SINOSTEEL ENGINEERING TECHNOLOGY NEWS LETTER

2020

A Giant Step Forward: The Tosyali Steel Complex is empowered with up-to-date technologies and cutting-edge equipment

High Quality Development: Grow through technology-driven innovation

A GIANT STEP FORWARD

Beyond Expectations

SINOSTEEL

As a core subsidiary of Sinosteel Group Corporation and a listed company (stock code: 000928), Sinosteel Engineering & Technology Co., Ltd. (abbr Sinosteel E & T) is a leading industrial engineering company focusing on industrial engineering and service, civil engineering and investment, energy saving and environmental protection, safety and protection as well as high-tech businesses.

Adhering to the principle of sustainable development and innovation-driven growth, Sinosteel E&T provides outstanding complete process and life-cycle service, as well as all-in-one solutions to partners around the globe. Meanwhile, with continuous input into technological innovation and research, Sinosteel E&T has made multiple breakthroughs in both process innovations & disruptive technologies in various fields, pacing up its speed to become a world-renowned company offering smart services that is highly-efficient, digital, safe and green to both customers and the society.

In a world of greater intelligence, flexibility and cost-effectiveness, bearing pioneer spirit, Sinosteel E&T will fully leverage all resources of Industry 4.0 to achieve sustainable development and provide more customer-oriented, versatile and value-adding services.

Industrial Engineering & Services

As Sinosteel E & T's wholly owned subsidiary, Sinosteel Equipment & Engineering Co., Ltd. (abbr Sinosteel MECC) is capable of industrial general contracting covering diversified areas including metallurgy, mining & mineral processing, coal chemical, energy & infrastructure. By accomplishing over 500 national key projects for giant steel producers, Sinosteel MECC has made outstanding contributions to the development of China's steel industry. With business footprints in more than 40 countries, Sinosteel MECC has also gained excellent reputation in overseas engineering market.

While having been ranked ENR's Top 250 International Contractors and Top 250 Global Contractors lists for consecutive years since 2008, the company hit a new high by ranking No.107 in 2019. Riding the tide of industry 4.0, Sinosteel MECC has achieved breakthroughs in multiple self-developed technological innovations, such as Travelling Grate Iron-Ore Pelletizing (TGIOP), TMCP for Long Product, 7.5m Top-charging Coke Oven Battery, which have played significant roles in leading the technology of relevant metallurgical process.

Environmental Protection

Sinosteel Tiancheng Environmental Protection & Technology Co., Ltd (abbr Sinosteel Tiancheng), a subsidiary of Sinosteel E&T, is a front runner in developing green solutions for iron and steel makers. Boasting of two national technology centers and one workstation for academicians of the Chinese Academy, Sinosteel Tiancheng has built a great number of model projects. At present, while working on its 7th national R&D program, the company is engaged in smart environmental solutions for industrial parks.

SINOSTEEL E&T:
" Beyond Expectations "

Health, Safety & Protection

Sinosteel Wuhan Safety & Environmental Protection Research Institute Co., Ltd. a subsidiary of Sinosteel E&T, focuses on providing professional HSE consulting services & solutions and helping partners to reach the goal of an accident-free workplace. Possessing rich experience in risk management and control, the company excels in basic research and technology. Currently, Sinosteel SEPRI is working on new way of 'Double-I', Integrated & Intelligent safety management platform for industrial parks.

Intelligent Manufacturing

Tianyu Intelligent Manufacturing Co. Ltd., a high-tech joint venture invested and founded by Sinosteel E&T, focuses on metal 3D-printing and parts repairing. Its core independently developed tech, casting forging-milling composite (CFMC) additive manufacturing, has made unprecedented progress in terms of shortening manufacturing process, increasing efficiency and saving cost. By adopting the technology & collaborating with world-renowned conglomerates both home and abroad, the company has paved the way for streamlined and green manufacturing.

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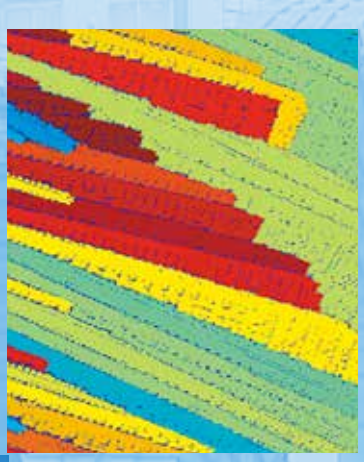

Cover Story

Welcome to Sinosteel E&T Newsletter, Issue 2020.

We are very pleased to announce that our very first steel complex built in Africa for Tosyali has started production and been running smoothly so far. The Tosyali steel complex is empowered with the latest integrated technologies and cutting-edge equipment, achieving an environmental-friendly and energy-saving production of high quality finished products at optimum transformation costs.

01

Cover Story

Tosyali / Algeria

The new DRI based integrated mini mill complex

COVER STORY

BEYOND EXPECTATIONS: SINOSTEEL E&T BUILT A STATE-OF-THE-ART INTEGRATED STEEL COMPLEX FOR TOSYALI IN ALGERIA

1x pellet plant

4Mtpa

1x DRI **2.5Mtpa**

In November 2018, a new steel plant complex undertaken by Sinosteel Engineering & Technology Co., Ltd. (abbr. Sinosteel E&T) for Turkish based Tosyali group was completed in Oran, Algeria.

The plant, including a pellet plant, a direct reduced iron (DRI) plant, a steelmaking plant, a continuous billet caster plant and two high-speed rebar rolling mill, is one of the largest steelworks ever built in North Africa.

Back in 2014, the year following ***China's Belt & Road Initiative (BRI)*** unveiled, Tosayli Group decided to build a new plant to support the booming construction industry of the region and exploit the advantages of local energy availability and raw material resources. After several rounds of bidding, the cotract was finally awarded to Sinosteel E&T, a leading Chinese company of industrial engineering, technology and service, on a EPC-basis including Project Management, Plant Engineering, Procurement and Manufacturing, Civil Works, Erection and Commissioning.

Steelmaking plant

2.3Mtpa

Continous casting plant

2.15Mtpa

2x Rolling mills **750'000tpa** **I'200'000tpa**

PLANT OVERVIEW

The new steel complex consists of:

- One pellet plant with 4 Mtpa capacity
- One DRI plant with 2.5 Mtpa capacity
- One steelmaking plant with 2.3 Mtpa capacity
- One continuous casting plant for billets with 2.15 Mtpa capacity
- Two rolling mills for long products with 750,000 tpa & 1,200,000 tpa capacity

as well as all auxiliary plants as:

- One 400kV main substation
- One SVC power compensation station
- Two limekiln plants
- Two oxygen stations
- Fume dedusting plant
- Water treatment plants
- Workshop and laboratories
- Compressed air station
- Raw water station.

Some Key Milestone Data

	Pellet Plant	DRI Plant	Steelmaking Plant
Start civil works	Feb. 2017	June 2016	May 2016
Start erection	May 2017	June 2017	Nov. 2016
Start production	Nov.2018	Nov. 2018	Dec. 2017

Sinosteel E&T was responsible for the complete turnkey supply of the whole steel plant complex including all main technological production units, the auxiliary plants, all infrastructure and civil works, as well as the installation and start-up of the plant. At the same time, Sinosteel E&T adopted all the latest technologies and state of the art equipment available in steelmaking, continuous casting and rolling of long products. The logistical organization and project management of the project was a huge challenge for the entire team in view of the demanding time schedule for the successful implementation of the project.

COVER STORY

THE COMPLEX IS EQUIPPED WITH THE MOST MODERN TECHNOLOGIES AND STATE-OF-THE-ART EQUIPEMENT

Pellet Plant

The 4Mtpa pellet plant project adopts the world-class travelling grate iron ore pelletizing (TGIOP) technology, which has been independently developed by Sinosteel E&T. The project construction covers an entire process of transporting iron ore concentrate from the wharf to the output of finished pellets. As a major part of the whole integrated steel plant, the pellet project, commenced on Feb. 9th, 2017 and put into operation on July 31st, 2018, has been producing high-quality DRI pellets consistently. With stable operation and high product quality, energy consumption and pollutant emissions reaching advanced world standards, the project has become a model plant in North Africa and even in the entire Mediterranean coast, and has been widely praised.

