Specification of Installing, Testing, Maintaining & Operating for

HYWZ 450-C Bell-less Top Equipment of Blast Furnace

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Chapter 1 Upper receiving hopper

1. Application instruction of equipment

The upper part of the furnace top is upper receiving hopper. The main function is storing burden as the skip car or the belt transporting the material within the burden tanks.

2. Technical parameter and specification

The dimension of upper opening is 1760×1760 (length×width)mm.

The dimension of lower opening is φ1035mm.

3. Structure and working principle

The upper hopper is composed of the lower cone and circular column. The inner surface of the lower cone is with the wear-resistant liner which is fastened by the bolt. The bolt is self-made anti-rotating type, and the liner is mould board. The liner could be dismantled and replaced.

4. Installing process

4.1 Clean the contact position of the supporting beam and hopper support

4.2 Detect this position with the gradienter

4.3 Hoist the upper hopper to the supporting beam by crane, align, pre-measure the elevation, calculate the thickness of the liner

4.4 Adjusting the distance between the furnace top center line and lower flange center of the upper hopper according to the diagram

4.5 Fill the clearance of the supporting beam and upper hopper outrigger with the liner, and fasten the anchor bolt.

5. Maintenance and repair

Safety measures of the wear-resistant liner replacement:

- Lock the charging system
- Evacuate the material in the receiving hopper and close the upper sealing combination
- Purge and clean the receiving hopper
- Cut off the hydraulic circuit

All the valves should adopt the respective locking device to conduct mechanical lock or

electrical lock. Detect the gas component in the hopper after purging for safe operating.

6. Recommended spares

- Wear-resistant liner at all part
- Connected bolt of the all wear-resistant liner
- Upper replaceable grizzly screen

Chapter 2 Upper sealing combination

1. Application instruction of equipment

Upper sealing combination is installed under the hopper, including block valve and upper sealing valve. The main functions are controlling the material and sealing the gas in the burden tank.

2. Technical parameter and specification

Diameter of the flow regulating valve: DN600

Opening scope: 0°～ 40 °

Max material speed: 0.4m^3/s

Drive type: hydraulic

Lower sealing valve diameter: DN700

Sealing pressure: 0.2MPa

Drive type: hydraulic

3. Working principle and structural features

3.1 Working principle

After bleeding of the burden tank, open the upper sealing valve, then open the block valve. The material is transported into the burden tank. Detect the material level, close the block valve and upper sealing valve, and then conduct the pressure equalizing.

3.2 Structural features

The upper sealing combination is complete equipment, including block valve and upper sealing valve. The block valve is spherical structure. The working surface of the valve flap is surfaced with cemented carbide forming a wear-resistant layer. The rotary support is

oil-impregnated bearing. It adopts grease lubrication with dust cap. Over the valve flap, there is a feeding draft cylinder, whose upper part is square and the lower part is round. The external drive adopts the ordinary cylinder, synchronous crank and synchronous & reverse gear to realize the synchronous and reverse linear movement of spherical valve disc. Valve plate rotating and lifting are realized by special-shaped crank and connecting rod. Valve plates are set to the sides of the valve seat after rotating to prevent the valve plate being scoured by the material flow. The fixing of rubber ring adopts detachable grip ring fixing for easy replacing. On the side of the valve body, there set access door for dismantling the valve plate.

4. Installing and testing

4.1 Installing

4.1.1 Clean the upper flange of burden tank

4.1.2 Valve groups are hoisted to the assembling position

4.1.3 Valves are set at the installing position. Leave 15-20mm clearance within upper and lower flanges, and install bolt.

4.1.4 Fasten the bolt.

4.2 Testing

4.2.1 The access door of upper sealing combination should open until the pressure testing of the furnace top.

4.2.2 All the equipments should be checked before testing. All the parts should meet the design requirement. The hydraulic pipeline and lubrication point should be unobstructed. The movement of the limit switch should be accurate.

4.2.3 Movement of valve plate is accurate, opening and closing of the valve disc is smooth, and there is no leakage at the sealing position during testing.

4.2.4 Adjusting cylinder speed

Sealing valve opens: 4s

Sealing valve closes: 3s

Flow valve opens completely: 3s

Flow valve closes: 3s

4.2.5 Electrical control testing of the block valve

- set the block valve at the complete open or close position

- install proximity switch. The distance between the sensor board and proximity switch is 8mm.
- operate the block valve several times, and then fix the proximity switch
- fasten anchor bolt
- the proximity switch should cut off or connect the electrical signal accurately when the block valve is open or close.

4.2.6 Electrical testing of upper sealing valve

- install proximity switch. The distance between the sensor board and proximity switch is 8mm.
- set the upper sealing valve at open position or close position
- operate the upper sealing valve several times, and then fix the proximity switch
- fasten anchor bolt
- the proximity switch should cut off or connect the electrical signal accurately when the upper sealing valve is open or close.

4.2.7 Lubrication system testing

The movement of distributor at every lubrication point is flexible. (Piston rod conducts upper and lower commutation)

5. Maintenance, repair and security technology

5.1 To prevent the upper sealing combination from accident in the process of maintenance and repair, these following measures should be adopted during checking, maintaining, and component replacing:

- close the pressure loop, open the bleed loop, and degas the upper sealing combination
- set the upper sealing valve at the open position, and block valve at close position
- cut off the hydraulic system with the stop valve

5.2 Valve plate dismantling and installing of the upper sealing combination

- open the access door of upper sealing combination, and rotate the valve plate to the side of the access door. Cut off the hydraulic system.
- hang the valve plate by the hoister by hand, and loosen the bolt which connect the connecting rod and assembly parts of the valve plate. The valve plate could be taken out in this way.

● installing sequence is on the contrary with the dismantling sequence.

5.3 Replacing of the wear-resistant liner tube of block valve and maintaining of the valve disc of flow valve

● loosen the hopper, and bolt which connect the upper sealing combination and burden tank. Elevate it (by hydraulic jack) and increase the clearance with the upper sealing combination. Make the clearance arrive at 20-40mm.

● the upper sealing combination is taken out by manual hoist

● replace the wear-resistant liner tube and maintain the valve disc of the block valve

5.4 Lubrication system of the upper sealing valve

Lubrication type: ZL-00 lithium grease (temperature is over 20℃)

Lubrication point: 12

It adopts centralized lubrication. Two points work every four hours, other ten points work every twelve hours.

