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Research Article

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Innovative Super Steel Belt Technology and its Application in the Drying and Treatment of Iron-bearing Waste Ash in Baosteel Zhanjiang lron & Steel Co., Ltd

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1. Introduction

During the ironmaking, steelmaking and steel rolling processes, steel enterprises generate a large amount of solid waste including iron, zinc, dust (ash) and mud, accounting for about 10% of the total steel production [1]. These solid wastes mainly include fly ash or sludge of blast furnace and rotary hearth furnace and some steel rolling sludge. The traditional way is to recycle these sediment (ash) as ingredients and return them to sintering, achieving internal recycling and utilization within the enterprise. However, some of the ash contains high levels of harmful elements such as zinc and lead. Directly returning to the batching process will cause zinc and lead to continuous circulation and enrichment in the system, resulting in excessive loads of zinc and lead in blast furnaces, which seriously affects the safety, stable production, and equipment life of steelmaking enterprises.

In recent years, with the frequent occurrence of haze weather and increasingly stringent environmental emission requirements, environmental protection has become a consensus of the whole society. It has become increasingly difficult for steel enterprises to entrust external units to dispose of the above solid wastes [2]. In order to achieve the secondary recycling of these solid wastes, it is usually preferred to build a rotary hearth furnace production line, which removes and recovers harmful elements such as zinc, lead, potassium and sodium in dust (ash) mud and then returns these products to production for recycling or sells them to other companies, achieving good environmental and social benefits.

In the process of treating the above-mentioned iron-bearing solid waste in the rotary hearth furnace, the uniformly mixed material obtained by strong mixing is subjected to the wet balls produced by the ball making or ball pressing equipment and its moisture content is generally 10 -17%. Before entering the rotary hearth furnace, the moisture content of the dry balls of the material is required to be less than 2% [3]. Therefore, in order to ensure that the moisture content of the dry balls of the material meets the production technical requirements of the rotary hearth furnace, the drying of the wet balls becomes an important part in the rotary hearth furnace production line.

2. The Current Status of Wet Balls Drying Technology for Rotary Hearth Furnaces in Steel Enterprises

At present, the wet balls (bulk material) drying equipment used in the rotary hearth furnace production line of steel enterprises is mainly mesh belt dryer and chain grate dryer. The flue gas flow of mesh belt dryer is as follows: The flue gas generated by the wet balls drying flue gas furnace at around 350 ℃ is blown to the top of the bulk material by several thermal circulation fans installed at the top. After the flue gas passing through the bulk material layer, the temperature of the flue gas will decrease accordingly. After the bulk material layer cools down, a part of the exhaust flue gas will return to the fan for use as cold air, while the other part of the cooled flue gas will be discharged into the atmosphere after dust removal through the main induced draft system. At the same time, during the forward movement of the wet balls, it is necessary to avoid rapid heating that may cause the wet balls to break or tend to break. The temperature gradually increases, and the amount of exhaust flue gas added needs to be adjusted according to the temperature requirements at different positions. The biggest drawback of this flue gas system is that the wet flue gas continues to be used as cold air, and the moisture content in the flue gas gradually increases. The ability of the hot flue gas to take away moisture is getting worse and the wet balls drying effect is also getting worse. Eventually, the moisture content of the wet balls after drying is greater than 2% and the finished product pulverization rate increases. Simultaneously causing an increase in the length and height of the bottom of the rotary hearth furnace and the pulverization rate of the finished product. Overall, the mechanical structure of this type of mesh belt dryer is unstable, the equipment is lightweight, the failure rate is high, the mesh belt is replaced once a year, and the wet flue gas in the air system is recycled back and forth, making it impossible to discharge water vapor. The wet balls drying effect is poor. Under positive pressure of the equipment, there is a large amount of dust on site. At the same time, there is a risk of high temperature flue gas overflowing and injuring workers [4-6].

The flue gas process of the chain grate dryer is as follows: the flue gas generated by the furnace for wet ball drying at around 350 ℃ enters the square flue gas hood at the top of the chain grate dryer through the flue gas main pipeline. The flue gas passes through the wet balls and the grate plate of the chain grate dryer in sequence. The flue gas is collected by the high-temperature section air collection main pipeline and enters the multi-tube dust collector. After dust removal, the flue gas is induced by the high-temperature circulating fan and enters the low-temperature blast drying section. The low-temperature flue gas passes through the grate plate of the chain grate dryer and the wet ball material before entering the exhaust gas main pipeline. It is then discharged to atmosphere after passing through the bag filter to meet the dust removal standards. The chain grate machine is composed of transmission device, running parts, frame, upper cover, air chambers, shovel plate, inspection door, slide plate and grease centralized lubrication system and other main components. The chain grate dryer is a heavy mechanical equipment, and its air system and material return system are complicated. In addition, the equipment is heavy and the installation period is long [7-11]. The investment in the wet ball drying system is huge.