DRI Plant

The 2.5Mtpa DRI project is the world's largest single DRI production line, and also the first DRI production line of joint efforts: built by Chinese, adopting the American Midrex gas-based reduction process. Construction of the project started in May 2016 and operation in November 2018.

It has been running smoothly up to now. The work scope of Sinosteel E&T includes EPC of non-core areas, supply and construction of steel structure, pipelines, fittings and valves in core areas.The main function of core area is to reduce pellets to direct reduced iron and reducing gas. Major workshops or buildings include reduction furnace, thermal DRI transfer system, natural gas reforming furnace, heat exchange system, combustion fan room, fan room for process gas compression, clarification tank, cooling tower and pumping station, as well as water treatment plant, chemical storage room, sedimentation tank, natural gas processing system, wet dust extraction system and main control building. The non-core area mainly covers oxidized pellet stockyard, pellet screening chamber, pellet storage bunker, pellet coating system, cold DRI passivating room, cold DRI storage chamber, dry dust extraction system, wet dust extraction system, machine maintenance workshop, spare parts workshop, pump station, electrical substation, vestibule and forwarding station.Despite of complicated project management and heavy construction work, Sinosteel E&T has given full play to its advantages and completed installation on time, guaranteeing both quality and quantity, and well received by the customer.

Steelmaking plant

The Steelmaking plant includes one 240t electric furnace (EAF transformer, 240MVA), one 240t ladle furnace (LF transformer, 52MVA), one set of raw material processing system (MHS) for electric furnace and ladle furnace (the main raw materials for steelmaking are 100% H/ CDRI) and one 8-strand continuous casting machine (CCM), of which the casting section is 180x180 mm (section range: 150x150 ~ 200x200mm), specified lengths is 12m, and arc radius R=10.25m. Among them, the EAF designed capacity ranks second over the world currently, with the largest unit production capacity.

Industrial support facilities include 1x15,000 Nm3/h+1x6,500 Nm3/h oxygen production station (OPS), one set of steelmaking water treatment plant (WTP), one dust extraction system (FDP), one compressed air station (C.A.S) and raw water treatment system (O.P.WTS), one SVC system (SVC), one lime plant (LP) and one Lime Kiln & Coke Powder Plant. Main products of the workshop are high-quality alloy structural steel, building steel, and ordinary carbon structural steel. Both of the DRI plant and pellet plant are located in its front section with two bar mills following them. This project is one of the most comprehensive projects in terms of metallurgical system construction.

Beyond Expectations

Being Sinosteel E&T's very first overseas DRI plus EAF mini steel mills, the Tosyali steel complex is empowered with the latest technologies & cutting-edge equipment, realizing an environmental-friendly and energy-saving production of high quality finished products at optimum transformation costs.

After its completion, the plant has become a symbol of the successful and long-standing cooperation between Tosyali group and Sinosteel E&T, an embodiment of win-win collaboration guided by "Beyond Expectations", the company's motto. The fulfillment of the project has proved that Sinosteel E&T is not only a total and sustainable solution provider but also a strong and reliable partner. While the project becoming an epitome in Africa, prospect for more accomplishments by Sinosteel E&T is very promising.

Beyond Expectations

UPON COMPLETION, THE NEW PLANT HAS BECOME ANOTHER EXAMPLE OF LONG-STANDING COLLABORATION

Rolling Mills

The two high-speed rebar mills are featured by the latest generation of equipment and advanced rolling technology for the efficient and flexible production of straight bars for the construction industry. The rolling mills are directly connected to the continuous casting plant for optimum hot charging conditions to ensure high mill productivity and energy saving. Rebar Mill 1 is designed to produce 12-32 mm rebar and 18-32 mm round bar with a capacity of 1,200,000 tons per year. Rebar Mill 2 is designed for the production of 8-12 mm rebar with a capacity of 750,000 tons per year. Each of the mill is equipped with modern walking beam furnaces.

Each of the rolling mills consists of 18 housingless stands in HV arrangement plus 2 high-speed twist-free-finishing blocks. The rolled stock is split in two separate bars in the intermediate mill and then fed to the two finishing blocks. With this arrangement, high-speed finishing rolling is performed on two independent strands for the complete size range, which improves the reliability in the rolling process as well as product quality and tolerances. In-line water quenching and self-tempering of rebar is performed by two water cooling lines located at the exit of finishing blocks. This enables the production of high-tensile /high-ductile rebar using low-carbon steels as starting material instead of micro-alloyed grades with considerable savings in transformation costs.

The rebar is produced at a maximum rolling speed of 40 m/s. A HSBD High Speed Bar Delivery system delivers the bars via rotating channels to the cooling bed, where they are smoothly braked down and delivered into the rake notches of the 108m-long rake type cooling bed. At the end of the cooling bed, the bars are collected in layers and transported to a cold shear for dividing into sales length of 6 to 12m. State-of-the-art bar collecting, short bar separation, bundling and tying facilities complete the bar mill production cycle and provide a high-quality bundle, ready for shipment.

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> *"State-of-the-art bar collecting, short bar separation, bundling & tying facilities complete the bar mill production cycle and provide a high-quality bundle, ready for shipment."*

1

2

3

1. Mr. Wang Jian (l) Mr. Fuat Tosyali (m) Mr. Lu Pengcheng (r) attending the completion ceremony
2. Ribbon cutting
3. Continuous casting
4. High-quality rebar in production

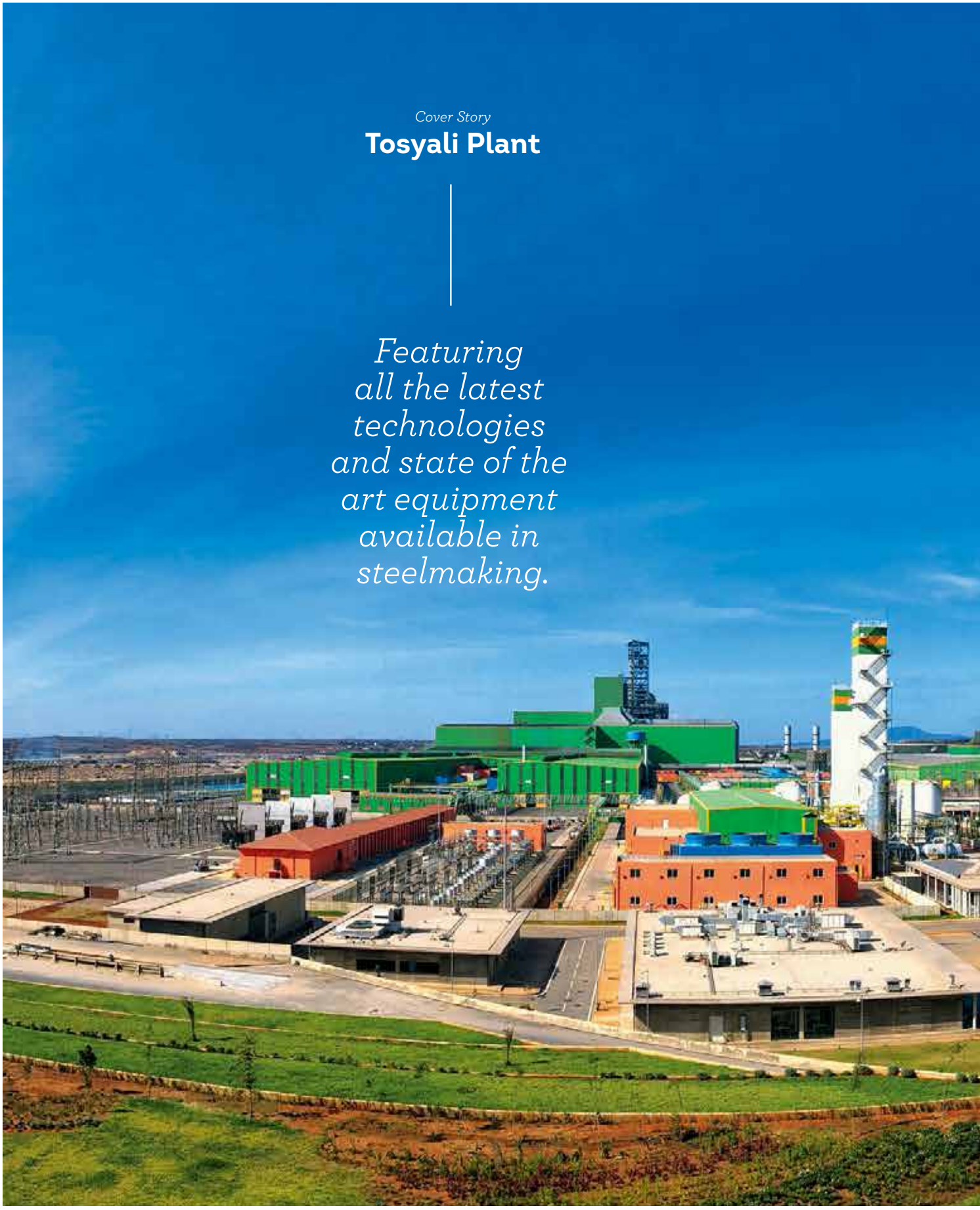
4

COVER STORY

Cover Story

Tosyali Plant

Featuring all the latest technologies and state of the art equipment available in steelmaking.