NO.	Lubrication position	Quantity	Feeding period
1	Half shaft outer packing	2ml at a time	Every 12 hours
2	Half shaft bearing	2ml at a time	Every 12 hours
3	Half shaft inner packing	3.5ml at a time	Every 12 hours
4	Splined sleeve sliding bearing	3.5ml at a time	Every 12 hours
5	Spliend sleeve inner packing	10 ml at a time	Every 4 hours
6	Spline shaft	10 ml at a time	Every 4 hours
7	Short-axis sliding bearing	3.5ml at a time	Every 12 hours
8	Tail shaft	3.5ml at a time	Every 12 hours
9	Tail shaft	3.5ml at a time	Every 12 hours
10	Half shaft inner packing	3.5ml at a time	Every 12 hours
11	Half shaft bearing	2ml at a time	Every 12 hours
12	Half shaft outer packing	2ml at a time	Every 12 hours

6. Regular inspection and maintenance

NO.	Position	Inspection content	Inspection period
1	Lubrication	Working situation of automatic lubrication system	Every 8 hours
2	Lubrication distributor	Whether the distributor reverse	Every 8 hours
3	Hydraulic system	Working situation of hydraulic system	Every 8 hours
4	Upper sealing valve	Opening and closing time of valve plate	Every 24 hours
5	Upper sealing valve	Abrasion situation of valve seat	Every month
6	Upper sealing valve	Connecting bolt	Every month
7	Upper sealing valve	Abrasion situation of valve plate	Every month
8	Upper sealing valve	Sealing situation	Every week
9	Upper sealing valve	Valve plate external driving mechanism	Every month
10	Upper sealing valve	Valve plate inner driving mechanism(crank, connecting rod, and pin shaft)	Every month
11	Block valve	Abnormal noise	Every 8 hours
12	Block valve	Opening and closing position	Every month
13	Block valve	Cylinder	Every month
14	Block valve	Limit switch	Every week
15	Block valve	Coder	Every week
16	Block valve	Wear-resistant liner tube	Every month
17	Block valve	Surfacing layer abrasion situation of the flow	Every 2 months

		valve disc	
18	Block valve	Connecting bolt	Every month
19		Whole sealing situation	Every 24 hours

7. Trouble clearing

NO.	Trouble	Reason	Solution
1	Leakage of block valve	Bolt of driving device	Fasten bolt
		Valve disc abrasion of flow valve	Inspect the valve disc of flow valve
2	Block valve moves with difficulty or moves abnormally	Hydraulic system	Inspect pressure Inspect hydraulic cylinder
		Breakdown of bearing	Inspect lubrication situation Inspect bearings Replace driving device（splined sleeve）
		Material locks the spherical valve plate	Inspect the valve disc of flow valve
3	Failure of limit switch	Sensor board position of proximity switch	Adjusting sensor board position
		Cable line	Inspect cable line
4	Value of coder is not accurate	Coder and shaft coupling bolt is loose	Readjust and fasten the bolt
		Clearance of gearing mesh is big	Adjust mechanical part
		Coder	Inspect coder
5	Gas leakage in the valve plate and valve seat	Aging of silicone rubber sealing ring of valve plate	Replace the sealing ring
		Abrasion of valve seat	Replace the valve seat
		Dislocation of valve plate and valve seat	Adjust the valve plate position
		Burden deposition on the valve seat	Clear up the valve seat
		Valve plate assembling and connecting rod bolt	Inspect bolt and fasten it

6	Gas leaks through the driving device	Sealing ring of transmission device	Inspect lubrication situation Replace sealing ring
7	Rotating and elevating failure of sealing valve	Centralized lubrication system Hydraulic system Half shaft assembly part	Inspect crank and connecting rod and pin shaft lubrication Inspect pressure of hydraulic system Inspect half shaft bearing assembly
8	Distributor does not move	System pressure	Inspect system pressure Replace distributor

8. Spare parts

8.1 Cylinders of block valve and upper sealing valve

8.2 Valve plate assembly part of sealing valve and sealing ring

8.3 Valve seat

8.4 Distributor of lubrication system

8.5 Sealing strip

Chapter 3 Burden tank

1. Application instruction of equipment

The functions of the burden tank are storing material and charging material with pressure.

2. Technical parameter and specification

2.1 Effective capacity of burden tank: 14-18m^3

2.2 Diameter of burden tank: φ3400mm

2.3 Design pressure: 0.2MPa

3. Working principle and structural feature

The lower sealing valve and flow regulating valve should be at close position to keep pressure stable in the furnace when the burden tank charges material. When charging is complete, close

the upper sealing valve, and conduct pressure equalizing to the burden tank (using semi-clean gas in the primary equalizing) in order to make the pressure arrive at the top pressure. At this time, open the lower sealing valve and flow regulating valve, and charge material in the furnace. After completing charging, the burden tank is empty. At this time, close the flow regulating valve first, and then close the lower sealing valve and conduct gas bleeding. The pressure in burden tank must be low to the atmospheric pressure, then the open the upper sealing valve again and charge material to the burden tank again.

There is wear-resisting liner inside of the lower cone of the burden tank for protecting. It is fastened to the burden tank by the special bolt and gasket for ensuring the sealing.

There sets access door at the upper part of burden tank for maintaining and replacing the following parts:

Inspect abrasion situation of burden tank liner and replace the liner.

There sets pressure bleeding valve and pressure sensor interface at the upper part of burden tank.

4. Installing and testing

4.1 Clean the contact position of the supporting beam and hopper support

4.2 Detect this position with the gradienter, align, and pre-measure the elevation. The platform elevation is according to the lower variation during construction. When pre-measure the elevation, measure the lower sealing combination valve, and lower bellow dimension (Free State) accurately, considering the sealing gasket thickness within the related flanges. Make it compare with the clear height dimension between the lower flange surface of burden tank and upper flange surface of the distributor.

4.3 Hoist the burden tank to the supporting beam slowly, and keep it horizontal at the same time. Measure and adjust the burden tank to make the coaxiality of the lower flange centre and top center line not beyond 2 mm. Perpendicularity deviations of the lower flange and top center line is lower than 2mm.

4.4 It could realize the required height of design by adjusting the plate thickness of the burden tank connector. It is fastened by bolt or welded directly.

4.5 After installing, eliminate the excessive big foreign body in the burden tank, ensure the normal operation of the lower equipment.