In view of the current status of wet ball material drying technology in the steel industry, in 2020, Beijing National Power Boyuan Environmental Protection Equipment Co., Ltd. and Baowu Group Environmental Resources Technology Co., Ltd. jointly developed a new drying technology that is compatible with the rotary hearth furnace for phase II of solid waste disposal center project in Baosteel Zhanjiang lron & Steel Co., Ltd. In order to better adapt to the requirements of rotary hearth furnace production for wet balll moisture, it can also reduce equipment investment, reduce the difficulty of equipment installation and maintenance, improve equipment stability, and improve the controllability of the flue gas system.

3. Technical Conditions for Phase II solid Waste Disposal Center Project in Baosteel Zhanjiang lron & Steel Co., Ltd

3.1 Process Conditions [12]

No.	Item Description		Unit	Type and Parameters
1	Materials	Material name		Iron-bearing waste ash briquet wet ball
2		Feed material size	mm	32x25x15
3		Bulk density	t/m^3	1.3-1.6
4		Initial moisture content of material	%	14-16
5		Heat source		Hot air furnace provides ~350℃ flue gas
6		Material distribution device		Swinging distributor + vibrating screen + wide belt
7	Handling capacity		t/h	>40
8	Production work system			24h continuous work
9	Control mode			Automatic control, continuous production
10	Ambient temperature		℃	0～40
11	Power supply			380V 50Hz

Table 1: Process Conditions

3.2 Technical Specification [12]

No.	Item Description	Unit	Type and Parameters
1	Effective width of super steel belt	mm	2000
2	Effective length of super steel belt (with hot air circulation section)	mm	39600
3	Length of the head and tail pulleys of the super steel belt	mm	54750
4	Layer number of super steel belt	Layer	1
5	Moisture content of pellets before drying	%	14-16
6	Moisture content of pellets after drying	%	≤2

7	Drying cycle	min	30(20-40)
8	Working speed of conveyor belt	m/min	0.5-2.2
9	Using temperature	℃	~325
10	Design temperature	℃	350
11	Load-bearing capacity of the super steel belt	kg/m^2	>500
12	Material thickness	mm	150-260
13	Sidewall height	mm	≥180
14	Inlet hot air temperature	℃	350
15	Inlet hot air volume	Nm^3/h	Around 75000
16	Internal circulation fan	Set	12
17	Exhaust volume	m^3/h	200000
18	Exhaust temperature	℃	≤130

Table 2: Technical Specification

3.3 Material Composition [12]

Item	Fe	SiO_2	CaO	Al_2O_3	MgO	P_2O_5	Cl
Total	40.65	2.49	7.60	1.11	2.24	0.17	0.24
Item	S	Zn	Na_2O	K_2O	Pb	C	Cr
Total	0.19	1.61	0.23	0.27	0.08	12.05	0.00

Table 3: Material Composition

3.4 Flue Gas Composition [12]

It is estimated that the flue gas temperature entering the equipment is less than 350℃ and the exhaust temperature is ≤130℃.

Composition	CO_2	H_2O	N_2	O_2	**Others**
Content (%)	18-30	3-8	60-70	3-10	**microscale**

Table 4: Flue Gas Composition

4. Process Flow of the Super Steel Belt Drying System of Phase II Solid Waste Disposal Center Project in Baosteel Zhanjiang Iron & Steel Co., Ltd