Beyond Expectations

photo credit: Christopher Burns

Company Headlines

Thanks to our strong track records and support of our customers, we harvested many new contracts & deals last year. The record high awards and honors are not only the recognition of our achievements but also incentives for us to move forward.

"On US Engineering News-Record (ENR) list of 2019 Top 250 International Contractors, Sinosteel MECC hit a new high by ranking No.107."

02

Headlines

NEW DEALS

01.

Tosyali Selected Sinosteel MECC For Its 4Mpta Beneficiation Plant Project

On Jan. 4, 2019, Sinosteel Equipment & Engineering Co., Ltd. (abbr Sinosteel MECC), a wholly-owned subsidiary of Sinosteel Engineering & Technology Co. Ltd. entered into an EPC contract with Tosyali Iron & Steel Industry Algeria SPA(abbr Tosyali) on its 4Mtpa beneficiation plant project in Oran, Algeria, with an estimated construction period of 15 months.

The scope of the project, covering the extension of B0 belt conveyor from PT1 transfer station to the newly-built BT1 transfer station, mainly includes raw material bins, ore grinding, screening, thickening system, filter press shop, utility and auxiliary facilities. The whole project is designed with a flexible process appropriate for grinding-separation of hematite & magnetite of various particle sizes and grades, thus saving the cost of raw materials considerably.

The project broke ground on October 26, 2019. By the end of 2019, the equipment of the main plant building and the first batch of steel structures had arrived at the site, and the civil concrete casting had been completed by 65%.

Sinosteel MECC collaborated with Tosyali as early as 2008 and has built a number of projects for Tosyali since then. It also boasts a wealth of project experience in Algeria, including Tosyali's 2.3Mtpa Steel Complex Project, BPM's Tubular Belt Conveyor Project as well as one of the world's largest direct reduction iron (DRI) plants.

02.

To Build a 2x480m² Sinter Plant for Shandong Iron & Steel Group

In March 2019, Sinosteel Equipment & Engineering Co., Ltd. (abbr Sinosteel MECC) signed a contract with Shangdong Iron & Steel Corporation Laiwu Branch (abbr SDIS Laiwu) on its EPC Project of Comprehensive Upgrading of Sintering System. According to the contract, Sinosteel MECC is responsible for the construction of large-scale environment-friendly, energy-saving and high-efficiency sintering machines and supporting facilities such as flue gas desulfurization and denitration,environmental dedusting system and utilities. The project consists of two 480m² sintering machines, a supporting fuel warehouse, finished product screening building, etc., with an estimated construction period of 13 months.

As one of the first batch of projects of SDIS Laiwu for system optimization and upgrading, the sintering plant was also Jinan Province's early kick-off construction in 2019.

NEW DEALS

03.

On April 25, 2019, at the Belt and Road CEO Conference of the Second Belt and Road Forum for International Cooperation, Sinosteel Engineering & Technology Co. Ltd. (abbr Sinosteel E&T) and Mongolia's Tsetsens Mining and Energy LLC (abbr TME) signed an EPC contract on the integrated coal & power project in Bulunjvte, Mongolia.

The Agreement with Bulunjvte, Mongolia Reached

The project mainly includes the construction of 2x150MW coal-fired power stations, 69km power transmission and transformation lines as well as supporting highways, railways and other infrastructures. Sinosteel MECC a wholly-owned subsidiary of Sinosteel E&T, would be in charge of the design, procurement and supply of equipment & materials, engineering construction, equipment installation & commissioning services, with an estimated construction period of 36 months. Listed by Mongolian Government among its National Strategic Development Projects (2018-2023), the successful construction and operation of the project will greatly ease the shortage of electricity in Mongolia and is of vital significance for increasing tax revenue and employment in Mongolia. TME, a wholly-owned subsidiary of BODI Group in Mongolia, engages in international trade, development & operation of mineral resources as well as construction and operation of a 600MW thermal power plant.

04.

To Supply a 2x265m^2 Sintering System & Stockyard for Shiheng Special Steel

In May 2019, Sinosteel MECC and Shiheng Special Steel Group Co., Ltd. entered into an EPC contract on a sintering system and stock yard project, with a scope covering the construction of two 265m^2 sintering production lines and a fully enclosed environment- friendly stock yard handling 24M/t of raw materials annually. According to the contract, the stock yard is expected to be put into production in August 2020, and Phase I and Phase II of the sintering system in September and October 2020 respectively.

Situated in Tai'an, a city of Shandong Province, Shiheng Special Steel is an integrated steel complex comprising of coking, iron making, steel making, steel rolling, power generation, machinery manufacturing and steel logistics.

05.

To Build a 2.5Mtpa Mixed Coke Oven Gas Heating System Project for MMK

On June 25, 2019, Sinosteel MECC and Magnitogorsk Iron and Steel Works (MMK) signed an EPC contract on a 2.5Mtpa mixed coke oven gas heating system. The project is scheduled to be completed in two phases, of which the first planned to be put into operation in 30 months and the second in 42 months. This is the 4th project of MMK undertaken by Sinosteel MECC as an EPC contractor since 2014. Previous collaborations between the two companies include sintering flue gas desulfurization, sintering and coking projects.

MMK, established in 1929, is one of Russia's largest steel conglomerates, having a complete production line from mining to metal processing.

06.

To Supply Blower House Project For Isdemir

On September 5, 2019, Sinosteel MECC a wholly-owned subsidiary of Sinosteel E&T, reached an agreement with Erdemir Group, Turkey's largest steel maker. According to the agreement, Sinosteel MECC is responsible to supply design and equipment of a new blower house for the 3,000 m^3 blast furnace at Isdemir Steel Plant, Erdemir Group's subsidiary in Iskenderun, including steam turbines, axial flow fans and supporting facilities. The project is expected to be in

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^ 05.

operation in September 2021 Sinosteel MECC has ushered in extensive cooperation with Erdemir Group in the field of metallurgical engineering since 2006. Sinosteel MECC has successfully completed multiple metallurgical engineering projects of blast furnace, coking, steelmaking, and etc. for Isdemir and Eregli Steel Plants, and have also been highly evaluated and recognized by Erdemir Group for its excellent engineering quality, high efficiency & outstanding customer service.

07.

Entering into a Contract with Wesizwe on the 1Mtpa Platinum Processing Plant Project in South Africa

07.

"In view of our friendly cooperation over the past years, Sinosteel MECC and Erdemir had become old friends with each other. Thank Erdemir for handing over the house blower project to us. I believe, it not only shows our mutual trust, but is also a sign for broadening our cooperation in the near future." Said Mr. Hua Guanglin, Deputy GM of Sinosteel E&T.

On September 25, 2019, Sinosteel MECC, a wholly-owned subsidiary of Sinosteel E&T and South Africa's Wesizwe Platinum Limited reached an agreement in Beijing on the 1Mtpa Platinum Processing Plant Project located in Bakubung, South Africa. Situated in Rustenburg, Northwest Province of South Africa, the project is expected to start operation in May 2021, with Sinosteel MECC being an EPC contractor. During this key meeting, Lu Pengcheng, the Deputy General Manager of Sinosteel Corporation and Chairman of Sinosteel E&T, underscored the importance of the project by stating that it marks not only a good start for cooperation between the two sides, but also an important step of Sinosteel E&T entering the South African market. "With open communication, flexibility and reliability, Sinosteel E&T will be dedicated to a highly efficient and successful project management and execution," said Mr. Lu also indicated that South Africa, richly endowed in natural and human resources, was a vital market for the company's business development of overseas mineral resources and engineering technology, and he looked forward to advancing mutually beneficial cooperation in many fields.