5. Maintenance, repair, and safety technology

5.1 Replacing of the wear-resistant liner

These following safety measures must be adopted before inspecting or repairing of the burden tank in the breakdown period of the furnace:

- eliminate the material in the burden tank
- close the flow regulating valve and lower sealing vale
- install maintaining blind plate between the bellow and lower sealing valve
- open upper sealing valve
- open the bleed valve
- purge the residual gas in the burden tank (spray the water vapor)
- cut off the hydraulic circuit

Notice: after purging and clearing, open the manhole to inspect the gas component in the burden tank for safety operation.

6. Recommended spare parts

6.1 Wear-resistant liner at all parts

6.2 Connecting bolt and gasket ring of all wear-resistant liner

Chapter 4 Lower sealing combination

1. Equipment usage brief introduction

The lower sealing combination composed of burden flow regulation valve and lower sealing valve is installed under the burden tank and the unit is used to adjust and control the burden flow and seal the BF gas.

2. Technical parameters & specification

Nominal diameter of burden flow regulation valve: DN600

Opening range: 0° ～ 40 °

Max. burden discharge speed: 0.4m^3/s

Drive mode: electrical (servo motro) / hydraulic (opening degree controlled by proportional valve)

Nominal diameter of lower sealing valve: DN700

Seal working pressure: 0.2MPa

Drive mode: hydraulic

3. Working principle and structure features

3.1 Working principle

Equalizing burden tank, then open lower sealing valve, open BFRV to discharge burden into BF. The opening degree of BFRV should be adjusted by proportional valve as per burden distribution mode. For pressure relief, First close BFRV, then close lower sealing valve, then relieve the pressure of burden tank.

3.2 Structural features

Lower sealing combination is integral equipment in which BFRV is used to adjust the burden flow and lower sealing valve is used to seal the gas. BFRV is of spherical valve disc structure, the working surface of spherical valve disk is of hard alloy wear resistant build-up welding. Swiveling bearing is of oily bearing with dust shield. There is a square top& round bottom burden conduit above the spherical valve disc. Outer drive adopts hydraulic cylinder + synchronized crank + synchronized counter gear to realize the synchronous & counter & linear movement of 2 spherical valve discs. The lower sealing valve realizes the swiveling and lifting movement through deformed crank + connecting lever. The valve plate swivels and stops on one side of the valve seat to avoid the impact on valve plate by burden flow. Dismountable pressure ring is adopted for easy of rubber seal fixing.

There is maintenance gate to disassemble the valve gate on one side of valve body.

4. Installation and test

4.1 Installation

4.1.1 Clean up the upper flange of bellow and the lower flange of burden tank.

4.1.2 Hoist valve combination to assembly position

4.1.3 Press bellow by fastening thread rod as tight as possible

4.1.4 Move valve combination to installation position and leave 15-20mm gap between flanges, then put bolts in place and loosen bellow

4.1.5 Fasten bolts and do not make the bellow bear any load.

4.2 Test

4.2.1 Keep the inspection gate of lower sealing combination in open situation prior to BLT pressure test in which condition the gate should be closed.

4.2.2 Inspection should be done before equipment test. All position should comply with design requirement, hydraulic pipeline and lubrication points should keep free and limit switch acts accurately.

4.2.3 To check if the movement of sealing valve plate is accurate, the valve spherical disc can be opened and closed smoothly and ensure there is no leakage at sealing position in the process of test.

4.2.4 Adjusting speed of oil cylinder

Sealing valve open 4S

Sealing valve close 3S

Burden flow regulating valve full open 3S

Burden flow regulation valve full close 3S

4.2.5 Test of electrical control device of BFRV

—Keep BFRV in close status

—Rotate encoder to make scale get back to 0°

—Operate BFRV several times to test open position and close position

—Check 0°valve position till being adjusted to accurate position

—Fasten setscrew (coupler)

—Install proximity switch and adjust the distance of switch and sensor board to 8mm

—adjust BFRV in open or close position

—Operate BFRV several times to finally position the proximity switch

—Fasten setscrew

—When BFRV stay in close or open status, the proximity switch should accurately connect or shut off electrical signal

4.2.6 Electrical test of lower sealing valve

—Install proximity switch and adjust the distance of switch and sensor board to 8mm

—adjust lower sealing valve in open or close position

—Operate lower sealing valve several times to finally position the proximity switch

—fasten setscrew

—When lower sealing valve stay in close or open status, the proximity switch should accurately connect or shut off electrical signal

4.2.7 Test for lubrication system

The distributor of various lubrication points runs freely (piston rod up-down directional invert)

5. Maintenance, repair, safety technology

5.1 The following measures should be taken during inspection, maintenance or spare parts replacement in order to ensure no accident occurs in process of maintenance and repair.

—The equalizing circuit closed, relief circuit opened, relieve pressure of lower sealing combination

—Lower sealing valve opened, BFRV closed

—Cut off hydraulic system by stop valve

—Install dummy plate between lower sealing combination and bellow

5.2 The disassembly and assembly of lower sealing valve plate

—Open the maintenance gate of lower sealing combination and make the valve plate swivel to the side of the gate; cut off the hydraulic system.

—Hang the valve plate by manual hoist, then disassembly connection rod and bolts of valve assembly parts to take the valve plate out.

—Assembly of lower sealing valve plate is in reverse order.

5.3 The replacement of wear resistant tube of BFRV and the repair of BFRV spherical valve disc

—loosen the bolts of bellow, lower sealing combination and burden tank, try to press the bellow to make the gas between bellow and lower sealing combination keep 20-40mm

—Take out the lower sealing combination by manual hoist

—Replace wear resistant tube and repair the spherical valve disc of BFRV.

5.4 The lubrication system for lower sealing combination

Grease grade: ZL-00 lithium base lubrication grease (ambient temperature higher than 20℃)

Lubrication points of equipment: 12 points, adopt centralized lubrication, in which 2 points work every 4 hours, the other 10 points work every 12 hours.