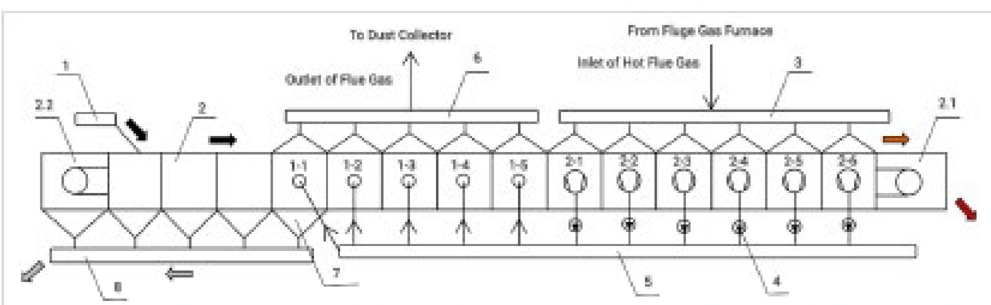

Figure 1: Process Flow of Super Steel Belt Drying System

1. Material Distribution Device 2. Super Steel Belt Dryer 2.1 Discharge End of Super Steel Belt Dryer 2.2 Dryer Inlet End of Super Steel Belt 3. Main Pipeline of High Temperature Flue Gas 4. Circulation Fan 5. Main Pipeline of Circulating Flue Gas 6. Main Pipeline of Low Temperature Flue Gas 7. Fine Material Collection Hopper 8. Material Return Rubber Belt 9. Low Temperature Drying Zone 1-1, 1-2, 1-3, 1-4, 1-5 10. High Temperature Drying Zone 2-1, 2-2, 2-3, 2-4, 2-5, 2-6

After the iron-bearing ash solid waste of Baosteel Zhanjiang Iron and Steel Co., Ltd. is briqueted, the wet balls are evenly distributed to the effective width of the entire super steel belt dryer (2) through the distribution device (1) and the feeding end of the super steel belt dryer. The super steel belt carries the wet ball material and slowly moves through the low temperature drying zone and the high temperature drying zone.

The heat source flue gas from the hot blast furnace first enters the high temperature drying zone (2-1 to 2-6) through the high temperature flue gas main pipeline (3) and the flue gas hood under the action of the circulating fan (4) and passes through the super steel belt and the wet ball material layer from top to bottom to dry and dehydrate the wet balls. After being dried, the qualified dry balls enter the rotary hearth furnace through the discharge end at head side of the super steel belt dryer (2.2) through the vibrating feeder.

After the heat exchange in the high temperature drying zone, the heat source flue gas carries the evapoured steam under the power of the circulating fan (4) and enters the low temperature drying zone (1-1 to 1-5) of the super steel belt dryer through the circulating flue gas main pipeline (5). Under the joint action of the upstream circulation fan (4) and the downstream induced draft fan, the flue gas passes through the super steel belt in the low temperature drying zone and the wet ball material layer on its upper part from bottom to top, and the wet ball material is heated and dried at low temperature. After the heat exchange, the low temperature flue gas passes through the upper flue gas hood and the low temperature flue gas main pipeline and enters the subsequent dust removal device and finally achieves standard emission.

The powdery materials scattered at the bottom of the super steel belt dryer (2) are collected into a plurality of powdery material hoppers (7) at the rear of the dryer by a cleaning device (not shown), and then transported to the upstream briquetting process via the material return rubber belt (8) at the bottom.

5. System Composition and Core Technology of the Super Steel Belt Dryer for Phase II Solid Waste Disposal Center Project in Baosteel Zhanjiang lron & Steel Co., Ltd

The super steel belt dryer system of phase II of solid waste disposal center project in Baosteel Zhanjiang lron & Steel Co., Ltd. consists of the dryer head drive section, tail tension driven section, low temperature drying zone, high temperature drying zone, heat source flue gas circulation fan, heat source flue gas pipeline, dust removal device, induced draft fan, material return equipment and control system, etc.

5.1 Core Technology of the Super Steel Belt Dryer

The core technology of the super steel belt dryer is a uniquely designed super steel belt, which is composed of a heat-resistant, wear-resistant, double wound reinforced balanced steel wire mesh belt and metal carrying plates (designed with ventilation holes) on them, connected by a number of secure bars and screws. The super steel belt is designed to operate stably under harsh working conditions such as high temperature and heavy impact loads, without the risk of sudden shutdown. Due to the special hinge connection technology between the super mesh belt and the ventilated carrying plates, the components of the super steel belt can expand freely in any direction under high temperature conditions without thermal deformation.

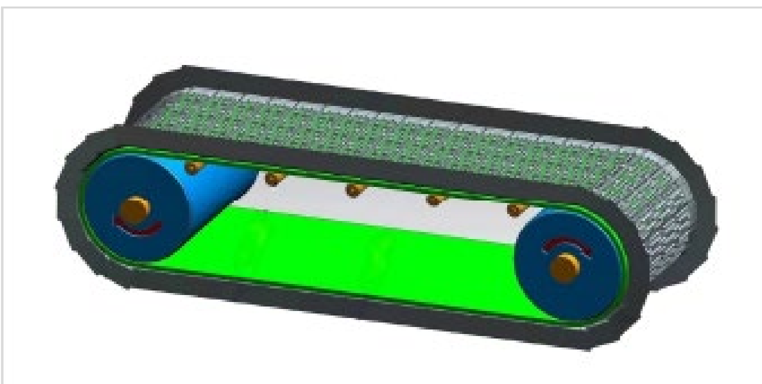

Figure 2: 3D Picture of Super Steel Belt (with Ventilation Holes)

The upper side of the super steel belt that carries the wet ball waste material is supported by a number of carrying idlers arranged throughout the entire width of the dryer. It can carry the waste material on the upper part of the super steel belt and its own weight. All the bearing blocks and bearings of the idlers are designed and installed on the outside of the dryer shell, which effectively avoids overheating of the bearings and facilitates grease filling and inspection and maintenance.