Mr. Li Zhimin, President of Wesizwe Platinum Limited, expressed his gratitude to Mr. Lu for making today's co- operation possible. As both witness and participant of the project, Mr. Li felt excited and delighted. He said that though there might be difficulties and challenges in the process of execution, he believed the two sides would unite in good faith, make concerted efforts, and reach a successful completion. "I hope that the cooperation between us can eventually achieve mutual complementarity in the interest of our common development." He said. Wesizwe is a listed company in South Africa jointly controlled by Jinchuan Group Co., Ltd. and China-Africa Development Fund. Mr. Hua Guanglin, Deputy General Manager of Sinosteel E&T, executives from Sinosteel MECC Mineral Processing Department and International Marketing Department attended the meeting.

08.

08.

Sinosteel Nuotai Long Product Intelligent Manufacturing Joint-venture Launched

On September the 25, 2019, Sinosteel MECC, Taier Heavy Industry Co., Ltd. (TAIER) and Administration Commission of Ma'anshan Economic and Technological Development Zone signed a contract on investment and construction of Long Product Intelligent Manufacturing Project at Ma'anshan Conference Center, marking the official launch of Sinosteel Nuotai Long Product Intelligent Manufacturing Joint-venture.

The joint-venture will be committed to R&D, manufacturing, sales and service of intelligent equipment for long products in metallurgical field, focusing on Thermo Mechanical Controlled Processing (TMCP) technology and its matching equipment for hot rolling mill and new type of water-cooling devices. >>>>>

NEW DEALS

>>>>> The joint-venture's core technology, known as TMCP, taking lead in meeting China's new national standard (GB/T1499.2-2018), has already developed a new generation of 500 MPa rolling technology and new ultra-high-speed rolling equipment. With continued development and application of the technology and its relevant equipment, the joint-venture will not only well replace inline quenching process largely adopted abroad, but also promote green, environmentally friendly & high-quality development of metallurgical industry in China. The application of advanced TMCP and process, mechanical and electrical integration of hot rolling mill can increase the grain size by two levels, while cancelling the additional usage of expensive micro-alloy elements such as V, Nb and Ti and lowering the content of Mn from 1.4% to 0.6% in wire line. The above can well cut production cost of RMB100 yuan/ton. Since bar and wire production lines are in great demand in the process of upgrading and new construction in China, the market for Sinosteel Nuotai Long Product Intelligent Manufacturing Joint-venture is promising. In terms of talents, the core members of the joint-venture team have been working in the field for more than 20 years, serving as senior experts and technical leaders in large-scale leading research institutes in the industry. The team boasts more than 100 patents with the advanced rolling process and has developed independent intellectual property rights for core equipment. Attending the signing ceremony, Mr. Lu Pengcheng, Deputy General Manager of Sinosteel Corporation and Chairman of Sinosteel E&T said that by implementing innovation-driven strategy, Sinosteel E&T always makes high-quality development of equipment manufacturing as its priority."We are relentlessly pursuing industrial transformation through technology innovation and moving forward to the medium-high end in the industry chain," said Lu.

He also noted that the set-up of Sinosteel Nuotai Long Product Intelligent Manufacturing Joint-venture is a symbol of what the company has achieved through years of dedication to technology innovation and development. "The joint-venture will not only further enhance our competitiveness and influence, but also lay a solid foundation for more business opportunities and expanding into diversified fields," remarked by Lu.

Other guests attended the ceremony included Mr. Tai Zhengbiao, Chairman and General Manager of Taier, representatives of the Ma'anshan Municipal Government and TMCP experts.

09.

Hebei Huaxi Special Steel Chose Sinosteel MECC For Its Iron-making & Steel-making Project

On October 15, 2019, Sinosteel MECC, a wholly-owned subsidiary of Sinosteel E&T, signed an EPC contract with Hebei Huaxi Special Steel Co. Ltd. in Beijing on the Iron-making & Steel-making Project. The project is part of the Renovation and Technical Transformation Program of Huaxi Special Steel. Sinosteel MECC will undertake the entire engineering design, equipment procurement and construction of a 2300m³ blast furnace, 170t converter, 12-strand billet CCM as well as the supporting utility and auxiliary facilities.

The project will be designed and implemented fully in line with the ultra-low emission standards of Tangshan Municipality. For example, the blast furnace gas system will be equipped with desulfurization facilities to ensure low emission in operation. Besides, guided by the principle of "conducting in an advanced, practical and reliable approach", the entire converter steel-making system will enjoy a relatively high level of mechanization and automation control, complete environmental protection and safety facilities, in order to reach the design capacity with clean production. 1.76 million tons of qualified hot metal and 1.7 million tons of liquid steel is expected to be produced annually once in operation.

At the signing ceremony, Dang Xianxing, GM of Huaxi Special Steel, expressed his faith and confidence in Sinosteel MECC's technical strength and had been previously achieved, the two sides shall work closer to ensure a fruitful cooperation by completing the project and reaching the target at one time. Wang Jian, Director and President of Sinosteel E&T, guaranteed that Sinosteel MECC would bring together its expertise in both talents and technology to complete the project timely with high quality. "Sinosteel E&T would like to seize the opportunity for closer and deeper cooperation with Huaxi in the future," said Wang. Qiu Zhe, Deputy General Manager of Sinosteel E&T, and Dong Yanjun, Deputy Project Director of Huaxi Special Steel were also at the meeting.

10.

To Upgrade High-Speed Bar Mill For GISE

In October 2019, Sinosteel Engineering Design & Reseasearch Institute Co. Ltd. (Sinosteel EDRI), a wholly-owned subsidiary of Sinosteel E&T, entered into an EPC contract with GISE New Materials Co., Ltd. on its High-Speed Bar Renovation Project, marking a further step towards closer cooperation between the two companies. Partially taking use of the current plant buildings and equiment, the project is designed to transform the existing steel rolling line into a high-speed bar mill. With a clear preference for the advanced hot rolling technology of Sinosteel E&T, the project is expected to produce rebar with no addition of Nb and V alloy and much lower content of Mn alloy. Meanwhile, key equipment will include a new type of Sinosteel E&T' self-developed water-cooling device, modular rolling mills and high-speed steel charging system. The products of the high-speed bar mill are Φ10mm ~ Φ 40mm hot rolled rebar, with a designed maximum speed of 45m/s and a guaranteed speed of 40m/s.

GISE New Materials is a subsidiary of Guangzhou Industrial and Investment Holding Group Co., Ltd. formerly known as Guangzhou Iron & Steel Enterprises.

11.

Signed A Contract With Shanxi Hongda Steel For Its 2x100t Converter Steel-making And Continuous Casting Project

In October 2019, Sinosteel MECC, a wholly-owned subsidiary of Sinosteel E&T, closed a deal and held a kick-off meeting with Shanxi Hongda Iron & Steel Co., Ltd. (abbr Hongda Steel) on its 2x100t Converter Steel-making and Continuous Casting Project in Hejin, Shanxi Province, marking the formal commencement of the project. The project is situated in Hejin, Shanxi Province & Sinosteel MECC will undertake the equipment procurement and general construction contracting of two 100t converters, two 8-strand billet CCMs and supporting utility and auxiliary facilities on an EPC basis. Expected to be put into operation in January 2021, once completed, the project will have an annual production of 3 million tons of liquid steel and 2.91 M/T of qualified billets.

12.

Sinosteel MECC To Build Blast Furnace For Donghua Steel

In November 2019, Sinosteel MECC, a wholly-owned subsidiary of Sinosteel E&T, signed an order with Tangshan Donghua Steel Group Co. Ltd. (abbr Donghua Steel) for EPC contracting a 2300m³ blast furnace and raw material feeding system under its Iron-making Optimization & Upgrading Project.

The raw material feeding system includes 3.5×104t/a finished sinter bins, underground sinter receiving bins, transfer stations, galleries and other process facilities, as well as supporting utility and auxiliary facilities. Technologically, advanced environment-friendly equipment, complete and optimized process and measures will be adopted. As a result, drop height during material transfer is expected to be decreased and sealing of dust-emitting points strengthened, thus minimizing the generation of pollutants.

The dedusting system is to be decided based on the type of materials, the nature of dust and working duty. High-efficiency electrostatic precipitators or bag filters will be used to remove dust from major dust-emitting points, reaching efficiency equal to or higher than 99%, so that the dust concentration at the posts and dust emission concentration can conform to national standards. The whole system will be designed with resistance balance technology, pipeline wear-resistant treatment technology and sealed dust conveying & recovery system.

