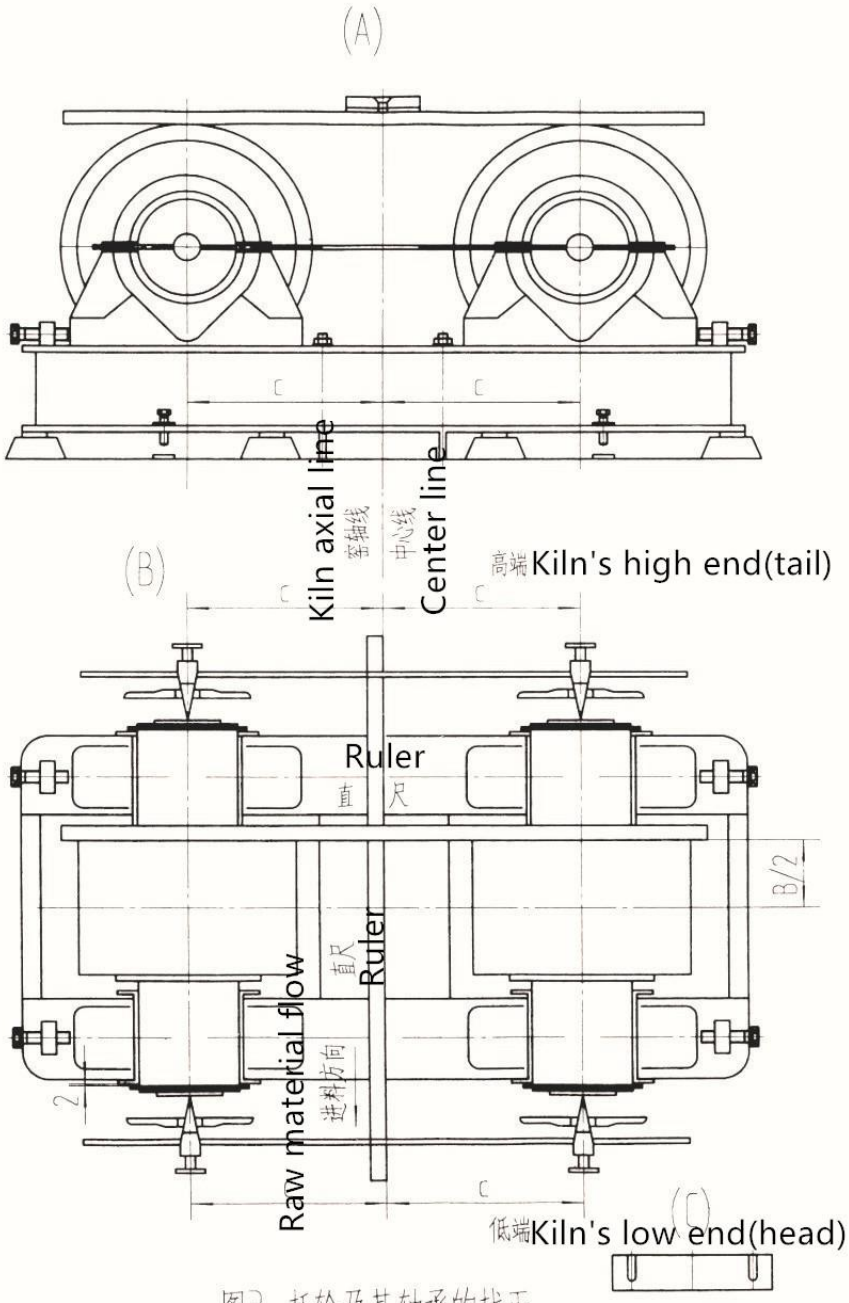

图3 托轮及其轴承的找正

Figure 3 Roller and bearing's alignment

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4.1.2 Inspect two sides of each shell section, allowance error of its circular length is not more than 0.2%D (D stands for internal diameter of shell body) and not

more than 7mm. On this section, the difference between D_{max} and D_{min} is $\varphi=D_{max}-D_{min}\leqq 0.2\%D$. If the error of "φ"could not meet the requirements, it should be rectified.

4.1.3 Measure the internal diameter of riding ring and outer diameter of kiln shell body after adding bearing plate, and then calculate its clearance to see if it meets the requirements of drawing.

4.2 Assembly and alignment the shell body:

Order of assembly the shell body sections should be decided by on site conditions. In order to keep range of alignment to be 2~4mm for clearances of shell section, 16 pieces of square steel plates of 100mm should be inserted on the interface. The steel plates must be evenly distributed along the circumference. In the meantime, the position of riding ring on the supporting rollers should be nearly the same as it is indicated on the drawing at cold state.

Use head and end riding ring at shell center as foundation, the straightness of shell body center line is: girth gear and shell body center on other riding ring is φ=4mm, shell body center on other parts is φ=12mm

Shell walls of every section jointing parts should be lined up by straightedge, and the maximum alignment tolerance on any part of circumference should not be more than 2mm. Please see Fig. 4.

It shall be especially pointed out: It would be appropriated to measure and align the shell body before sunrise as shell body might be deformed under strong and continuous sun shine.

4.3 shell body welding：

Welding of shell body is one of the most important works during the erections of rotary kiln, following items needed to be paid more attention.

4.3.1 Welders must be skilled and only when proved by examination could they do the work.

4.3.2 According to the site conditions, the welding of shell body: inner part could use hand welding to seal the bottom and the outside part could adopt auto-weld or

manual weld. Q235-B steel plates, welding wire should be used whose quality is nearly to that of 08A wire, when it is welded by hand, welding rod whose quality is nearly to that of T507 should be adopted and before use, it should be dried for 2 hours under the temperature of 250℃.