The lower return side of the super steel belt is supported by return and Anti-sagging middle supporting idlers. The super steel belt dryer transmits driving force through the friction between its super mesh belt and the head driven drum. At the same time, the tensioning pneumatic cylinder or hydraulic cylinder at the tail of the dryer maintains the tail drum and its super steel belt at a constant set tension through the dryer tensioning control box, ensuring that the super steel belt automatically and freely expands and extends in the hot state, and automatically and freely contracts in the cold condition, avoiding slipping of the super steel belt [13].

The running speed and residence time of the water-containing wet ball waste material on the super steel belt carrying plate of the dryer can be adjusted by the variable frequency speed regulating motor of the super steel belt drive unit, so as to realize the efficient removal of wet ball moisture and achieve the ideal drying effect. The super steel belt dryer is a high temperature heat transfer equipment, and its shell is designed and installed with heat insulation materials. During the transportation of the wet ball on the carrying plates of super steel belt, there is no relative movement between the material and the carrying plates, so the wear of the super steel belt is minimal, and the secondary crushing of the wet ball material during the drying process is effectively avoided.

5.2 Required Heat Calculation for Iron-Bearin Ash Drying Process of Super Steel Belt Dryer

5.2.1 Known Parameters

No.	Description	Parameters
1	Weigh of iron-bearin ash (Drying capacity per hour)	M_b=40 ton
2	Initial temperature of iron-bearin ash	T_0=30°C
3	Initial moisture content of iron-bearin ash	W_{in}=16%
4	Moisture content after drying	W_{out}=2%
5	Iron-bearin ash temperature after drying	T_1=130°C
6	Specific heat of iron-bearin ash	Cp=460 J/kg•K
7	Calculation pressure	P=0.1MPa
8	Working time	T_w=1 hr

Table 5: Known Parameters

5.2.2 Calculation of Required Heat

5.2.2.1 Required Heat Consumption for Drying and Evaporating Water

No.	Description	Calculation
1	Evaporated water	$M_{w1} = M_b \bullet (W_{in} - W_{out}) = 5.6\times10^3$ kg
2	Initial water enthalpy	H_0= 125.73 kJ/kg
3	Outlet steam enthalpy	H_1= 2736.70 kJ/kg
4	Heat used to dry and evaporate water	$Q_1 = M_{w1} \bullet H_1 - M_{w1} \bullet H_0 = 1.462\times10^7$ kJ

Table 6: Heat Consumption Calculation for Drying and Evaporating Water

5.2.2.2 Required Heat Used by Water in Iron-Bearing Ash

No.	Description	Calculation
1	Amount of water in iron-bearing ash	$M_{w2} = M_b \bullet W_{out}$ = 800 kg
2	Outlet water enthalpy	H_2= 546.38 kJ/kg
3	Heat used by water in iron-bearing ash	$Q_2 = M_{w2} \bullet H_2 = 4.371\times10^5$ kJ

Table 7: Required Heat Calculation Used by Water in Iron-Bearing Ash

5.2.2.3 Heat Absorption of Iron-Bearing Ash

No.	Description	Calculation
1	Solid content of iron-bearing ash	$M_{Fe} = M_b \bullet (1 - Win - Wout) = 3.28\times10^4$ kg
2	Heat absorption of iron-bearing ash	$Q_3 = M_{Fe} \bullet C_p \bullet (T1 - T0) = 1.509\times10^6$ kJ

Table 8: Heat Absorption Calculation of Iron-Bearing Ash

5.2.2.4 Drying Equipment and Environment Radiation Heat Exchange

No.	Description	Calculation
1	Height of drying equipment	Height = 2.6m
2	Width of drying equipment	Width = 2.6m
3	Length of drying equipment	Length = 54.75m
4	Drying equipment area	S_{dryer} = 2(Height Width)•Length + 2•Height•Width =582.92 m^2
5	Ash hopper area	S_{hopper}= 15 [2•(3.6m+0.5m)•1.8m/2 +2•(2.6m+0.5m)•1.8m/2] =194.4 m^2
6	Pipeline area	$S_{pipeline} = \pi \bullet 1.3m \bullet (21.6m+18m+35m) = 304.672m^2$
7	Total area	$S_{total} = S_{dryer} + S_{hopper} + S_{pipeline} = 1.082\times10^3\ m^2$