Sr.	Lubrication position	Grease feeding Qty.	Frequency
1	Half shaft outer packing	2ml / time	1time / 12 hours
2	Half shaft bearing	2ml / time	1time / 12 hours
3	Half shaft inner packing	3.5ml / time	1time / 12 hours
4	Spline bush sliding bearing	3.5ml / time	1time / 12 hours
5	Spline bush inner packing	10 ml / time	1time / 4 hours
6	Spline shaft	10 ml / time	1time / 4 hours
7	Short shaft sliding bearing	3.5ml / time	1time / 12 hours
8	Tail shaft	3.5ml / time	1time / 12 hours
9	Tail shaft	3.5ml / time	1time / 12 hours
10	Half shaft inner packing	3.5ml / time	1time / 12 hours
11	Half shaft bearing	2ml / time	1time / 12 hours
12	Half shaft outer packing	2ml / time	1time / 12 hours

6. Regular inspection & repair

Sr.	Position	Checking item	Checking frequency
1	Lubrication	Working status of automatic lubrication system	1time / 8 hours
2	Lubrication distributor	If distributor changes feeding direction	1time / 8hours

3	Hydraulic system	Working status of hydraulic system	1time / 8 hours
4	Lower sealing valve	Open & close time of valve plate	1time / 24 hours
5	Lower sealing valve	Check abrasion situation of valve seat	1time / month
6	Lower sealing valve	Check bolts connection	1time / month
7	Lower sealing valve	Abrasion situation of valve plate	1time / month
8	Lower sealing valve	Sealing situation	1time / month
9	Lower sealing valve	Drive mechanism outside valve plate	1time / month
10	Lower sealing valve	Drive mechanism inside valve plate (crank, connection rod and pin shaft)	1time / month
11	Burden flow regulating valve	Abnormal noise	1time / 8 hours
12	Burden flow regulating valve	Open & close position	1time / hours
13	Burden flow regulating valve	Oil cylinder	1time / month
14	Burden flow regulating valve	Limit switch	1 time / month
15	Burden flow regulating valve	Encoder	1 time / month
16	Burden flow regulating valve	Wear resistant bush tube	1 time / month
17	Burden flow regulating valve	Abrasion of build-up welding of BFRV spherical disc	1 time / 2 month
18	Burden flow regulating valve	Checking bolts connection	1 time / month
19		Checking whole sealing situation	1 time / 24 hours

7. Trouble shooting

Sr.	Fault	Reason	Trouble shooting

1	BFRV leakage	Bolts of drive mechanism	Fasten bolts
		Abrasion of BFRV disc	Check BFRV disc
2	BFRV abnormal or hard movement	Hydraulic system	Check pressure Check hydraulic cylinder
		Bearing is damaged	Check lubrication situation Check bearing Change drive mechanism(spline shaft bush)
		BFRV is stuck by burden	Check BFRV disc
3	Limit switch does not work	Position of sensor plate of limit switch	Adjust position of sensor plate
		Cable line	Check cable line
4	The value of encoder is not accurate	encoder coupler setscrew is loose	Readjust & fasten bolts
		Big clearance of gears	Adjust mechanical parts
		Encoder	Check encoder
5	Gas leakage between valve plate and valve seat	Aging of silicon rubber seal of valve plate	Change rubber seal
		Abrasion of valve seat	Change valve seat
		Dislocation of valve plate and valve seat	Adjust position of valve plate
		Burden pile-up on the valve seat	Clean up valve seat
		Valve plate assembly and connection rod bolts	Check bolts and fasten it
6	Gas leakage through drive unit	Rubber seal of drive mechanism	Check lubrication situation Change rubber seal

7	Fault of swiveling and lifting movement of sealing valve	Centralized lubrication system Hydraulic system Half shaft assembly parts	Check the lubrication situation of crank, connection rod and pin shaft Check hydraulic system pressure Check half shaft assembly bearing
8	Lubrication distributor does not work	System pressure	Check system pressure Change distributor

8. Recommended spare parts

8.1 BFRV, oil cylinder of lower sealing valve

8.2 Assembly parts of sealing valve plate and rubber seal

8.3 Valve plate

8.4 Distributor of lubrication system

8.5 Sealing strip

Chapter 5 Bellow

1. Equipment usage brief introduction

The BF will deform owing to thermal expansion during operation (axial / radial), which will greatly influence the normal operation of BF top charging equipment. The function of bellow is to buffer deformation, absorb displacement and overcome the influence of deformation.

2. Technical parameters & specification

Working temperature: -20-400℃

Working pressure: 0.2MPa

Nominal diameter: 500mm

3. Structural features and working principle

The bellow is composed of stainless steel corrugated tube, protective tube, wear resistant liner, upper & lower flange and 3 adjustable threaded rod. The bellow can absorb the thermal deformation of BF. The protective tube can prevent the burden from breaking through the bellow. Wear resistant liner can guild the burden flow. The adjustable threaded rod may draw the bellow to expected length. The bellow will be depressed owing to thermal expansion of BF to absorb the thermal deformation of BF.

4. Installation requirement

The installation of bellow should be as per assembly diagram and the requirement of bellow installation instructions. Before installation, first check the dimensions and draw the bellow to expected length by adjusting the nut of threaded rod, then fasten the bolts, at last, loosen the adjusting nut.

The bellow is made of thin wall stainless steel, so damage prevention on corrugated tube should be done during transportation and installation, especially to prevent the welding arc from splashing to damage the corrugated tube during on site installation.

The foreign matters should be removed before installation to ensure the normal movement of bellow.

In order to keep the bellow in good working status, the deformation of bellow including axial, radial and torsion deformation can not be used to adjust the system installation tolerance.

5. Key points of maintenance

Check regularly if the connection bolts are loose and the abrasion situation of wear resistant bush.

6. Recommended spare parts

Wear resistant liner

Chapter 6 Burden distributor

1. Equipment usage brief introduction

BLT distributor lies on the crown of BF and welded on the crown ring. The distributor is directly exposed to the high temp. outgoing gas, normally BF top temp is about 200-300℃, in emergency situation the temp may reach 600℃ and even more. In order to protect distributor and make it work normally under the permissible range (under 50℃), cooling water and nitrogen auxiliary sealing are considered inside distributor.

The equipment is used to flexibly discharge burden as per process requirement in form of circular, spiral, sectional, point and central charging to discharge the burden to any area of BF throat section.

2. Technical parameters & specification

Central throat tube diameter: 500mm

Chute rotation speed: 0～9.8rpm

Chute tilting speed: 0～8°/s

Chute tilting angle working range: 0-45°（cover whole radius）

Chute length: 1600-1800mm

Cooling water consumption: 4-6m3/h

Nitrogen consumption: 40-200m3/h

Chute replacement angle: 25-30°

3. Structure and working principle

Burden distributor is the core equipment of the burden charging system.