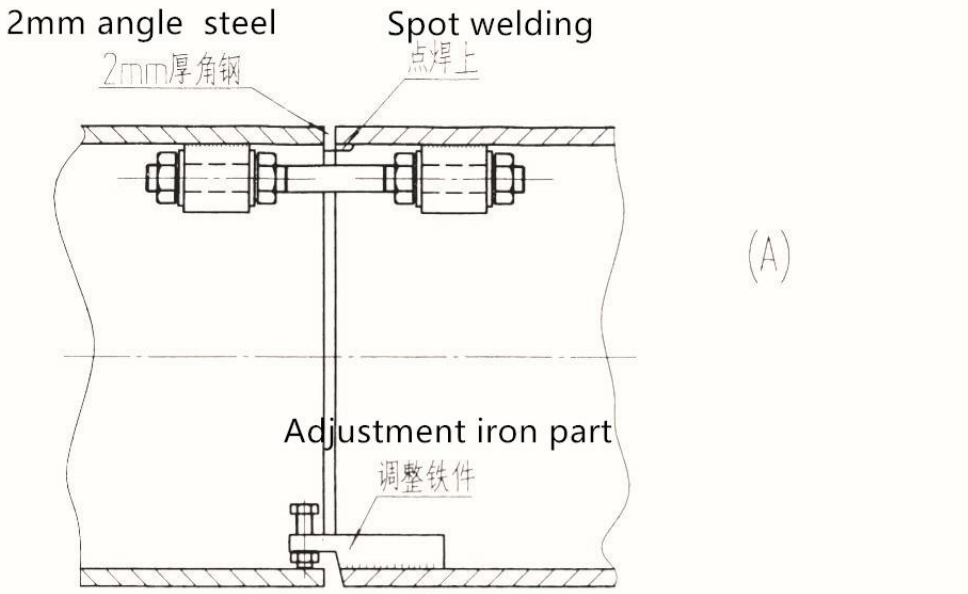
4.3.3 Shell body joints must be kept clean and dry and those iron plates used to keep clearances of joints should be removed one after another while welding but they couldn't be removed at the same time.

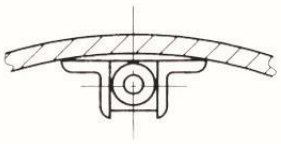
4.3.4 No other job can be done on the kiln while welding the shell body.

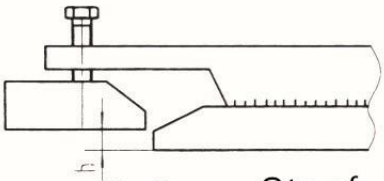
4.3.5 Stop welding when it is raining, windy and snowing. When weld under conditions of low temperature (below 5℃), groove should be preheated before welding and heat reserved after welding. If the shell is shone by the sun and it would cause temperature to be quiet different and make shell body to be bent. Only when the sun has set, welders could start welding. If one side of shell bent by heat radiation while the shell is in production, it should be protected from heat insulation by asbestos plates.

4.3.6 Between every welding layer, the lighting and extinguishing arc points should not be overlapped. External appearance of welding seam should not have defects of undercut, abscess, gas holes, cracks and etc. Ray flaw detection should be taken on the cross part of longitudinal and girth welding seams and also on those area, which the welder is not sure of welding. Quality of the welding seam should meet the requirements of Ⅲ grade in GB3323. If not, then it should be done over again.

4.3.7 After the welding of shell section is finished, check the distance between width center of riding ring and that of supporting roller, it should be conformed to the cold size on drawing. The allowance error is 5mm. Riding ring and its two sides of check rings should be tightly contacted.







(B)

Shell diameter	Qty of bolts	Qty of angle steel	Qty of adjustment iron parts
窑筒直径	螺栓个数	角钢个数*	调整铁件个数
Φ2.5-5.2m	12-16	12-16	12-16

*2mm角钢应当放在正对着拉紧螺栓的位置
并在焊接时逐个地去除。

2mm angle steel should be removed dead against tension bolt position one by one when welding

图4　筒体对口

Figure 4 Shell body alignment

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5 Installation of transmission unit

After the kiln shell assembled into a whole part, it is better to install transmission

unit and fix it temporarily, so as to make use of transmission unit, which can rotate the shell to carry out alignment and welding. The installation of transmission unit must meet the following requirements:

5.1 Longitudinal seam on the shell used to fix the girth gear should be smoothened by abrasion wheel, and it should be 100mm wider than the spring board.

5.2 The tolerance of girth gear outer round radial runout and end face runout are all 1.5mm.

5.3 Pay attention to the installation direction of spring pulling board(Spring plate). When the kiln is running, spring pulling board can only bear the tension. When connection fitting bolt of girth gear and spring pull board is installed, yoke plate of one side between washer and spring pulling board should place 0.3mm gasket, tighten the nut with channel, fix cotton pin, and then remove the gasket, to keep the clearance of 0.3mm.

5.4 When fix the base of driving unit, its horizontal direction should be decided as per kiln centerline, its axial direction should be decided as per girth gear centerline, its surface elevation should be decided base elevation with catch wheel supporting device, and its surface inclination should be the same as the base inclination of supporting unit.

5.5 Use the girth gear as datum to install the pinion. Its position size should be confirmed to the requirements of drawing and the permitted tolerance is ±2mm. Use slope gauge to align the inclination, when the kiln has rotated for one week in cold state, bottom clearance between pinion and girth gear should be 0.25mm+(2-3) mm, (mm stands for gear modules). After it is put into use, when kiln body reaches normal temperature, tip clearance should not be less than 0.25mn.

Check the engagement of the girth gear and pinion, engaged area along girth height is more than 40% and along the gear length, 50%.

5.6 The coaxial tolerance of main gear box low speed shaft and pinion axial is 0.2mm. On the axial hole section of gear box, measure its horizontal straightness error, its axial degree of inclination tolerance should not be more than ±0.05mm/m.

6 Installation of other parts of kiln must be conformed to the requirements in drawings.

7 Requirements of laying refractory bricks

Please ask supplier to provide details. The below requirements are used in general cases.