8	External surface temperature	T_{surf} = 324 K
9	Ambient temperature	T_{envi} =293 K
10	Blackbody radiation coefficient	C_0 = 5.67 W/m^2 • K^4
11	Emissivity	ε1=0.8
12	Radiant heat dissipation	$Q4=\varepsilon 1 \bullet C_0 \bullet S_{total} [(T_{surf}/100)^4 - (T_{envi}/100)^4 \bullet T_w = 6.21 \times 10^5$ kJ

Table 9: Radiant Heat Dissipation Calculation

5.2.2.5 Convective Heat Exchange Between Drying Equipment and Environment

No.	Description	Calculation
1	Surface heat transfer coefficient	α = 8.141 W/M^2 •K
2	Convection heat transfer	$Q_5=\alpha \bullet S_{total} \bullet (T_{surf} - T_{envi}) \bullet T_w = 9.513\times10^5$ kJ

Table 10: Convective Heat Exchange Calculation

5.2.2.6 Leakage Heat

No.	Description	Calculation
1	Initial air leakage temperature	T_{leak} = 20
2	Air leakage rate	η_{leak} =10%
3	Leakage high temperature enthalpy	$Iout_k = 0.1Vy \bullet Ct_k (T_{out}) = 1.292\times10^6$ kJ
4	Leakage initial enthalpy	$Iin_k = 0.1Vy \bullet Ct_k (T_{leak}) = 1.86\times10^5$ kJ
5	Leakage heat	$Q^6 = Iout_k - Iin_k = 1.105\times10^6$ kJ

Table 11: Air Leakage Heat Calculation

5.2.3 Calculation Results-Total Required Heat Consumption

No.	Description	Calculation
1	Heat consumed by water	$Q_{total1}=Q_1+Q_2= 1.506\times10^7$ kJ
2	Heat consumed by iron-bearing ash and others	$Q_{total2}=Q_3+Q_4+Q_5+Q_6= 4.187\times10^6$ kJ
3	Total required heat consumption	$Q_{total}=Q_{total1}+Q_{total2}= 1.925\times10^7$ kJ

Table 12: Calculation of Total Required Heat Consumption

5.3 Design and Verification Calculation of the Key Component of Super Steel Belt Dryer - Ultra Long Carrying Idler

For the technology of super steel belt, the widest super steel belt currently in operation in the world has a limited width of 1.6 meters. How to ensure that the deflection of the middle part of the carrying idlers is less than 5mm under high temperature and heavy material load conditions, and the drying output of the super steel belt is not less than 40 t/h, while reducing the air leakage rate of the dryer equipment body under the 350℃ high flue gas temperature environment and the maximum operating speed of 2.2 m/min for phase II solid waste disposal center project in Baosteel Zhanjiang lron & Steel Co., Ltd., and the super steel belt has a width of 2m, poses a huge challenge in terms of technology. Therefore, it is necessary to optimize the traditional carrying idlers structure and conduct finite element analysis and verification under thermal and full load conditions.

The new type of ultra-long and high strength carrying idler device with self-sealing function in this project can meet the requirements of large-span through a split design. The sealing component is set on the connecting shaft group, which can rotate and slide relative to the sealing component. At the same time, the sealing component can seal the conveyor shell. When the hollow idler deforms due to thermal expansion and contraction, the connecting shaft groups at both ends can translate on the supporting component to adapt to the deformation of the hollow idler. At the same time, the sealing component can always maintain the sealing state of the dryer shell, thereby reducing the air leakage rate of the super steel belt dryer, improving the drying effect of wet ball materials on the super steel belt, reducing electricity and heat energy consumption, and effectively reducing production costs [14].