The blast furnace is designed on the strength of the comprehensive long-campaign technology for furnace proper. Double rectangular cast houses are to be adopted, and hot metal transported by locomotive by applying "One Ladle" mode. High-efficiency top-combustion hot blast stoves will be equipped with gas and combustion air heat exchangers to reach high blast temperature. Moreover, the dry type gas bag filter system, top gas bleeding and recovery process as well as adjustable axial flow blower-gas turbine coaxial unit (BPRT) process will be chosen. The refined EIC-based detection and control technology can strengthen the monitoring and analysis of blast furnace, thus meeting the needs of modern large and medium-sized blast furnace production & operation.

13.

To Build The 8Mpta Prime Quality Special Steel Project For Guangdong Jingshenglan

On December the 30, 2019, Sinosteel MECC, a wholly-owned subsidiary of Sinosteel E&T signed an EPC contract with Guangdong Jinshenglan Metallurgical Technology Co., Ltd. (abbr Guangdong Jinshenglan) on its Prime-quality Special Steel Project, with annual output of 8 M/T.

Under the agreement, Sinosteel MECC is responsible for carrying out the subgrade treatment of the whole plant and building a steel scrap yard, an electric furnace shop, a refining shop, a continuous casting shop, a steel rolling shop, a lime kiln plant, a steel slag treatment plant & utility & auxiliary systems.

Sinosteel MECC has won the bidding by virtue of its advanced, complete and reliable design as well as cutting-edge technologies. Therein, short-process smelting process, horizontal furnace charging technology and flue gas waste heat recovery for preheating charge scrap will

be adopted for electric furnace steel-making while, vertical arrangement, energy-efficient transformers with side outgoing lines and heavy-current lines will be used for LF, ensuring a three-phase unbalance of less than 5%. Apart from that, the project will be equipped with a complete dedusting system collecting dust from various flue gas points so as to reduce dust pollution and achieve green production. The continuous casting-direct rolling technology will be applied for the steel rolling system, so that high-temperature billets would be directly fed into rolling mills through a fast roller table instead of heated by a reheating furnace. Such process is expected to save energy consumption, reduce metal loss as well as cut exhaust gas emission. At the same time, a pre-water cooling device is designed after the pre-finishing mill train to perform temperature-controlled rolling, so as to control the temperature of rolled pieces entering the finishing mill train.

Guangdong Jinshenglan is a key enterprise of Yunfu City, and its Prime Quality Special Steel Project is also one of the major projects under construction of Guangdong Province.

^13.

14.

Sinosteel Tiancheng Awarded An EP Contract Of Flue Gas Desulfurization & Dedusting Project

In October 2019, Sinosteel-Tiancheng Environmental Protection Science and Technology Co., Ltd. (abbr Sinosteel Tiancheng), a subsidiary of Sinosteel E& T, entered into an EP contract with Sinopec-SK (Wuhan) Petrochemical Company Limited on its Flue Gas Desulfurization and Dedusting Project of 2.8Mtpa Catalytic Cracking Unit, with an estimated construction period of 300 days. Based on its deep domain knowledge in the industry, Sinosteel Tiancheng will address the customer need for ultra-low emission by adopting its self-developed technology, focusing on flue gas purification and synergetic removal of multi-pollutant via bag filters. At the same time, by-products with economic value will be produced and "zero discharge" of high-salt wastewater achieved.

It is also the first time of Sinopec's large-scale oil refining project adopting Sinosteel Tiancheng's self-developed technology, marking both recognition and a breakthrough of the technology in the petrochemical industry.

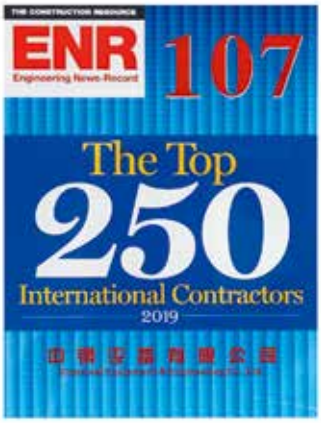
AWARDS & HONORS

Sinosteel MECC's Ranking In ENR's TOP 250 International Contractors List Hit A New Record

01.

On US Engineering News-Record (ENR) list of 2019 Top 250 International Contractors, Sinosteel MECC, a wholly-owned subsidiary of Sinosteel E&T Co., Ltd., hit a new high by ranking No.107. Due to Sinosteel MECC's outstanding performance in the field of international engineering in 2018, the number jumped from previous year's No.157, the biggest leap ever since the company had been listed.

On the list of Top 250 Global Contractors released during the same period, the ranking of Sinosteel MECC also surged from No.247 in the previous year to No.170. Founded in 1876, ENR is the world's most authoritative academic journal in the field of engineering construction and has two the most world renowned and authoritative rankings in the industry, one of which is the ranking of Top 250 International Contractors. Published annually in August, the list ranks the 250 largest world construction contractors based on general construction contracting export revenue. While the other list, Top 250 Global Contractors, evaluate companies' performances based on total construction contracting revenue regardless of where the projects are located.



2.5Mtpa Pellet Plant Project Won *2019 National Quality Engineering Award*

02.

The 2.5Mtpa Pellet Plant built by Sinosteel MECC, a wholly-owned subsidiary of Sinosteel E&T received the National Quality Engineering Award. By virtue of its advanced design concept, first-class pelletizing technology and outstanding construction management performance, the project was listed among the 15 overseas projects winning the 2019 National Quality Engineering Award.

The National Quality Engineering Award, initiated in 1981, is one of the earliest awards approved by China's State Council in the engineering construction field. Under the administration of the National Development & Reform Commission, it is also the most authoritative cross-industry and multi-disciplinary state-level quality award. It upholds the value of systematic, scientific and economical management, guiding engineering construction companies to develop in quality-oriented, green and innovation-driven way. Sinosteel MECC undertook the pellet project in 2016 and was in charge of engineering design, equipment procurement, machinery installation supervision, commissioning, personnel trainings & others. A world-leading production process composed of chain grate-rotary kiln-annular cooler was applied, featuring advanced equipment & high automation level. Besides, Sinosteel MECC independently developed material balance system and implemented ground-breaking construction technologies and practices, resulting in an internationally advanced plant with main technical and economic indicators exceeding contractual expectations. The completed project not only achieved low fuel and electricity consumption and lower production costs, but also zero discharge of waste water & slag from the plant. The project team of Sinosteel MECC, bearing in mind the mission of Customer First and Beyond Expectations, completed the project four months ahead of the schedule in a professional, practical and efficient manner. As a result, their great performance won recognition and praise from the customer, making the project a model of cooperation among Chinese companies, i.e. a benchmark project integrating Chinese design, made equipment & project management.

Up till 2019, Sinosteel MECC has won the National Quality Engineering Award for six times and the Industrial Quality Engineering Award for eight times. All those honors have become incentives driving the company to keep forging ahead and making new breakthroughs.

03.

The 2.5 Mtpa Travelling Grate Iron Ore Pelletizing Project Won *The Excellent Achievement Award For Engineering Design Of Metallurgical Construction*

With advanced design concepts and first-class pellet production technology, a 2.5 Mtpa travelling grate iron ore pelletizing (TGIOP) project undertaken by Sinosteel MECC, an owned subsidiary of Sinosteel E&T Co., Ltd., received the second prize of Excellent Achievement Award for Engineering Design of Metallurgical Construction in 2019. The annual award is established by China Metallurgical Construction Association for promoting of technological innovation and design capability.The award-winning project contracted by Sinosteel MECC as an EPC project in 2013. The project was commenced in November 2013, put into trial operation in October 2016 and successfully passed the performance assessment in March 2017. The whole line runs smoothly, and the travelling grate machine system and refractory materials are in stable state, reaching the production targets both in quality and quantity. In the project, in view of the pelletizing characteristics of magnetite pellets with rich sulfur and magnesium, self-excited oscillation jet combustion technology was applied to a travelling grate

machine for the first time, and numerical simulation and simulation software were used to optimize the design mode of the units of the travelling grate machine. As a result, the project took the lead in developing TGIOP technology and equipment with independent intellectual property rights, formed a design and manufacturing capacity of 2-8 million tons of pellets, achieving a technological breakthrough. The honored project is not only the first application of TGIOP technology independently developed by a Chinese company, but also the first EPC project adopting TGIOP introduced by a Chinese company to foreign countries. It pioneered the development path and direction of the Chinese TGIOP in the industry.