7.1 Requirements of laying refractory bricks：

7.1.1 Specifications and quality of refractory bricks must be conformed to the requirements.

7.1.2 Handle with care when transport refractory bricks. Throwing bricks is strictly forbidden.

7.1.3 While laying bricks, bricks lack of edges and corners, with cracks or the shape is not conformed to the requirements and not well burned should not be used.

7.1.4 Store the brick and prevent it from raining and moisture according to its kinds, types, grades and different tolerance grades.

7.2 Notice and requirements of laying bricks:

7.2.1 Contents, particulars and mixed proportion of the clay should be conformed to requirements. Clay must be evenly mixed and used up within two hours.

7.2.2 At last, lines for inserting bricks should not be less than two lines and thickness of inserted bricks should not be less than 3/4 of original size. If the clearance is less than 1.5 times of the designed thickness of bricks, inserting brick with upside down is forbidden.

7.2.3 In one section of brick laying area, every line of laid bricks should be of the same grade, thickness and tolerance (0-2 0r 0±2).

7.2.4 When the refractory bricks are laid, the longitudinal brick seam should be parallel with kiln centerline and girth brick seam must be perpendicular to kiln centerline.

7.2.5 Surface of the laid refractory bricks should be leveled and error of the two adjacent bricks should not be more than 3mm. Brick to brick must be tightly jointed

and there should be no clearance, and looseness.

7.2.6 Normally the brick seam is 2.5mm, and it must be checked by 15×2.5 (Width×thickness) plug gauge. Depth of insertion into brick seam should not be more than 20mm. Set 10 check points within every 5 square meters, not more than 3 points surpass the stipulated brick seam. For brick seam over 3mm, iron sheet should be used to insert tightly.

7.3 Notice of laying bricks in freezing season:

7.3.1 Place for store refractory bricks must be raised up and covered by waterproof cloth to prevent them from being immersed by ice and snow.

7.3.2 In working place, it should have heating equipment and thermal insulating facilities to keep the temperature to be not less than +5℃. Even if stop working or have holidays, heat preservation should not be shut off. Refractory clay should be mixed with hot water and while laying bricks, brick seams should be kept from freezing.

7.4 Warming of kiln liner:

Temperature should be strictly controlled while drying the kiln. Rising of the kiln temperature should be stable, step by step and it should be even-distributed. It should be kept about 250°～300°.Time for kiln warming could be prolonged for 10-20%. In the course of drying kiln, rotate the kiln in time according to kiln temperature to prevent high temperature from appearing in some areas. If the bricks are found loose and fallen off inside kiln, stop to repair and then go on drying.

Ⅳ. Operation, Maintenance and Repair

To operate, maintain and repair rotary kiln correctly will prevent failure of equipment, prolong safety operation period of rotary kiln, extend equipment service life, reduce power and auxiliary materials consumption. Therefore, workers shall pay attention to operation and maintenance with good.

1 Test run of rotary kiln：

1.1 Before having test run, check foundation level to see if it is changed, bolts at every part have been tightened, and every lubricating point have been filled full with lubricating oil or grease. Before rotating kiln, on journal of supporting rollers which use slide bearings should be poured one layer of oil with oilcan. Inspect revolving part to see whether it is blocked up and every cooling water pipeline is smooth. Only when every part is checked to be in good conditions, worker can start to have test run.

1.2 Before the whole set of kiln test run, every part should have test run separately. Race the motor for 2 hours and gear box for 8 hours (4 hours driven by main motor). Record the electrical current, rising of temperature and listen whether there is any abnormal sound.

1.3 Time for kiln shell body test run before laying bricks should not be less than one day (continuously). And it is required to have the following inspections:

1.3.1 Check lubrication condition of every part, rising of temperature, electric current and also check if there is oil-leaking. Raising of temperature normally should not be more than 30℃ and load of motor should be over 15% of the rated power.

1.3.2 Check transmission unit to see if there are any abnormal noise of vibrating, impacting, and etc, whether the engagement of girth gear and pinion is normal or not.

1.3.3 Check if the engagement of riding rings and supporting rollers are normal and clearance between thrust ring on supporting roller shaft and lining bush on supporting roller is normal.

1.3.4 Sealing unit on the two ends of kiln shell body and air-blowing units of some sealing structures are in good conditions or not while operating. Excessive clearance of air-leakage is not allowed.

1.3.5 Bolts at every part are loosening or not

1.4 After laying bricks, test run of kiln shell should be taken at the same time when

warm the kiln. And at this time following inspection work should be done.

As the weight of kiln increased, check temperature rising of every oil tank, it should not be more than 35℃. Temperature raising of bearing should not be over 40℃, load of motor should not be over 25% of the rated power. In particular, check the adjustment of supporting roller to see if it is right e.g. if the engagement of supporting roller and riding ring surface is even and etc. Other inspection items are the same as that of test run before laying bricks.