5.3.1 Load Calculation

No.	Description	Calculation
1	Width	Width = 2 m
2	Length	Length = 2.4 m
3	Unit weight of mesh belt	w_{mesh}= 253 kg/m
4	Load carrying capability of mesh belt	wFe = 600 kg/m^2
5	Weight of mesh belt	W_{mesh} = length * Wmesh = 607.2 kg
6	Weight of material	W_{fe} = width*length*wFe = 2.88x10^3 kg
7	Total weight	W_{total}= W_{mesh}+W_{Fe} = 3.487x10^3 kg
8	Quanity of carrying shaft	Num = 4
9	Load of carrying shaft	Wp=Wtotal/num = 871.8 kg
10	Weight of idler	Ws = 90 kg
11	Total load of single load	Load = (Wp+Ws)/2 = 480.9 kg

Table 13: Load Calculation of Ultra-long Carrying Idler

5.3.2 Calculation Settings

Shaft length of carrying idler: 2548mm; Shaft diameter: 45mm; Load points: 2; Load per load point: 5000N; Calculate temperature at 350 ℃

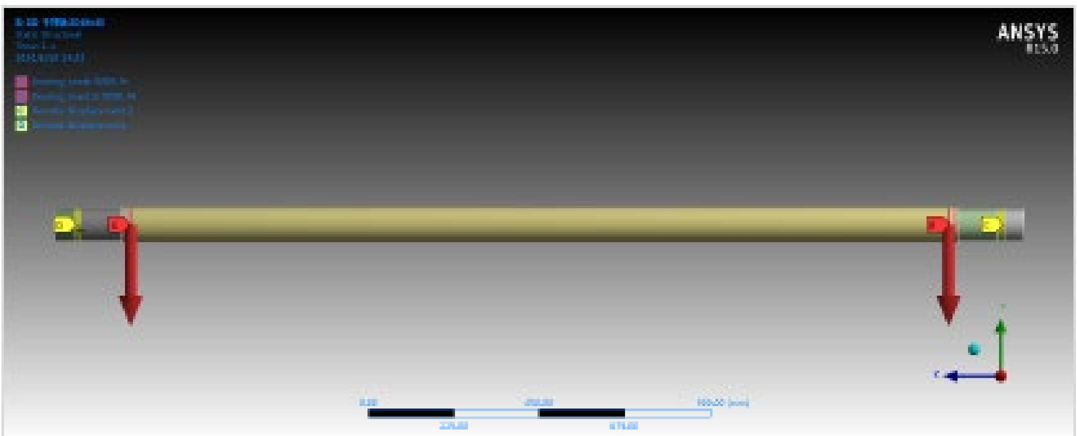

Figure 3: Finite Element Analysis of Carrying Idler

5.3.3 Calculation Results

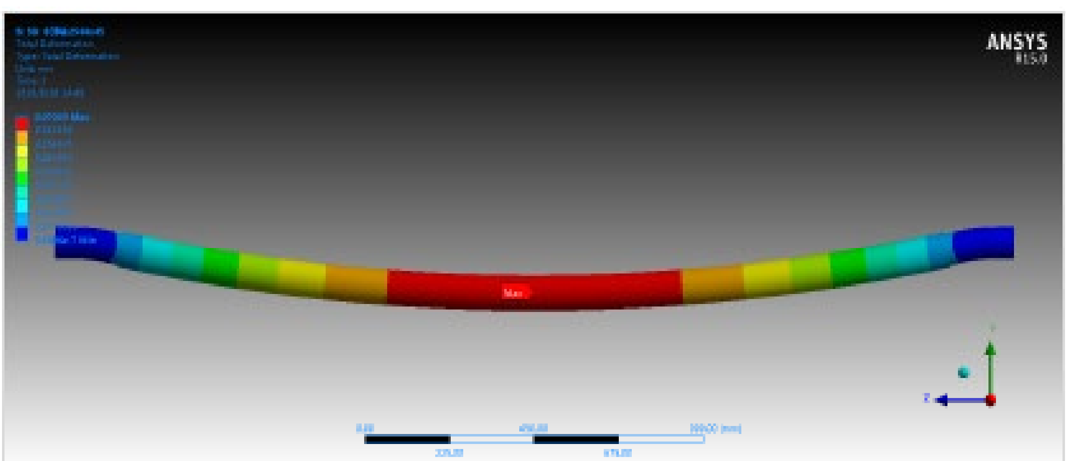

Figure 4: Total Deformation of Finite Element Analysis of Carrying Idler

The maximum deformation occurs in the middle of the shaft is 0.07mm

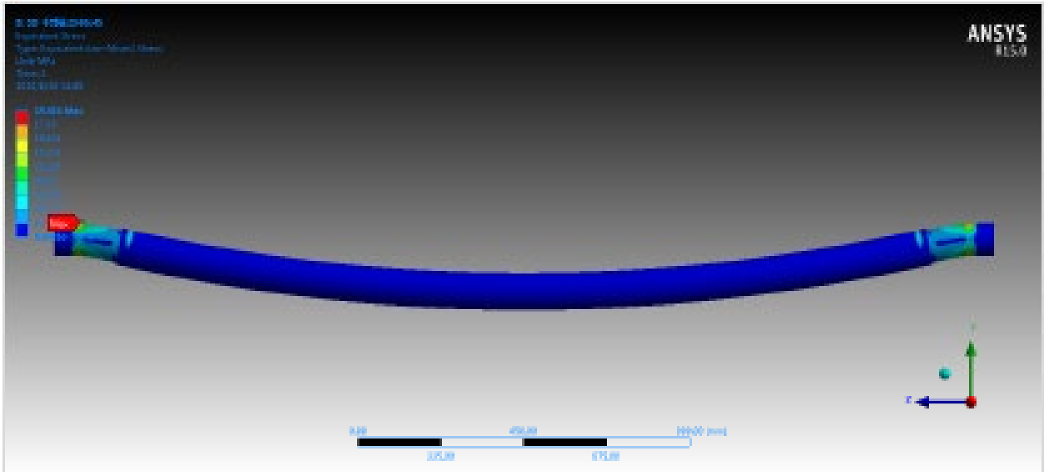

Figure 5: Equivalent Stress of Finite Element Analysis of Carrying Idler

The maximum equivalent stress occurs at the bearing positions at both ends, which is 19.86MPa

5.3.4 Verification Results

The material used to carrying idler shaft in this project is 40Cr, which has a better mechanical properties at high temperatures, with a yield strength of 625 MPa at a temperature of 400℃.

Heat Treatment	Test Temperature（℃）	σ0.2	σb	σs	ψ	ak (J/cm2)
		MPa		%		
Oil quenching at 820 ∽840 ℃ Tempering at 550 ℃ for 3 hours	20	805	955	13.0	55.5	85
	200	720	905	15.0	42.0	120
	300	695	895	17.5	58.5	
	400	625	700	18.0	68.0	100
	450	550	600	18.5	75.5	
	500	440	500	21.0	80.5	80

Table 14: High Temperature Mechanical Properties

The calculation results show that 19.86 MPa<625 MPa meets the static strength requirements.

6. Technical Characteristics of the Super Steel Belt Dryer for Phase II Solid Waste Disposal Center Project in Baosteel Zhanjiang lron & Steel Co., Ltd

6.1 A unique super steel belt structure was adopted in phase II solid waste disposal center project in Baosteel Zhanjiang lron & Steel Co., Ltd. Due to the lack of relative motion between the wet ball material and the super steel belt, the wear of the super steel belt is very small, and the stability of the equipment is greatly improved. And because all the rotating components are installed on the outside of the dryer body, the maintenance and repair workload required for the super steel belt dryer is very low, and all routine maintenance work can be carried out during the operation of the equipment.