In addition, Sinosteel MECC successfully completed the construction of the 4 M/T pellet project of TOSYALI in Algeria and the 2 Mtpa pellet project of Fujian Sansgang Group, and successively undertaken the 2 × 4.8 Mtpa pellet project of HBIS Laoting and the 4 Mtpa pellet project of Liuzhou Iron and Steel Group in Fangchenggang. The pellet project of Sangang Group, put into operation at the end of 2019, has made several "firsts" within the industry.

04.

Sinosteel MECC Listed Among the Top Benchmarking Companies for Overseas Project

On October 21, 2019, China Engineering and Consulting Association (abbr CEDA) revealed the list of Top Benchmarking Companies for Overseas Project for the first time. Sinosteel MECC, a wholly-owned subsidiary of Sinosteel E&T Co. Ltd. was honorably included.

As China's economy has been transitioning from a phase of rapid growth to one of high-quality development, enterprises engaged in engineering and consulting are facing both new opportunities and challenges. Against such background, CEDA organized the selection to award enterprises which have been making major contributions to economic development by participating in the China's Belt and Road Initiative (BRI) and conducting businesses in the international engineering market. By doing so, experience can be shared, communications improved, and influence of those well-performed enterprises enhanced. Sinosteel MECC was not only awarded the title of Top Benchmarking Companies for Overseas Project, but also included in the 2019 Directory of Top Benchmarking Companies released at the same time. While accomplishing over 500 national key projects for giant steel producers and making great contributions to the development of China's steel industry, Sinosteel MECC is also one of the Chinese companies expanded global presence at the earliest time. Striving to become a leading partner and through years of exploration, Sinosteel MECC has gained excellent reputation in overseas metallurgical engineering market, achieving footprints and cooperation relations with enterprises in more than 40 countries. Besides, seizing the opportunity of BRI, the company continues to prove itself a strong and reliable partner providing complete-process and life-cycle services, as well as green, innovative and sustainable solutions for companies in metallurgy, electricity, mining and coal coking and chemical industries.

The keep-going implementation of BRI will attract more investment and facilitate the construction of new projects, bringing in more opportunities to Chinese companies. Meanwhile, as a result of the widely application of IT technologies such as the Internet, Internet of Things (IOT) and BIM within the industry, engineering design is expected to play a more essential role, creating

value for clients and society in the future. All these indicate new possibilities for Sinosteel MECC to make greater contribution and achieve high-quality develoment.

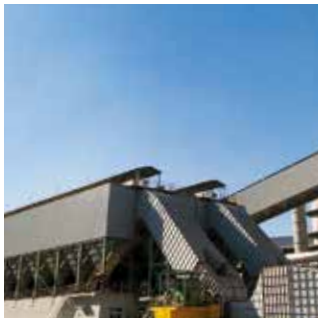
05.

Sinosteel Tiancheng Won Special Prize Of *2019 Science And Technology Progress Award Of The Ministry Of Education*

Recently, China's Ministry of Education has officially revealed the winners of Outstanding Achievement Award for Scientific Research (Science & Technology) in Institutions of Higher Education, 2019. As one of the main contributors, Sinosteel Tiancheng Environmental Protection Science & Technology Co. Ltd. (abbr Sinosteel Tiancheng), a subsidiary of Sinosteel Engineering & Technology Co., Ltd., received the Special Prize of 2019 Science & Technology Progress Award for its project of "Advanced Technology and Application for Multi-Pollutants Control in Non-electricity Industrial Flue Gas". It is also the only special-prize winning project.

Apprised once a year, the Outstanding Achievement Award for Scientific Research (Science and Technology) in Institutions of Higher Education is open to colleges and universities nationwide. It consists of Natural Science Award, Technical Innovation Award, Science and Technology Progress Award and Youth Science Award. Winners come from both individuals and institutions who have made prominent contributions to scientific discoveries, technological innovations as well as promotion of scientific and technological progress. Altogether 315 projects and individuals, have been granted the honor nationwide, including 120 of Natural Science Award, 49 of Technical Innovation Award, 136 winners of Science and Technology Progress Award and 10 of Youth Science Award. Only one special prize, representing the highest honor, among all awards was given.

The project of "Advanced Technology and Application for Multi-Pollutants Control in Non-electricity Industrial Flue Gas", led by Tsinghua University, was jointly completed by Sinosteel Tiancheng and other participants. Through 18-year of joint research in a mode of "industry-university-research-application", the project team has completed theoretical innovation, bench scale, pilot scale and industrial application, achieving breakthroughs in various aspects such as theory of cooperative control of conventional and non-conventional pollutants in flue gas, core functional materials, technology and equipment for in-depth treatment and evaluation system. Besides, it also succeeded in forming a new integrated system, known as "basic theory - technical method - decision support - industry leading". The research results have been applied in industrial furnaces / boilers of many industries such as metallurgical coking building materials, petrochemical and nonferrous metal, all of which have been in well operation and reached the strictest criteria of ultra-low emission. The relevant achievements of the project include 67 authorized invention patents and 135 items of utility modes and software copyrights, with technical products applied in 31 provinces, municipalities and autonomous regions in China, and exported to 21 countries and regions including the United States, Australia, South Korea, Japan and other countries along the Belt and Road. Obviously, both economic and social results have been achieved.



Apart from the above-mentioned honor, Sinosteel Tiancheng was also awarded the First Prize of 2019 Environmental Protection Science and Technology of the Ministry of Ecology and Environment, meriting the project of "Technology and Application: Ultra low emission Control of Multi-pollutants in Multi-process in Steel. Industry". Led by Institute of Process Engineering and Chinese Academy of Sciences, the project was jointly accomplished by 5 institutions. Totally 39 awards of 2019 Environmental Protection Science and Technology were granted.

China's industrial furnaces applied in steel, cement, glass and other industries are large in quantity and wide in range. In addition, different processes, furnace profiles & fuels could result in a wide emission temperature range of flue gas and great fluctuation in working conditions. Plus the complex flue gas compositions, efficient treatment and control of flue gas are facing unprecedented challenges. Sinosteel Tiancheng, who has been actively participating in ***China's Blue Sky Initiative,*** has engaged in related R&D and application projects of key technologies for multi-pollutants in-depth treatment of flue gas. The Company is not only capable of providing ultra-low emission technologies & solutions covering all processes of iron & steel industry from raw materials to sintering/pelletizing, coking, iron-making, steel-making and steel rolling, but also independently developed Fluid Catalytic Cracking (FCC) flue gas filtration technology for deep purification of regenerated flue gas, making a breakthrough in petrochemical industry.

Sinosteel Tiancheng has established two national technology centers, namely the National Engineering and Technological Research Center for Industrial Flue Gas Dedusting attached to the Ministry of Science and Technology and the National Engineering & Technological Center for Flue Gas Control of Environmental Protection Industry attached to the Ministry of Ecology and Environment. Besides, it also boasts of the only academician workstation focusing on ultra-low emission technology in the iron and steel industry in China by far. In recent years, in line with national policies and based on market demand, Sinosteel Tiancheng has been working on industrial hard-nut problems and achieved progress in improving capacity for applying research results to production. With its innovation achievements successfully applied to various fields such as treatment of air pollution in steel, power, petrochemical, building materials and other industries as well as resource utilization of agricultural organic wastes, Sinosteel Tiancheng will continue its dedication to building the beautiful country and achieving sustainable development of the Chinese nation.