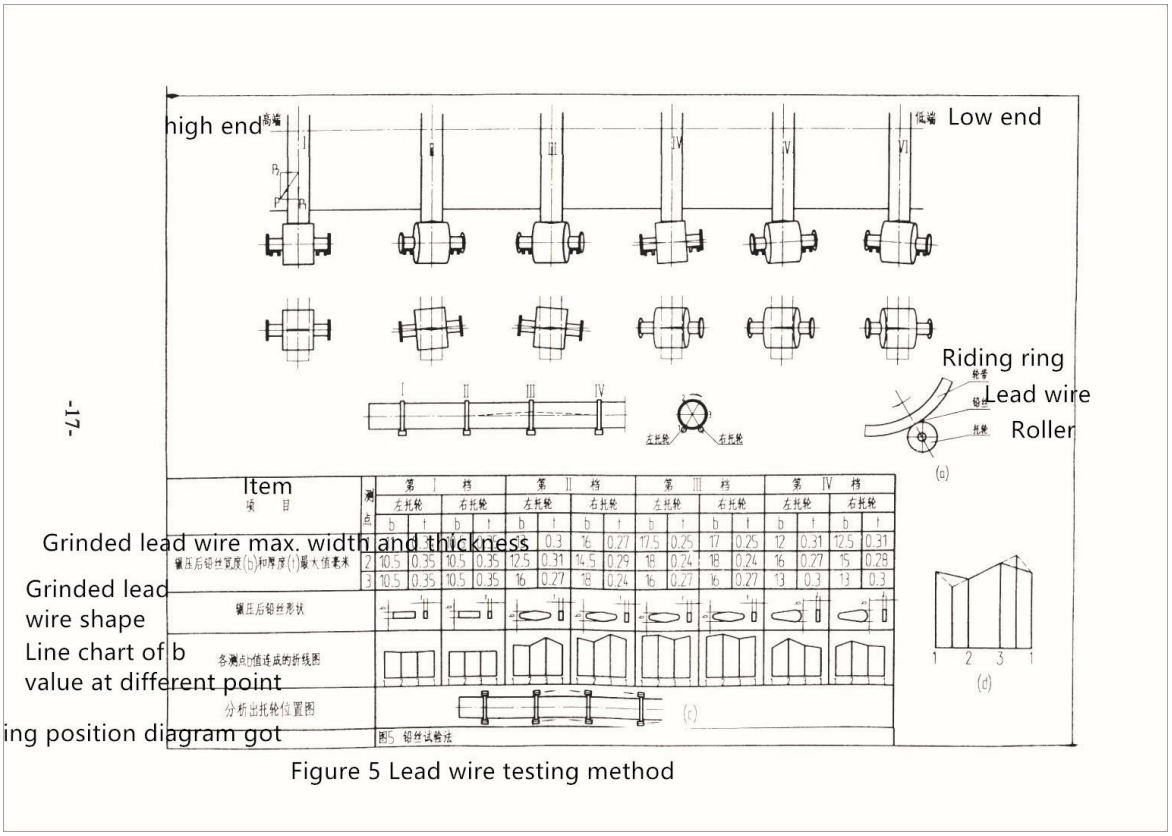


Figure 5 Lead wire testing method

2 The maintenance of normal operation of rotary kiln

First, carefully adjust and maintenance supporting roller device, that is to say, find out the state the supporting roller located in, so it is necessary to observe operation state of supporting roller. Determine stress condition of supporting roller and contact condition between the supporting roller and the riding ring, it can also be done by lead wire testing way.

2.1 Lead wire testing way:

This method requires surface of supporting roller to be even and smooth. While testing, put the lead wire between riding ring and supporting roller illustrated as Fig.5(a). Through analyzing of rolling form of the lead wire, it would be better if it is fused whose diameter is about 2mm, could judge the engagement of supporting roller and riding ring and also stress condition. And it can also decide the centerline of kiln shell body is straight or bent.

Supporting base in Fig.5(b) is supporting roller to be totally paralleled down. The surface pressure is evenly distributed on the full width of supporting roller, shape the pressed lead wire is rectangles. If all supporting rollers are adjusted to this shape, then the kiln would move downward with its own sliding gravity while the kiln is operating. Whereas supporting base Ⅱ and Ⅲ and axial line of supporting roller has cut an angle which is relatively to the kiln centerline. At this time, distribution of engaging surface pressure is that pressure on the center point is the biggest, and shape of the pressed lead wire is like prism. If rotating direction of kiln is like the illustrated drawing, then supporting base Ⅱ would push the kiln down to the low end, whereas supporting base Ⅲ would push the kiln up to the high end.

The max. supporting roller engaging surface pressure of supporting base Ⅳ appeared on the high end, shape of the pressed lead wire is like triangle, but axial line of supporting roller on horizontal plane has not cut an angle which is relative to the kiln centerline, therefore it is not tending to push the kiln to move axially.

For supporting base Ⅵ, axial line of supporting roller on horizontal plane has cut an angle which is relative to the kiln centerline, the pressed lead wire is also shaped as triangle. For supporting base Ⅴ, the max. supporting roller engaging surface pressure appears on the high end and it pushes kiln down to the low end; whereas, for supporting base Ⅵ, it appears on low end, then it would push the kiln to the up end.

Lead wire testing method could not only measure the engagement of supporting roller and riding, but also could judge its load-bearing and whether the kiln axial line has bent horizontally or longitudinal and where the value of eccentric angle is the biggest.

Testing method and procedure are as follows:

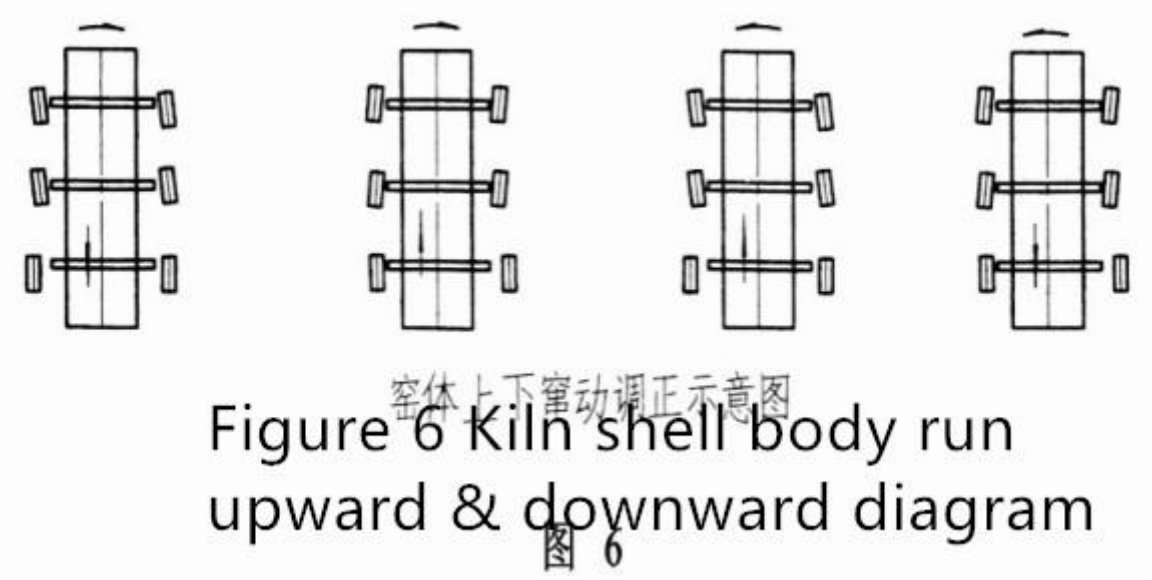
Firstly, on the circumference, divide the riding into three equal parts (or more) and mark them. Parts of same number should be on one of the kiln shell generatrix. Even up the prepared lead wire that is a little bit wider than the supporting roller and put it into the marked riding ring. Fill parameters of the pressed lead wire into the table illustrated as Form 5(c). According to the parameters recorded in the form to draw broken line with pressed lead wire width as ordinate and riding ring girth equal length as abscissa. Then judge as per parameters of the form. For example, the installation of base Ⅰ supporting roller is totally to be paralleled to the kiln centerline, and it is found that back force on "Ⅰ" supporting base is very small. Supporting base Ⅱ indicates under the riding ring there is a little bit slope and it could be observed that all the supporting rollers are tending to move up to the high end, therefore it is known that the kiln is pushed to move to the low end. Width of the lead wire pressed under the right and left supporting roller are all most the same, therefore they bear the same force. Compared to width of the lead wire pressed by the neighboring supporting roller, width of the lead wire pressed by "Ⅲ" supporting base is very big, positions of the left and right rollers of it is very much closer to the kiln centerline, and it could also see the max. bending points are two. Left supporting roller of supporting base Ⅳ turns a little bit upwards to the low end and pushes kiln to move up to the high end; Whereas the right supporting roller is also a little bit bent upwards to the high end and moves down to the high end and it is tending to tend to push the kiln to move downwards. Besides, it could also be observed the max. bending points of kiln shell body are two. According to the above-analyzed result, it would be very easy to draw the position diagram of

supporting roller and it is known where the max. bending point of the kiln shell body locates. If it is needed to accurately determine the supporting roller position on the Max bending point, then divide the riding ring into six equal parts, add testing points between 1-2, 2-3, 3-1. Take the lead wire pressed by the right supporting roller of "Ⅱ" supporting base as an example, it could be found that the max. bending point is between 3-1 (see Fig.5(a))

2.2 Adjustment of rotary kiln supporting roller fitted with mechanically catch wheel:

Adjustment of supporting roller is one of the important work when maintain rotary kiln. In the course of rotary kiln operating, sometimes the kiln shell body would travel up and down. If the movement is not very big, then it could be adjusted by pouring lubricating oil of different viscosity. When the kiln shell body travels downward, pour lubricating oil with low viscosity, to make the kiln body move upward. If the kiln shell body travels upward, then pour the lubricating oil with higher viscosity and make the oil film to become thicker so as to eliminate frictions between supporting roller and riding ring, therefore make the kiln body to travel downward.

If the up & down movement of kiln body is too big, then according to the traveling direction of the kiln shell body (see Fig. 6), determine the reversing direction of supporting roller and then screw the top wire of supporting roller bearing base so as to achieve the goal of adjustment.



窑体上下窜动调正示意图

Figure 6 Kiln shell body run upward & downward diagram

图 6

While adjusting supporting roller, following items should be noticed:

2.2.1 Adjustment of the supporting roller normally should start from couples of supporting rollers on the kiln feed end and as far as possible to keep the centerlines of every supporting rollers on kiln discharge end near sintering zone to be paralleled to kiln shell body centerline, and avoid to adjust from the girth gear and couple of supporting rollers at kiln head.

2.2.2 Adjustment of supporting roller should be done while the kiln shell body is rotating. Each time, the top wire is only allowed to rotate 30°-60° so as to make it to be appropriately step by step.

2.2.3 Twisting angle of supporting roller centerline is not allowed to be over 30°. Twisting directions of every couple of supporting rollers should not arise as Fig. 7, it should be like that is illustrated in Fig.8. Positions of every couple supporting roller axial lines must be as illustrated in Fig.9 and should not be like what is illustrated in Fig. 10.

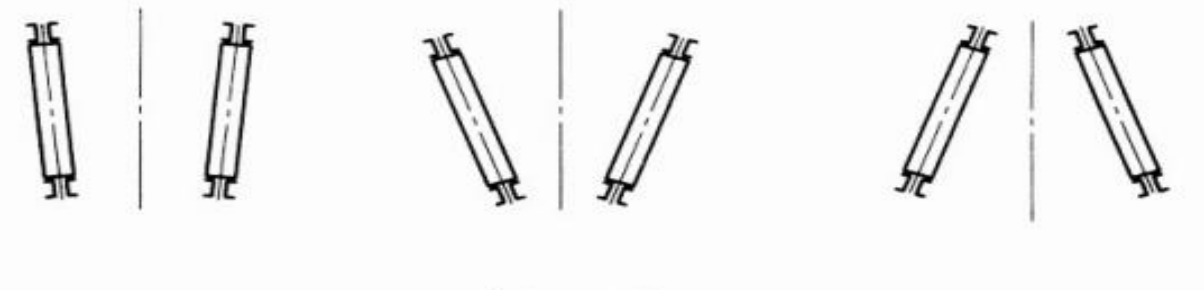


图 7

图 8

2.2.4 The supporting roller which is with Max force-bearing should not be used to do the adjustment, otherwise it would be easy to cause accident. And tyre and axle of supporting roller would also be easily damaged.