The burden distributor is of round box structure. The upper part is burden guide tube connected with bellow through flange. The lower part is connected with crown ring through flange. The middle part is water cooling disc. There is a complex rotating & tilting chute under the burden guide tube located in the distributor center. The mechanism is made up of three parts i.e. fixing part, rotating part (β angle movement), lift up & down and tilting part (α angle movement).

The fixing part is mainly composed of central throat tube, upper rotation support bearing. There is wear resistant liner inside the central throat tube. The wear resistant liner is supported by the steel ring fixed at the bottom of central throat tube. The wear resistant liner has three parts on which there is hanging hole to facilitate installation.

The rotation parts is composed of drive device located on cam shaped top cover, small gear input shaft, upper rotating support with outside tooth, rotation drum, support ring and lower rotating support; The upper part of rotation drum is connected with outer ring of upper rotation bearing through flange by bolting and driven by it to rotate, the lower part of rotation drum is connected with lower rotation bearing through crank and trunnion by bolting.

The lifting up & down－tilting part is composed of outer drive system, support bearing system, support ring system and chute device; The burden discharge mode e.g the single ring or multiple ring is realized by chute rotation and tilting movement. i.e. β angle, α angle movement; The chute is hanged and stuck on the chute support frame and it connects crank

by spline shaft and it connects rotation drum by shaft sleeve; The rolling wheel of crank connects with trunnion which is fixed on the inner ring of lower rotation bearing; The outer ring of lower rotation bearing is fixed on the support ring driven by adjustable connection lever to do up & down reciprocating movement. Based on above mechanism, the chute can rotate as well as tilt ranging from 0°～45°driven by rotation drum. The reciprocating movement of support ring is made by two groups of symmetrical 4 connection lever driving mechanism.

The outer drive device of α angle movement is composed of servo motor, speed reducer and gear box mounted on the cover. Test device and encoder are set for α angle; The movement of β angle adopts cycloidal pin wheel speed reducer, Y series general electrical motor（VVVF motor is an alternative if required）.The test device and encoder of β angle is set on the top of burden distributor.

4. The requirement of installation, test and operation

4.1 Installation requirement

4.1.1 Check the allowable deviation of crown ring before installation, the following requirement should be met:

— Allowable horizontal deviation in diameter direction of flange;

4.1.2 Install seal on crown ring;

4.1.3 Hoist the burden distributor to BF crown before the above work is done or at the same time;

4.1.4 Lower the burden distributor and clean up the lower flange of burden distributor;

4.1.5 Install bolts when burden distributor is 30mm away from the crown ring, keep level and no horizontal movement;

4.1.6 Lower the burden distributor and cross fastening the bolts and use torque indicating wrench (torque 300N.m) to ensure even fastening;

Under below circumstances, refastening bolts are required:

—Before BF pressure test

—After BF heating

—After 2 days of BF operation

—During the first shutdown of BF

4.2 The requirement of test and trial running

4.2.1 Chute tilting angle (α angle) test lies in the main drive shaft on the top cover, speed ratio: 6:1, absolute value encoder is installed to feedback the signal to control the tilting movement of chute.

4.2.2 Chute horizontal rotation (β angle) test lies on the top cover, speed ratio: 1:1, proximity switch is set at the position of 0°to record rings of burden charging by program.

4.2.3 The test for proximity switch & encoder of chute tilting (α angle) and encoder of chute rotation (β angle) may refer to the test procedure of lower sealing combination.

4.2.4 The inlet of cooling water for distributor lies under the upper flange. The inlet flow of cooling water (flow meter is needed) should be controlled within 4-6m3/h. The outlet of cooling water for distributor lies above the lower flange and the water will be discharged through U type water sealing system.

4.2.5 Four nitrogen connection ports in total. 1 port in upper position and 2 ports in lower position are acting as auxiliary nitrogen sealing. The port in middle position is used to make up nitrogen for distributor box and its nitrogen flow should be strictly controlled.

4.2.6 Angle indication

The pointer and dial of chute tilting (α angle) is installed on the drive shaft. During test, pay attention to the consistency among pointer, the real tilting angle of chute and element or instrument indication of computer control center. During BF operation, the real angle of chute tilting can be seen from the outside dial at any time.

4.2.7 Lubrication system

Lubrication system works normally, each grease distributor (piston rod) acts normally.

5. Maintenance key points

5.1 Grease centralized lubrication system

Mainly refer to upper and lower rotation bearing.

The lubrication points are mainly on the lubrication pipe 1#, 4 grease feeding points for upper rotation bearing, 5 grease feeding points for lower rotation bearing. Grease feeding frequency: 1 time/4 hours, feeding Qty: 3.5-5ml/time.

Grease grade: ZL-00 lithium base grease (ambient temperature above 20℃)

5.2 The temperature of burden distributor

The temperature of burden distributor should be strictly controlled within 30-42℃ by

adjusting suitable consumption of nitrogen and cooling water.

6. Maintenance and repair

The maintenance and repair should be as per below procedure:

—BF blow-down

—Open the repair gate of burden distributor

—Check inner situation, mainly check if bolts are loosen, pin shafts are firm, the movement is stable.

—Check inner lubrication situation

—Add grease to inner manual grease feed points

—Clean up inside box

Regular check

Sr.	Position	Check items	Check frequency
1	Lubrication	Automatic lubrication system working situation	1time / 8 hours
2	Lubrication distributor	Check distributor directional invert situation	1time / 8 hours
3	α angle servo motor	Current	1time / day
4	β angle motor	Current	1time / day
5	Encoder, proximity switch	Check if loose	1time / week
6	Chute	Abrasion situation	1time / 2month

7. Equipment fault and analysis

Sr.	Fault	Reason	Method
1	slewing hard	Temp. over-high	Check water cooling and nitrogen system Automatic lubrication system Check water sealing system

		Upper & lower slewing bearing	Check the fixing situation of slewing bearing Check if slewing bearing has abnormal noise
		Horizontal drive	Check horizontal drive
		Horizontal drive speed reducer	Check horizontal drive speed reducer
		Electrical reason	Check electrical
2	Tilting hard	Stock level overhigh inside BF	Check stock level
		Electrical reason	Check electrical
		αangle gear box	Check lubrication situation of αangle gear box Check bearing of α angle gear box
		Pin shaft connection	Check if pin shaft is lost Abrasion situation of pin shaft
3	Gas leakage	Connection bolts The gland bush of packing	Check and fasten Press the gland bush tight
4	Distributor temp. increasing	Water cooling system U type water sealing unit breakdown Over high temp. inside BF	Check water cooling system Rebuild water sealing Take measures to lower the temp.
5	Abnormal noise	Movement not stable	Check inner situation

8. Chute replacement

The chute replacement tool is of an integral steel structure. The head of the tool is for holding the chute and the tail of the tool is counter weight, in the middle of the tool there is a hanging hole. At the end of the centerline there is a hanging ring which is to adjust the chute replacement angle. The tool itself has no drive device and depends on the hoist device such as electrical hoist or electrical sliding trolley) as main hoist and manual control on the replacement angle at the tail of the tool to carry out the chute replacement operation.