6.2 The super steel belt drying technology provides an innovative and energy saving drying method for the rotary hearth furnace. The system adopts multiple circulating fan flue gas system configurations, and the control of the heat source flue gas system is more reasonable. During the production process, the operating parameters of each fan can be adjusted according to the amount of wet ball waste material. Each circulating fan can adjust and match the flue gas amount separately through frequency conversion, achieving optimization of the wet ball drying curve and better drying effect. At the same time, the full utilization of heat source flue gas has been achieved, reducing the energy consumption of the entire production process, minimizing the pollution and safety issues caused by the leakage of heat source flue gas, and better adapting to the requirements of downstream rotary hearth furnace production for material moisture. At the same time, the controllability of the flue gas system and the stability of the dryer have been improved.

6.3 The super steel belt dryer adopts a segmented control process for drying flue gas (high and low temperature drying zones), and each drying chamber body is controlled by a separate fan to accurately control the temperature curve, resulting in better wet ball drying effect.

6.4 The super steel belt dryer is equipped with multiple circulating fans and flue gas systems, which is more conducive to repair and maintenance works. When a single circulating fan fails, it can be disconnected for online maintenance. The drying process and effect of wet ball can be adapted to production needs by adjusting other circulating fans, thereby achieving fine and intelligent control of the entire drying system, improving the overall equipment availability, and ensuring continuous and stable production of the rotary hearth furnace.

6.5 The rotary hearth furnace of phase II solid waste disposal center project in Baosteel Zhanjiang lron & Steel Co., Ltd creatively adopts a full boiler form to increase steam recovery, reduce the amount of cold air added, and introduce some of the low rank flue gas that needs to be discharged at around 150 ℃ into the super steel belt dryer as a heat source, achieving a large amount of energy recovery [2].