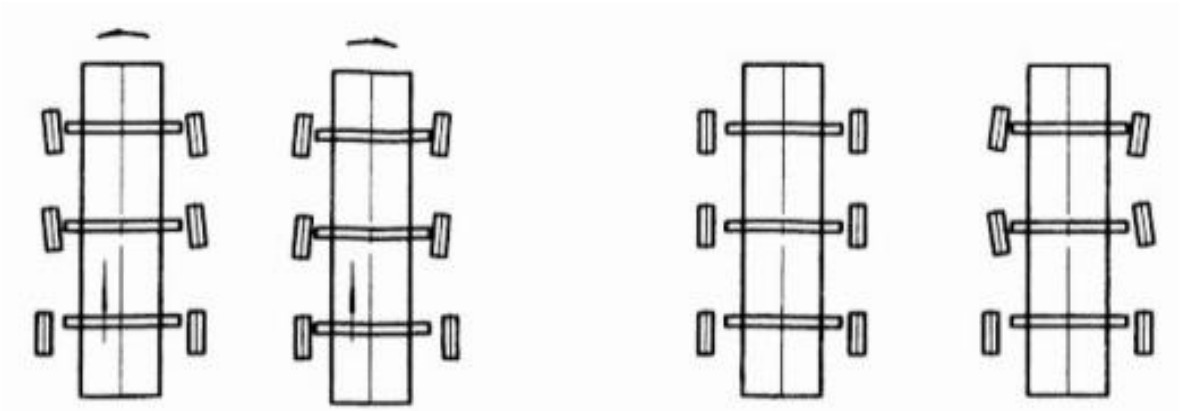


图 9

图 10

2.3 Adjustment of rotary supporting roller fitted with hydraulically catch wheel:

Rotary kiln fitted with hydraulically catch wheel requires the axial line of supporting roller is totally paralleled to the kiln shell body centerline, therefore when use lead

wire testing method, the pressed lead wires are all to be rectangular strip of equal width. It could be known that the bearing force of each supporting roller as per the wire width that the left and right supporting rollers pressed. To those who bear excessive force the supporting roller should be moved far away from the centerline and on the contrary, it must be moved to the direction of kiln head centerline. The parallel movement is not allowed for any vary in amount of the two bearings on the same of the supporting roller, or any reverse adjustment. Because kiln shell body is totally to be paralleled to the kiln centerline, kiln shell body is always tending to sliding down with gravity effect and permanently set the riding ring on the hydraulic thrust retaining roller would force the kiln shell body to move once up and down according to the anticipated period (normally every 2-8 hours) so as to efficiently guarantee even wear between riding ring and supporting roller and greatly eliminate the amount of work for adjusting supporting roller.

The up & down movement of the hydraulic catch wheel depends on that it could guarantee on the direction of the whole width of supporting roller, it has the chance to contact with riding ring so as to prevent it from wearing grooves on the surface of supporting roller. Adjustment of travel is assured by adjusting position of limited switch.

2.4 Daily maintenance during operation:

2.4.1Every part of transmission system and catch wheel must be checked regularly (every hour). If it is found that there is noise, vibration, heating and other abnormal conditions, fix it in time.

2.4.2 Check engagement and wear between riding ring and supporting roller to see if it is even, and if the force-bearing is excessive and the surface is carved and pocked.

2.4.3 According to the relative displacement in one circle of revolution between riding ring and its washer to determine the clearance and its wearing condition. Notice if there are cracks on the welding part of washer.

2.4.4 Every shift check foundation bolts and fixed bolts of transmission bottom plate and supporting unit, if it is loose, screw tightly immediately.

2.4.5 Check the foundation to see if it is vibrating and subsiding.

2.4.6 Check sealing frictional ring on kiln end and sealing unit on kiln head to see if they are well sealed and seriously worn and torn.

2.4.7 Every hour check the temperature and lubrication of supporting roller bearing and observe the clearance between thrust ring and lining bush to see if it is on the right state.

2.4.8 Once a week check and operate the auxiliary transmission (but don't connect clutch) so as to assure if the main power suddenly broken off, it could start up successfully.

2.4.9 Regularly check the temperature of kiln shell (especially the sintering zone) and keep the temperature of kiln body below 380℃.The kiln of other types should also keep below prescribed temperature.

2.4.10 Work of maintenance should be closely incorporated with kiln monitor and they should constantly get in touch with each other.

2.5 Abnormal conditions and trouble-shooting:

2.5.1 Any supporting roller's axial lines should be on the right position, otherwise it should be adjusted by the way of adjust supporting roller.

2.5.2 If it is found that the foundation is subsiding, lower the speed of kiln and report to the chief engineer to study and fix.

2.5.3 When the main power is suddenly broken up, immediately use the auxiliary transmission unit to operate the kiln.

2.5.4 Flame is not allowed to directly contact with the refractory bricks. If "red kiln" is found (normally it is said to be caused by refractory bricks dropping off or being worn to be thinner), stop the kiln immediately and repair. Vulcanizing is not allowed.

2.5.5 When the riding ring is found to be taken off from the supporting roller, report immediately and find out the reason, then adjust it carefully.

2.5.6 Reasons for supporting roller and riding ring surface worn to be polygon.

2.5.6.1 Engagement of transmission gear is not right or gear teeth are heavily worn out and causes impaction.

2.5.6.2 Supporting roller axial line is not paralleled to the kiln centerline.

2.5.6.3 It is owing to slope of supporting roller and uneven wear of bush, or when the bush is worn unevenly, only replaced one bush.

2.5.6.4 Sliding and uneven surface wear appeared between riding ring and supporting roller.

2.5.6.5 Foundation is subsiding or not firm and cause vibration.

2.5.6.6 The supporting roller and ridingring surface are not well-lubricated and over worn and caused the supporting base to move longitudinally.

2.5.6.7 The supporting roller and riding ring's material quality is uneven or have structural defects so that they would be worn to be grooves on soft area and wedges or corners on hard area.

2.5.6.8 Eliminate the causes of over wear, if it is slightly worn, after eliminate the causes, it could be automatically ground to be level, but when it is worn heavily, it should be fixed by turning.