Chute replacement procedures are as follows:

8.1 BF blow-down;

8.2 Open chute replacement hole and observation hole;

8.3 Tilt chute to 25°, and at the same time put the chute on the chute replacement tool;

8.4 Then operate as per instructions of diagram;

9. U type water sealing device

The function of U type water sealing system is to seal the gas from the burden distributor and discharge the cooling water. Generally, the height difference is considered as per about 1.5-2 times the pressure of BF top. There is deposit tank at the bottom of the U type water sealing system equipped with water make-up valve, air discharge valve, drainage discharge valve etc. Regular drainage can be done during production frequency 1 time / day, when drainage, open horizontal valve and close vertical valve to discharge drainage, after drainage, open vertical valve and close horizontal valve.

U type water sealing unit checking:

Water outflow checking 1 time / 8 hours

Regular drainage, 1 time / 3-5 days is suggested（except for special situation）

The fault analysis of U type water sealing device:

Sr.	Fault	Reason	Trouble shooting
1	The flow of water not free	Gas in water large amount of consumption	Gas emission Adjust nitrogen flow
2	The outflow of water not stable	The inflow of water not stable	Take measures to stabilize the flow.
3	Gas off	Water seal breakdown	Rebuild water seal Procedures are as below: Open the valve under the deposit tank to relieve air and water, pay attention to safety during operation; Close valve of deposit tank, close the right side valve Open make-up water valve which may make up water to U type water sealing unit Make-up water level to burden distributor box Open the right side valve

10. Recommended spare parts

10.1 Servo motor

10.2 Chute rotation motor

10.3 α angle speed reducer

10.4 β angle speed reducer

10.5 Lubrication distributor

Chapter 7 Crown ring

1. Brief introduction of equipment use

Crown ring is the link of the BLT equipment and BF throat, the upper sealing side is the benchmark of the whole BLT equipment installation, so high standard is required on manufacture, inspection and installation.

2. Installation points

The main welding parts of BLT should be welded well before installation, such as chute inspection door, chute inspection hole, SLI interface etc.

Chapter 8 Operation instruction

1. Power

1.1 Electric

1.1.1 The motor power in this complete equipment are all AC 380V, installed capacity: chute β angle rotary motor 5.5KW, chute α angle motor 5.5KW, hydraulic system 22KW, lubrication system 1.1KW, and the operation system ≯0.8, the start frequency is designed according to different factories.

1.1.2 Basic type of Limit switch power is DC 24V.

1.1.3 The electric is confirmed according to the factory design.

1.2. Water

In normal production, water supply only used in distributor; the water supply pressure is the water supply pressure of upper flange surface of distributor add the highest BLT pressure, and add 0.1-0.3Mpa again, soften is not needed in normal, water temperature ≯40℃,cooling water quantity: 4-6m3/h.

1.3 Gas

The gas is mainly nitrogen, used foe auxiliary sealing of pressure equalizing, blowing of valve base and cooling in case of emergency.

Nitrogen pressure: 40-200m3/h

When the BLT temperature goes up abnormally in urgent situation, sealing valve set urgent interface.

2. Production operations

2.1 Charging Procedures and routing

As for the diagram of charging routing, please refer to attached drawing.

The diagram of charging routing has clearly defined the operation approaches. However due to the various requirements from clients, the charging procedures have not been prepared. Either through automatic control or manual operations, the operation approaches in this manual are of the same. The exact control measures can be designed by the client or the entrusted manufacturers.

2.2 Special Notes

2.2.1 The upper and lower sealing valve can be concurrently stay in closing position but not in open position. The inter locking of the two sealing valves depends on the perfectly closing position. That is, if one of them fails to be perfectly closed, the other valve will not receive electricity so as to ensure the normal working of the system in case of miss operations.

2.2.2 The details of the safety operations are in Safety Notes.

3. Distributing Procedure

3.1 When the burden receiving hopper is empty the stock stop valve will close. Following the burden selection program, bring the burden to the hopper with weighing device through the Skip or conveyor. When reaching the proper quantity, the signal will be sent out to stop

conveying burden. Then comes the burden selection procedure, record and display the message concerning the type and weight of burden in the hopper.

3.2 When the burden tank is empty, the burden flow regulating valve and lower sealing valve will close. Open the relieving valve to lower the pressure inside the burden tank to the level of atmospheric pressure and send the signal for the burden tank to receive the burden.

3.3 Open the upper sealing valve and stock stop valve to make the receiving hopper to discharge burden into the tank. When the hopper is empty, the right signal will be given and the stock stop valve and upper sealing valve will be closed. Then another signal will be sent out (May Repeat Procedure 1).

3.4 The above operations unless specially pointed out shall be interlocked with the burden feeding system.

3.5 When receiving the signal for closing of upper sealing valve, close the pressure relief valve and open the first pressure equalizing valve to increase the pressure to a stable value with semi-cleaned BF gas. Then close the first pressure equalizing valve and open the second pressure equalizing valve until the pressure inside the burden tank is equal to or higher than that of inside blast furnace and then close the second pressure equalizing valve and open the lower sealing valve.

3.6 If the burden line reaches a set value when charging is needed. Following the program to adjust the rotation α and β initial angle and control the rotation direction of β angle (positive or reverse). In line with the distribution mode (such as single, double and multiple ring shaped distribution, spiral shaped distribution or point distribution), adjust appropriately α angle. The order of operations is as follows:

3.7 Put the stock level indicator to the highest point, turn β angle to the set position and burden flow regulating valve to the set angle (γ angle), then start distributing burden in the furnace.