7. Operation Effect of Super Steel Belt Dryer System at Phase II Solid Waste Disposal Center Project in Baosteel Zhanjiang lron & Steel Co., Ltd

The super steel belt dryer system at phase II solid waste disposal center project in Baosteel Zhanjiang lron & Steel Co., Ltd. was officially put into operation on April 22, 2021. It has been running safely and stably for nearly 42 months. The moisture content of the solid waste dry balls discharged from the head of the super steel belt dryer is less than 2%, and the drying effect is excellent. The specific effects are as follows:

7.1 Compared with chain grate dryers and mesh belt dryers, rhe super steel belt dryer system at phase II solid waste disposal center project in Baosteel Zhanjiang lron & Steel Co., Ltd. has more complete heat exchange. Under the same conditions of flue gas temperature and flow rate, it can replace the heat source flue gas temperature from 250 ℃ at the inlet to 100 ℃ at the outlet (or even lower).

Figure 6: Operation Picture of the Super Steel Belt Dryer System at Phase II solid Waste Disposal Center Project in Baosteel Zhanjiang lron & Steel Co., Ltd

7.2 Baosteel Zhanjiang Iron and Steel Co., Ltd. Phase II adopts an innovative super steel belt wet ball drying system, which better meets the requirements of wet ball moisture in rotary hearth furnace production, reduces the direct investment and accessory equipment investment of the rotary hearth furnace wet ball drying system, and the total investment in the overall system and construction cost has been reduced from about 2.99 million USD to about 1.37 million USD, with an overall investment reduction of about 50%.

7.3 The super steel belt dryer system at phase II solid waste disposal center project in Baosteel Zhanjiang lron & Steel Co., Ltd. adopts labyrinth and flexible sealing technology to optimize the internal structure of the dryer, effectively control the overall equipment air leakage rate, and ultimately achieve a reduction of 70,000 m^3/h in drying flue gas volume and 100 kW in circulating fan power, saving 75.5×10^4 kW•h of electricity annually, with an annual energy saving cost of 104,584 USD.

7.4 The phase II of Baosteel Zhanjiang Iron and Steel Co., Ltd.'s solid waste wet ball super steel belt dryer adopts modular design. The intermediate standard sections of the dryer and its connection with the upper flue gas hood and lower ash hopper are connected by bolts, sealing gaskets, etc., which improves the airtightness of the equipment, reduces the installation difficulty of the equipment, and greatly reduces the on-site installation and welding workload. The entire system installation period has been shortened from the traditional 90 days to about 25 days, and the construction period has been shortened by 70%.

7.5 There is no other conveying equipment between the wet ball drying system of Baosteel Zhanjiang Iron and Steel Co., Ltd. Phase II super steel belt and the upstream distributor. The number of wet ball drops has been reduced from 3 to 1, and the drop height has been reduced from a total height of 3m to 1m. The pulverization rate of finished dry balls has been reduced from 20% to 25%, and the comprehensive energy consumption has been reduced by 20% [15].

8. Future Prospects of Super Steel Belt Dryer Technology in Solid Waste Treatment Fields Such as Iron Ash and Zinc Ash etc

8.1 With the advancement of society and technology, fully utilizing energy and reducing pollutant emissions have become one of the main problems facing by the steel industry. In addition, the environmental standards for the steel industry are becoming increasingly strict worldwide, and the demand for the treatment of solid waste such as iron ash and zinc ash in steel enterprises is growing day by day.

8.2 The dust ash and solid waste in the steel and metallurgical industries have the characteristics of multiple types, large quantities, complex compositions, and difficult drying [16]. However, traditional mesh belt and chain grate drying processes have problems such as low output, poor drying effect, unstable equipment operation, high failure rate, expensive repair and maintenance costs, and huge system investment.

8.3 From the nearly 42-month operation practice of the phase II super steel belt dryer at Baosteel Zhanjiang Iron and Steel Co., Ltd., after continuous research and improvement, the super steel belt dryer technology has the characteristics of high drying efficiency, low energy consumption of the entire production process, high overall equipment availability, high controllability and stability of the drying system, low investment, and low repair and maintenance costs.

Against the backdrop of the Chinese government's proposal for carbon peak and carbon neutrality, and drawing on the successful experience of Baosteel Zhanjiang Iron and Steel Co., Ltd.'s Phase II super steel belt drying technology, vigorously promoting and applying this new type of solid waste wet ball drying technology is of great significance for the steel industry to further improve energy conservation and emission reduction effects.

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