2.5.7 If the sampling hole is blocked up, it is permitted to clear it with iron stick or steel pipe.

2.5.8 If it is difficult to start-up after short period of stoppage, it may be caused by not in time to operate kiln at low speed and the kiln centerline bent, if the bent is not too big, rotate the kiln to 180°. Put the bent part of shell body upward and heat it. If the temperature is higher, the kiln must be revolved for a few circles and make the bent part stop upward, repeatedly doing it until the bent part recovers to normal shape. If it is bent heavily, mass repair is suggested for treatment.

2.6 Notice of safety:

2.6.1 Any repair should be done only after stopping the kiln and "No Start!" mark must be hung on the switch of electric motor.

2.6.2 During operation, hand and other things are not allowed to be stretched into the inner parts of bearing, reduce gear box and girth gear housing to repair, check and wash. Facility for safety protection shouldn't be removed.

2.6.3 Close to the rotary parts, it is not allowed to bind the rag onto hand or finger to wipe the outward appearance of machine. Pay attention not to let the wiping material to be twined round the rotary parts.

2.6.4 Work clothes must be tightly tied so as to prevent clothes corners and sleeves from being bound by rotary part of machine components and cause personal injury accident.

2.6.5 Repair tool and parts should not be put on the rotary components especially on the supporting roller.

2.6.6 Inspection glass must be used while monitoring kiln. Direct observation is not allowed and the hole should be closed while not watching.

2.6.7 Before operating the kiln, it should have strictly inspection and be sure that there is nobody in the kiln and after giving out warning signal, the kiln can start up.

3 Stoppage and Inspection

During production, sometimes it is necessary to stop kiln for a short term inspection and repair, even if times of kiln stoppage should be decreased, but it could not be avoided. No matter it is long-term kiln stoppage or short-term kiln stoppage, before stopping, contact with all the relative production manager.

3.1 Short-term kiln stoppage:

Just after stopping the kiln, it is on the heating or thermal state, If it is not very often to rotate the kiln shell, then the kiln center line would be very easy to be bent. Keeping the kiln center line from being bent is very important and needs cautions, Therefore we suggest:

Within 1st hour after kiln stoppage, every 5-10 minutes, operate the kiln for 1/4 revolution.

Within 2nd hours after kiln stoppage, operate the kiln for 1/4 revolution every 15-20 minutes.

Within 3rd hours after kiln stoppage, operate the kiln for 1/4 revolution every 30 minutes.

3.2 Long-term kiln stoppage and inspection:

3.2.1 After kiln stoppage, rotate the kiln according to the above-mentioned stipulated period until it is totally cooled down then people could enter into the kiln.

3.2.2 While stopping kiln and put out fire, draw air nozzle out, and according to conditions of inspection requirements, discharge part or all of materials out of the kiln.

3.2.3 After kiln stoppage, following items should be inspected:

3.2.3.1 Cooling water of every part has already been discharged out.

3.2.3.2 Check every wear surface, clearance between axle and bush, clearance between girth gear and pinion and etc.

3.2.3.3 Check all the joint bolts to see if they are loosening or damaged, especially the joint bolt of girth ring, and also if there are cracks on welding seams of kiln shell and bottom plate.

3.2.3.4 Check whether the lubricating oil of every lubricate points need to be replaced, washed or filled up. If it is necessary to replace, first discharge the stored oil out, clear it, then refill the new oil.

3.3 Start-up & stoppage of auxiliary transmission

When the main electricity is cut off and main motor couldn't be operated, in order to prevent shell from being bent and need rotating the kiln then the auxiliary transmission could be used. Besides, the auxiliary transmission will also be used for requirement and intend to rotate the kiln onto certain position and stop for repairing. It should be pointed out that while using auxiliary transmission, as the kiln speed is very low, oil spoon of supporting roller sliding bearing would form indirect lubrication, so it should be better if it is not used for long period of time(not over half an hour),otherwise, it would be heating or the power would rise up, even when the bush appeared to have drying kiln, and produce sound of striking, If it must be continuously used, pay close attention to the lubrication of every supporting roller bearings, artificially pouring oil onto the journal at certain period of time and in the meantime, notice raising of the temperature of the main reducer bearing.

Operation of start-up

3.3.1 When it changes to be auxiliary drive from main drive:

Stop the main motor at first, switch on auxiliary power (in the meantime electric interlock device will break up main power source); then close-up clutch on the output shaft of auxiliary gear box by hand. If angular gear position on the clutch is not appropriate, turn couplings of auxiliary motor by hand for alignment. Only when the clutch of auxiliary transmission is confirmed to well jointed, working face of angular gear has been well connected (clearance is not allowed) and meanwhile handle contact board of angular gear clutch has already switched on the switch auxiliary motor, could it be start-up, and the handle shall be fixed by special spring pin.

3.3.2 Operation of stoppage while stop use the auxiliary transmission

Switch off the clutch, change power to the main motor, at this time the electrical interlock system will break up auxiliary power source, then it could be switched on by main transmission, it shall be pointed out that please don't operate clutch while the kiln is running, close-up of clutch shall enter into the position of engagement, and fully come off from contact while switch off. While it is on the two limit positions, it shall be fixed with spring pins.

4 Lubricating & cooling

Another important work of maintaining rotary kiln is every rotating parts of rotary kiln should be well lubricated so as to prolong the service life of parts and reduce the expenses of repair.

For rotary kiln lubricating points and lubricants, please see table 1

Pay attention to the following items while lubricating rotary kiln:

4.1 Lubricating oil and grease should be used correctly, while use substitute, it must be conformed to the requirements of the stipulated oil qualities and features. And only use the oil with strong viscosity to replace the oil with low viscosity.

4.2 When the new kiln continuously operates for 400-500 hours, after the gear is well engaged to the bush, oil must be totally drained out. Clean the oil pan and fill it

with fresh oil. After that every 6 months is as a period to replace with fresh oil.