D

photo credit: Jordan Opel

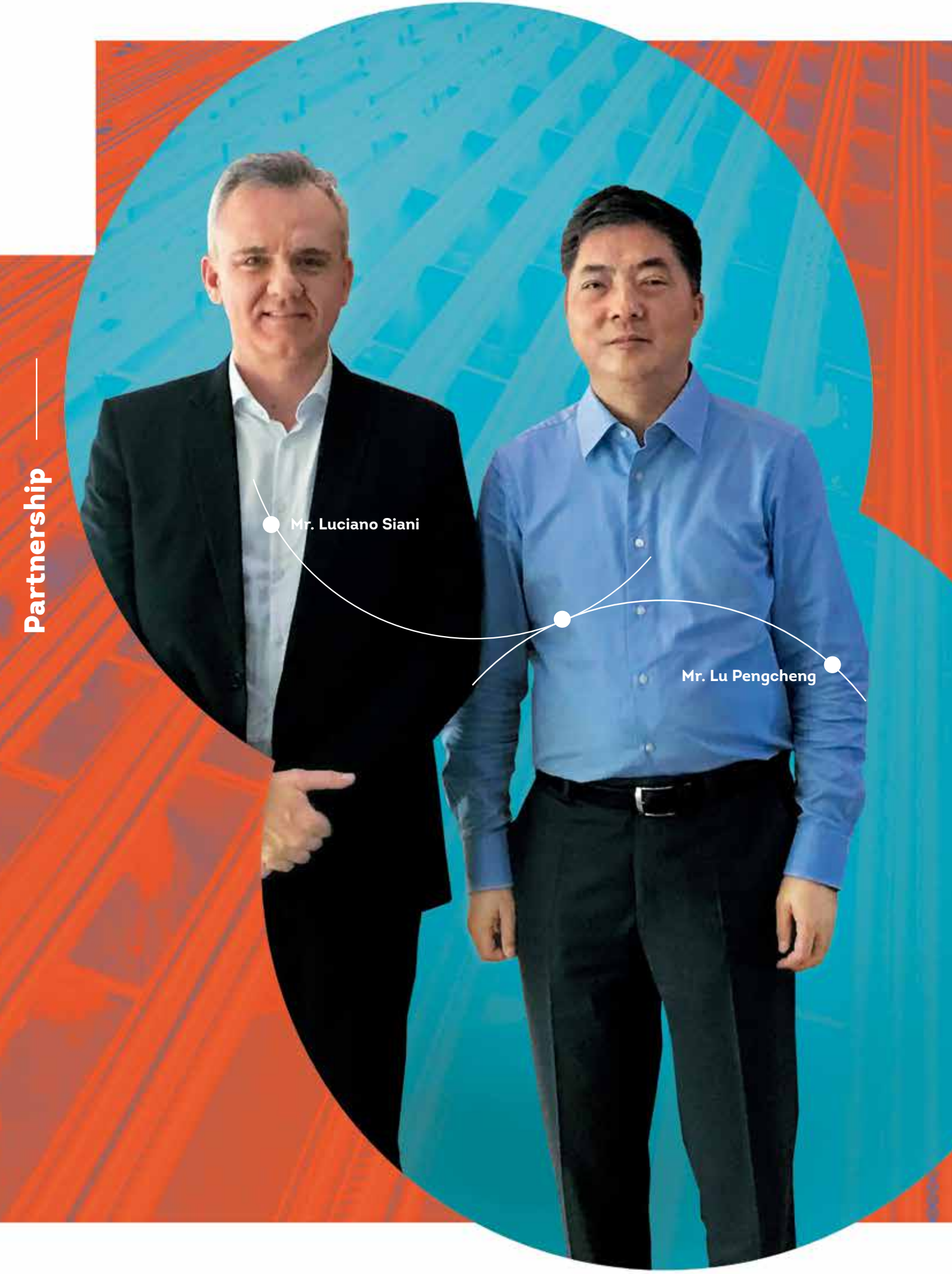
Partnerships

With business footprints in more than 40 countries, we have made friends around the globe. Our values of serving customers with truthfulness, excellent execution and high efficiency have earned us the title of "reliable partners & friends" whom our partners can always bank on.

"Morocco welcomes more investment from China, and our local companies share the same stance to join hands with competitive Chinese companies just like Sinosteel E&T in mining, renewable energy, electrical goods and other possible sectors." said H.E. Aziz Mekouar, Morocco's Ambassador to China.

03

Partnership



Sinosteel E & T and VALE Have Broad Prospects for Cooperation

On August 22, 2019, Mr. Lu Pengcheng, Deputy General Manager of Sinosteel Corporation and Chairman of Sinosteel Engineering & Technology Co., Ltd. (abbr Sinosteel E&T) met with senior executives of VALE S.A., including Mr. Luciano Siani, company's CFO, and Mr. Sergio Espeschit, President of the China region. During the meeting, both parties had extensive and in-depth talks on strengthening cooperation in multiple fields. Mr. Lu expressed his warm welcome and briefly introduced the overall development and business scope of Sinosteel Corporation. Mr. Lu noted that, Sinosteel Corporation, as a leading service provider, engages in comprehensive integration business in the steel industry in China, including raw material supply and product sales, engineering technology and equipment manufacturing, new material development and sales, and trade logistics. Through many years of development, the corporation has grown to enjoy world-renowned influence in the industry.

Sinosteel Corporation is also committed to the development and processing of metallurgical mineral resources, as well as expansion of engineering technology in overseas markets. In the process, Sinosteel has established and maintained friendly cooperation with VALE.

Mr. Siani expressed his gratitude to Mr. Lu for the meeting and introduced VALE's latest development and plans. He mentioned that VALE was currently reorganizing its global business and seeking partners for new projects. "We welcome Sinosteel to join us on global projects' investment and look forward to further cooperation in engineering and other fields," he said. **Executives of Sinosteel Corporation responsible for overseas mining and iron ore trading business, executives of Mineral Processing Department, Mining Department and the Brazilian branch of Sinosteel E&T attended the meeting.**

"Sinosteel has established and maintained friendly cooperation with VALE"

Mr. Lu Pengcheng Meeting with Moroccan Ambassador in Beijing

Mr. Hua Guanglin (right) accompanied Moroccan ambassador visiting Sinosteel Exhibition Hall

On September 30, 2019, Mr. Lu Pengcheng, deputy General Manager of Sinosteel Corporation and Chairman of Sinosteel Engineering & Technology Co., Ltd., (abbr Sinosteel E&T) met with H.E. Aziz Mekouar, Morocco's Ambassador to China, in Beijing. The two sides exchanged views on pursing cooperation in possible fields. Mr. LU expressed his warm welcome on behalf of the company to the ambassador. He recounted how impressed he was by the progress and development of Morocco during his business trip earlier in May. "Led by our chairman Mr. Xu Siwei, the Sinosteel delegation had met executives from HIMVEST Holding, Attijariwafa Bank (Morocco's largest bank), Sonasid Group as well as Governor of Marrakesh Region," Mr. Lu said. "Through separate meetings and company-tours, I had gained better understanding of Morocco's local politics, economy, investment policy and industrial market. During the trip, Chairman Xu discussed with HIMVEST on the potentiality of future cooperation in the fields of mining, equipment and parts trading, etc." He added.

Mr. Lu indicated that right after the trip, Sinosteel E&T began working on exploring new opportunities of conducting investment and business with Moroccan companies in the field of mining, iron & steel and chemical fertilizer, aiming to draw on each other's strength and deliver win-win results through cooperation .

Boasting an exquisite scenery and a pleasant climate, Morocco is uniquely situated as a gateway to Africa, Europe, and the Middle East. With such superior geographical advantage, while endowed with numerous exploitable resources, the country has developed into a regional commercial and financial hub with strong trade and logistics as well as huge economic potential. Mr. Mekouar told Mr. Lu that Morocco's Port of Tanger Med, the biggest port in Africa, had already become one of the most important destinations for Chinese investors. Especially since the launch of ***China's Belt and Road Initiative (BRI),*** Morocco and China have witnessed increasing exchanges in many sectors and the ties between the two countries continued to run deep. He also expressed his willing to help seeking new drivers and expanding new space for collaboration between the two sides. "Morocco welcomes more investment from China, and our local companies share the same stance to join hands with competitive Chinese companies just like Sinosteel E&T in mining, renewable energy, electrical goods and other possible sectors." Mr. Mekouar added.

Mr. Hua Guanglin, Deputy General Manager of Sinosteel E&T, attended the meeting.