3.8 When the burden tank is empty, close the burden flow regulating valve (in closing operation, first open it to the maximum opening limit and wait for 3-5 seconds before closing it) the lower sealing valve. When corresponding signal is sent out, lower the stock rod. The burden distribution is over.

4. Basic interlocks

4.1. Stock stop valve

The condition for the opening of stock stop valve**:**

The upper sealing valve is in opening position.

The condition for the closing of stock stop valve:

Interlock is not in use.

4.2 Upper sealing valve

The condition for the opening of the upper sealing valve:

Closing of stock stop valve

Closing of pressure equalizing valve

Closing of lower sealing valve

The pressure relief valve is opened and the pressure in the burden tank reaches the atmospheric level (as indicated by pressure sensor)

The conditions for the closing of upper sealing valve:

The closing of stock stop valve

The burden tank is not overfilled.

4.3 Lower sealing valve

The conditions for the opening of lower sealing valve:

The closing of upper sealing valve

The closing of pressure relief valve

The pressure in the burden tank is equal to or slightly higher than that in the furnace (as indicated by the pressure sensor.)

The conditions for the closing of lower sealing valve:

The closing of burden flow regulating valve (γ=0)

4.4 Burden flow regulating valve

The conditions for the opening of burden flow regulating valve (γ)

The opening of lower sealing valve

The stock rod is not in the furnace (on the upper limit)

The chute is rotating

The tilting angle of the chute is right and reaches the correct position

The conditions for the closing of burden flow regulating valve (γ)

Reception of signal indicating that there is no burden.

The burden flow regulating valve (γ) is opened to the largest limit (as indicated by position sensor)

4.5 Pressure relief valve

The conditions for the opening of relief valve:

The closing of pressure equalising valve

The closing of the lower sealing valve.

The conditions for closing the pressure relief valve

The inter lock is nor in use.

4.6 Pressure equalizing valve

The conditions for the closing of pressure equalizing valve

The closing of pressure relief valve

The closing of upper sealing valve.

The condition for the closing of pressure equalizing valve

The interlock is not in use.

5. The arrangements of alarm points

In the case of the following conditions there will emit alarm signals and the following operations will suspend for handling. The alarm shall be in the form of Audio and visual.

5.1 Stock stop valve, upper sealing valve, lower sealing valve, first pressure equalizing valve, second pressure equalizing valve, pressure relief valve, or emergency pressure relief valve, has not been opened or closed for a prolonged period of time. (The designated time duration is to be determined.)

5.2 The burden flow regulating valve has nor opened or closed to the designated position for a prolong period of time. (The designated time duration is to be determined).

5.3 After the burden receiving hopper finish discharging to the burden tank for some time, the stock level indicator still shows “Empty”. (The designated time duration is to be determined).

5.4 After the burden tank finish distributing inside the furnace for some time, the stock level indicator still shows “Not Empty”. (The designated time duration is to be determined).

5.5 The pressure equalizing valve emits alarm when the designated pressure has not reached within the designated time. (The designated time duration is to be determined).

5.6 The pressure relief valve emits alarm when the pressure has not reached zero within the designated time. (The designated time duration is to be determined).

5.7 α angle emits alarm when it does not reach the right position within designated time. (The designated time duration is to be determined).

5.8 β angle emits alarm when it does not reach the right position within designated time. (The designated time duration is to be determined).

5.9 The stock rod emits alarm when it fails to reach to the right position within designated time. (The designated time duration is to be determined).

5.10 Alarm for the wring burden selection procedure is to give out when the selection information from the charging system is not in line with the requirement for step operation of the system.

5.11 The failure of dry-oil lubricating system. (Signal from lubricating system).

5.12 When temperature of the burden distributor is higher than 70 ^{0}C, alarm will be sent out for the high temperature in the furnace top. (Not interlocked with the program).

6. Drive source parameters and signal source of actuators

NO.	Name	Drive source	Voltage/oil pressure	Power/ Flow rate	Action time	digital/analog signal source	Switch signal source
1	Stock stop valve	Oil cylinder	8 MPa	50L/min	Open 2S		Proximity switch
					Close 3S		Proximity switch
2	Upper sealing valve	Oil cylinder	8 MPa	50L/min	Open 4S		Proximity switch
					Close 3S		Proximity switch

3	γangle burden flow regulating valve	Oil cylinder	8 MPa	50L/min	Open 3S	EAC58C10-GP6PPDR-1024BT	Proximity switch
					Close 3S		Proximity switch
4	Lower sealing valve	Oil cylinder	8 MPa	50L/min	Open 4S		Proximity switch
					Close 3S		Proximity switch
5	Achute	Servo motor P60B18550	～200V	5.0kw	Upper limit	EAC58C10-GP6PPDR-1024BT	Proximity switch
					Lower limit		Proximity switch
6	βrotary	Motor Y132S-4	～415V	5.5kw	0°angle	EAC58C10-GP6PPDR-1024BT	Proximity switch
7	Hydraulic station	asynchronous motor	～415V				
8	Bleeding valve	Oil cylinder	8 MPa	50L/min	Open 2.5s		Proximity switch
					Close 2s		Proximity switch
9	Primary pressure equalizing valve	Oil cylinder	8 MPa	50L/min	Open 2.5s		Proximity switch
					Close 2s		Proximity switch
10	Burden tank pressure sensor					PMC133IZ-1B1F2562T2	
11	Distributor pressure sensor					PMC133IZ-1B1F2562T2	
12	Distributor temperature sensor					WZP-240	
13	Burden tank stock level indicator					PULS68	

STATISTICS OF ANALOG QUANTITY		
No.	Name	Source of signals
1	Burden Tank Pressure	instrument
2	Furnace Top Pressure	instrument
3	Gear Box Pressure in the burden distributor	instrument
4	Gear Box Temperature in the burden distributor	instrument
5	Cooling Water Pressure in the Gear Box of the Burden Distributor	instrument
6	Cooling Water Flow in the Gear Box of the Burden Distributor	instrument
7	Temperature of the Inlet Cooling water of the Gear Box of the Burden Distributor.	instrument