4.3 Once every shift, check the oil level. If the oil level dropped down to the lower limit of oil level indicator graduation, then it should be filled with oil right away until it rises to the upper limit of oil level indicator graduation.

4.4 If there is oil leaking, immediately fix it and if the leaking oil flows down to the foundation, it should be handled in time so as to prevent the foundation from being corroded.

4.5 When the kiln is stopped for long time, before start-up, use oil can to pour oil on the oil pan of supporting roller sliding bearings, then to operate it. When use auxiliary transmission to operate for long time, it must be checked often and pour oil according to the requirements.

Workers who are maintaining the rotary kiln should also pay attention to the cycle of cooling system of supporting roller bearing, use water flow from supporting roller into water channel to cool surface of the supporting roller. Water level height of water channel could be controlled by rotating the polyvinyl chloride(PVC) bend pipe. Regularly check the pipe to see whether the water is continuously flowing out, when the kiln stopped for long period of time or to be shut down in the winter, all cooling water should be drained out so as to prevent it from freezing and expanding to be checked. In order to discharge water from spherical bush, close the adjusting value on the water outlet pipe for a moment, quickly revolve the T-value on water inlet to 90°to make it contact with atmosphere and then rapidly open the adjusting value, the cooling water would naturally flow out with siphon principle. If it is still not drained out, then it can be blown out by using compressed air on the hole which T-value contacts with atmosphere.

Lubrication oil inside the main gear box is cooled and filtered by the cooling filter in the gear box oil supply station. The cooling filter could also be used to cool alone, so as to cool lubrication oil regularly.

5 Repair of the rotary kiln

During operation, parts of rotary kiln will be worn out as time goes by, it will reduce

the precision of equipment, and even affect the output of the rotary kiln, therefore it should be repaired. According to the mount of repair, it is classified into overhaul, medium and minor maintenance. Work out the repair plan according to operation and maintenance of rotary kiln, the main ways to repair the rotary kiln is minor repair and medium maintenance. These works will be held while stopping the kiln to lay kiln liner. For medium maintenance, it would be better to be separately to be 2～3 times during the period of laying kiln lining. Only the transmission unit and gear box could be repaired after finishing laying bricks, but it should be also be finished rapidly within short term (e.g. 8～12hours). For overhauling, it would need long time (e.g. 10～12 days), and for this condition, all the worn parts of the kiln should be replaced, check and adjust all the units of kiln

5.1 If the main parts of rotary kiln have been worn to the following extents then they should be replaced and repaired:

5.1.1 Teeth thickness of the driven gear has been worn down 30%, or the flange has been damaged and could not be repaired, it should be replaced or repaired.

5.1.2 There are cracks on kiln shell section or part of it is deformed, then it needs to be replaced or repaired.

5.1.3 Riding ring section has been worn 20% or surface has been worn to be cone and polygon and part of it has penetrated cracks, then it needs to be replaced.

5.1.4 When diameters of the supporting roller and journal of retaining roller have been worn out for 20% smaller or thickness of supporting roller flange has been rubbed 25%, or it has been rubbed to be cone or other shapes, or there are penetrated crackles on the wheel edge, it must be replaced or repaired. While replacing the supporting roller and catch wheel, the relative lining bush must be re-scrapped.

Annex

Table of Lubrication Items

Lubrication point			Lubrication oil		Life cycle			Remark
Name		Way of lubrication	Designed trademark	Alternative grade	Replacement cycle for the first time	Fuel quantity a time	Normal replacement cycle	
1	Main driving gear box	Circular lubrication	Gear oil L-CKC320 （first-class） （GB5903-1995）	220 Synthetic Extreme Pressure Industrial Gear Oil （Q/SHG。 J02.137-2003）	600 hours	650L	0.5-0.75 year	Or consult the manufacturer
2	Auxiliary driving reducer	oil impregnation	Gear oil L-CKC320 （first-class） （GB5903-1995）	220 Synthetic Extreme Pressure Industrial Gear Oil （Q/SHG。 J02.137-2003）	500 hours	10L	2 years	Or consult the manufacturer
3	Supporting roller bearing	Oil spoon continuous lubrication	Gear oil L-CKC320 （first-class） （GB5903-1995）	320 Synthetic Extreme Pressure Industrial Gear Oil （Q/SHG。 J02.137-2003）	600 hours	420L	0.5-075 year	
4		Oil cup	Extreme pressure lithium based	Synthetic lithium-based grease	600 hours	Fill inside the rolling bearing	Once per shift	

			grease No.2（GB7323-1994）	No.2 SH-T0380-1992		and 2/3 spacing of bearing upper cover chamber		
	Catch wheel bearing		Gear oilL-CKC460(first-class)（GB5903-1995）	320 Synthetic Extreme Pressure Industrial Gear Oil（Q/SHG。J02.137-2003）		To oil marking line about 100L	0.5-0.75 year	
	Pinion unit bearing	Oil cup	Extreme pressure lithium based grease No.2（GB7323-94）	Synthetic lithium-based grease No.2 SH-T0380-1992				
5	Girth gear and pinion	continuous lubrication with oil tank	KLUBER C-F3ULTRA	Common Open Gear Oil 220(SH-T0380-92)	600 hours	165L	1year	
		Spraying	KLUBER Grafloscon C-SG0ULTRA	742 Open Gear Grease				
6	Riding ring, and supporting roller, riding ring and catch wheel	Continuous contact	graphite block	Steelwork Waste electrode			0.25-0.5L	
7	Inner surface of riding ring and washer	Spraying	KLUBER Wolfracoat C fluid	No.4 high temperature grease（No.50 high		proper quantities	Spray and lubricate once a day	Or supporting roller bearing waste oil added

				temperature grease）（ZBE36009-88）				with 15-17# graphite
8	Kiln tail sealing device friction ring	Continuous contact	Extreme pressure lithium based grease No.2（GB7323-94）	Synthetic lithium-based grease No.2 SH-T0380-1992		proper quantities	0.25-0.5year	