8	Temperature of the Outlet Cooling water of the Gear Box of the Burden Distributor.	instrument
9	Nitrogen Flow in the Gear Box of the Burden Distributor	instrument
10	Nitrogen Flow Pressure in the Gear Box of the Burden Distributor	instrument
11	Nitrogen Flow Temperature in the Gear Box of the Burden Distributor	instrument

STATISTICS OF DIGITAL QUANTITY		
No.	Name	Source of signals
1	A angle detection	absolute encoder
2	B angle detection	absolute encoder
3	Γ angle detection	absolute encoder

STATISTICS OF DIGITAL QUANTITY		
No.	Name	Source of signals
1	Stock stop valve open	Limit switch
2	Stock stop valve close	Limit switch
3	Upper sealing valve open	Limit switch
4	Upper sealing valve close	Limit switch
5	Burden flow regulating valve open	Limit switch
6	Burden flow regulating valve close	Limit switch
7	Lower sealing valve open	Limit switch
8	Lower sealing valve close	Limit switch
9	Primary pressure equalizing valve open	Limit switch
10	Primary pressure equalizing valve open	Limit switch
11	Secondary pressure equalizing valve open	Limit switch
12	Secondary pressure equalizing valve close	Limit switch
13	Bleeding valve open	Limit switch
14	Bleeding valve close	Limit switch
15	Accident bleeding valve open	Limit switch
16	Accident bleeding valve close	Limit switch
17	Stock level indicator full	stock level indicator instrument
18	α angle zero limit	Limit switch
19	α angle upper limit	Limit switch
20	β angle zero level（0^0）	Limit switch
21	β angle middle level（180^0）	Limit switch

7. Safety cautions

7.1 HYWZ-C BLT charging system belongs to BF gas equipment, the application of which shall abide by the stipulations in GB 6222-86 safety Regulations for BF gas in industrial enterprises.

7.2 If there is fire during the equipment inspection, application should be submitted to relevant department for fire permit.

7.3 Prior to equipment inspection the ambient atmosphere shall be taken for analysis at various platforms where BLT equipments locate. If the operators have to enter, first flush the equipment and then analyse the gas inside the equipment. Entrance of personnel is not permitted unless the gas is found to be safe and during the process of inspection, necessary monitoring is needed.

7.4 During equipment inspection and before resuming production after inspection- flushing has to be performed. Before opening the flushing valve, first open pressure relief valve. If steam is used as the flushing medium, the water discharging valve shall also be opened. At the end of the flushing, keep the upper sealing valve open for 3 minutes so as to leave no dead angle. Both flushing and relief shall be adequate. When steam is used for flushing, the period of time 10 minutes longer than with that with nitrogen as the flushing medium. In winter especially in Northern areas, the flushing time shall be prolonged considering the ambient temperature.

7.5 When flushing during inspection is over, open the manhole of the sealing valve and keep the pressure relief valve of the burden tank in opening position to ensure the smooth air circulation.

7.6 When the inspection is over- the manhole shall be sealed and air shall be flushed. If steam is used as the medium, before opening the pressure equalizing valve neither the flushing valve nor the pressure relief valve can be closed in case that there may be some accidents resulting from the negative pressure caused by condensation of steam.

7.7 During inspection the tools and devices that are likely to generate sparks shall not be used and measures shall be taken to eliminate sparks. For example in dismounting chute some measures shall be taken to avoid bumping and get rid of the sparks.

7.8 The inspection of the equipment on the various platforms of the furnace top shall not take place in the evening or night. If such inspection is necessary the projector for light shall meet relevant requirements.

7.9 In case of thunder and rain storm no maintenance and repairing is allowed on the furnace top.

7.10 During inspection a blind plate shall be put between the burden distributor and the flange of the bellows. The blind plate shall be qualified. That is between two rings flat plate wound by asbestos cord insert a steel plate that is smooth on the edges without any defects such as burr, scar or sand hole. Never insert a randomly found steel plate.

7.11 The thickness of the steel plate used as blind plate shall be strong enough to with stand 0.05 MPa for high pressure furnace top and 0.03 MPa for normal pressure furnace top even during the delay of the blast furnace.

7.12 All the platforms where the furnace top equipments located belong to the dangerous area of BF gas. Therefore appropriate measures shall be designed to prevent poisoning accidents during maintenance and repairing, such as equipped with respirator and supervisors especially during the inserting and removal of blind plate.

7.13 Where non-conductive sealing gasket is used to separate two facilities (including pipelines) the bridging of conducting wire is needed so as to ensure any part of the equipment or any section of the pipeline has satisfactory grounding. If the bridge wire is broken during inspection, reconnect the wire after inspection and before resuming operation.

7.14 During inspection the furnace top charging system shall not be used as grounding pole for electric welding. A separate wire connecting to the earth shall be attached to the parts to be welded.

7.15 When flushing is over take off the steam flushing joint, which shall not be kept to prevent the negative pressure from condensation from mixing with BF gas.

7.16 As for the items that are not included in this section all the clients shall follow the safety regulations in their own companies.

Chapter 9 Main attentions

1. Cooling water quantity

1.1 Crown ring water quantity: 4-6 m^3/h (crown ring without water cooling is not needed)

1.2 Distributor water quantity: 4-6 m^3/h

Attentions: flow meter must be installed in inlet pipeline and the water quantity should be controlled strictly.

1.3 Other water of distributor: 3-5m^3/h

Attentions: inlet water pressure 0.6MPa, used for normal detection.

2. Nitrogen quantity

2.1Nitrogen quantity for distributor

There are four points of nitrogen interfaces in distributor: 1 in upper part, 1 in middle and 2 in lower part. Flow of nitrogen in upper and lower part: 100-150m^3/h (sealing auxiliary), flow of nitrogen in middle: 5-10m^3/h (used in balance).

Note: the min. nitrogen quantity of distributor is 40m^3/h. (Middle interface)

2.2 Nitrogen quantity for upper and lower sealing combination

The nitrogen quantity for upper and lower sealing combination is 5-10 m^3/h (sealing in auxiliary shaft end) , urgent nitrogen interface is set in lower sealing combination and will open when the furnace temperature is abnormal (automatic adjusting valve is suggested).

3. Distributor temperature

The temperature of distributor should be controlled in 30℃-40℃ (higher in summer), if abnormal situation happen, it should be deal immediately.

4. Equipment lubrication

Lubricating should be kept well in normal situation, avoiding the equipments run in abnormal situation. Oiling and checking should be done regularly.