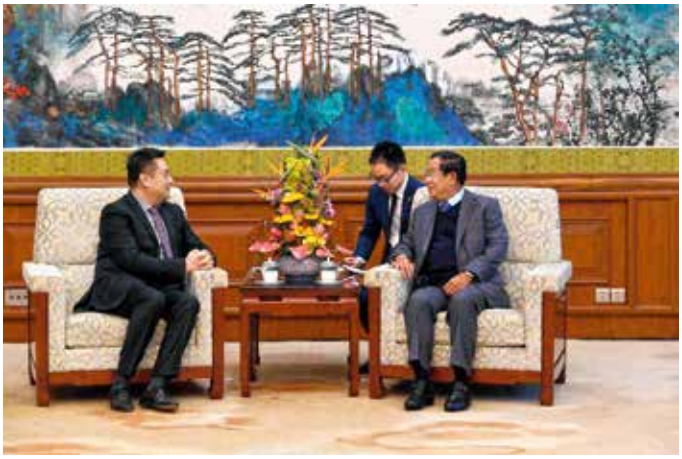
Ambassador Aziz Mekouar expressed his gratitude and the sincere friendship between Morocco and China, saying it was such a pleasure to visit Sinosteel right before the 70th anniversary of the founding of the People's Republic of China.

Mr. Lu Pengcheng (in white shirt) held a meeting with Mr. Mekouar (right)

Mr. Wang Jian Paid an Official Visit to Cambodian Prime Minister Samdech Techo Hun Sen

From January 20 to 23, 2019, Samdech Techo Hun Sen, Cambodian Prime Minister paid an official visit to China as his first state visit of the year. During Hun Sen's visit, Mr. Wang Jian, Director and President of Sinosteel E&T made an official visit and reported about the latest progress of the company's project in Cambodia.

Mr. Wang briefed about the footprints of Sinosteel E&T in Cambodia. "Sinosteel E&T entered the Cambodian market in 2014, and since then has kept pushing forward the collaboration of several projects such as power transmission and transformation lines, hydropower stations, coal-fired power plants and highways," said Mr. Wang. At present, the Coal-fired Power Plant, featuring BOO mode, "has made practical progress by gaining approval from Cambodian authorities and both Execution Agreement and Power Purchase Agreement been signed." added Wang. He also presented on the company's next step in the field of energy and infrastructure, aiming to achieve win-win results through industrial engineering & services to both Cambodian companies and the society.



Mr. Wang Jian (left) and Hun Sen at the Diaoyutai State Guesthouse, 2019

Hun Sen expressed that he warmly welcomed Chinese companies to participate in Cambodia's infrastructure construction & operation as well as other related fields. Hun Sen said, "The two sides should make joint efforts to push forward the Coal-fired Power Plant Project and remain committed to establishing a model of cooperation for mutual benefit." As early as August 2018, Mr. Wang Jian met with Samdech Hun Sen in Cambodia. It was also Hun sen's first meeting with executive from Chinese enterprises since he was elected as the Prime Minister.

China and Cambodia share profound traditional friendship, and bilateral relations and cooperation have made great progress. Guided by the ***Belt and Road Initiative (BRI)***, the Chinese Government has encouraged and offered strong support to Chinese enterprises in participating in the construction and operation of Cambodian production capacity, transportation, electricity and other infrastructures.

Mr. Wang Jian (left) and Mr. Hun Sen in Cambodia, 2018

> *"Sinosteel E&T entered the Cambodian market in 2014, and since then has kept pushing forward the collaboration of several projects such as power transmission and transformation lines, hydropower stations, coal-fired power plants and highways,"*

Wang Jian Attended Development of New Economic Platform & Indonesia-China Investment Cooperation Promotion 2019

From September 21 to 26, 2019, China Chamber of Commerce for Import and Export of Machinery and Electronic Products (abbr CCCME) organized the event of Development of New Economic Platform and Indonesia-China Investment Cooperation Promotion 2019 (abbr Cooperation Promotion 2019) in Indonesia, aiming to exchange views on China-Indonesia bilateral investment, intergovernmental cooperation and new investment opportunities. Mr. Wang Jian, Director and President of Sinosteel E&T, attended the event.

At the conference, Mr. Wang Jian presented on the progress and development of the company, "as a leading company in industrial engineering, Sinosteel Equipment & Engineering Co., Ltd. (abbr Sinosteel MECC), a wholly-owned subsidiary of Sinosteel E&T, started its overseas market exploration as early as the 1990s and up till now has established cooperation relations with companies from more than 40 countries." Mr. Wang stressed that the company has attached great importance to the Indonesian market. "Sinosteel MECC tapped into the Indonesian market in 2006, becoming one of the pioneers among Chinese enterprises. During the process of market exploration, Sinosteel MECC has gained Indonesian highest-level of business license to conduct engineering and service, and set up a local representative office in 2016." said Mr. Wang. Through years of development and following ***China's Belt and Road Initiative (BRI)***, the company has successfully completed a number of projects in Indonesia's steel, electricity, mining and other fields ."

Wang Jian also came up with suggestions and measures for enhancing exchange and collaboration between Chinese and Indonesian enterprises, so as to promote mutually beneficial cooperation for sustainable development. "With the support from intergovernmental cooperation, especially by the implementation of investment and financing policies, we will seize the opportunity to deepen cooperation and endeavor to make more contributions to the industrial development of Indonesia to the best of our ability," added Mr. Wang.

During the Cooperation Promotion 2019, Mr. Wang also met with representatives from the Railroad Bureau of the Ministry of Transportation of Indonesia, executives from Wika Group, an Indonesian state-owned engineering and investment company, and Ogasaka Group as well as other enterprises. Wang also paid a visit to the Economic and Commercial Office of the Embassy of the People's Republic of China in the Republic of Indonesia.

China and Indonesia are important neighbors and natural cooperative partners with common interests. As early as 2013, China's President Xi Jinping initiated the *21st Century Maritime Silk Road* during his visit to Indonesia. Ever since then, the two countries have become closely linked through *the BRI* and have reached consensus to build a multi-faceted partnership. The two sides will continue to carry forward good-unneighborly friendship, expand cooperation in infrastructure, resources, telecommunications, human resources development and other fields, as well as strengthen cooperation under the framework of *the BRI*.

Wang Jian Attended the 3rd Future Investment Initiative

Mr. Wang Jian at the plenary session of 3rd FII, 2019

The 3rd Future Investment Initiative summit was held in Riyadh, the capital of Saudi Arabia, from October 29 to 31, 2019. Mr. Wang Jian, Director and President of Sinosteel Engineering & Technology Co., Ltd., attended the summit along with more than 6,000 global leaders and public figures from financial institutions, governments, multi-national companies, investment banks and credit rating agencies from over 30 countries. The Future Investment Initiative(FII) is hosted by Saudi Arabia Public Investment Fund (PIF, one of the world's largest sovereign wealth funds) as to build an international platform focusing on utilizing investment to drive growth opportunities, enable innovation and disruptive technologies, and address global challenges. Since its first session successfully held in October 2017, the summit has gradually developed into an annual gathering of political and business elites, and it is also known as Davos in the Desert.

Organized around three agendas, namely "Sustainable Development", "Technology for Good" and "Advanced Society", the summit witnessed a series of thoughts and insights through various interactive working sessions, such as dialogues, plenary and round-table conferences among policy makers, business leaders, investors and world leaders, as well as in-depth interaction with global media. The event concluded with ideas, expertise and the development of innovative solutions driving the future of investment and economic value creation.

In the "The Sky's the Limit" plenary session, Wang Jian, together with Darren Davis, President & CEO of Ma'aden, Saudi Arabia, Young-Hoon Lee, President & CEO of POSCO Engineering & Construction Co., Ltd., Ben Way, CEO of Macquarie Group Asia and Yusuff Ali, Chairman of Lulu Group, shared opinions on the topic of "How infrastructure investments will reinvent communities and turbocharge the global economy".

Mr. Wang said that with the irresistible arrival of 5G and blockchain which will lead to a new round of technological and industrial innovation around the globe, infrastructure, though as a traditional industry, will be no exception. The future will be the Internet of Everything era. Sinosteel has been working on the application of 5G technology to build intelligent steel plants, which will surely accelerate industrial transformation and upgrading.

During the summit, Mr. Wang also met with leaders from governmental organizations such as Saudi Arabia Industrial Clusters and the Royal Commission and the Sovereign Investment Funds. He also had talks with representatives of Saudi-based Chinese enterprises and the Embassy of China in the Kingdom of Saudi Arabia. They exchanged views on how to take full use of regional advantages, how Sinosteel could enhance its contributions via industrial engineering and services, how to better promote the implementation of ***China's Belt and Road Initiative (BRI) and Saudi Vision 2030*** Besides, Mr. Wang also reported about Sinosteel's latest business progress in Saudi Arabia to the Commercial Counselor of the Embassy of China in the Kingdom of Saudi Arabia and held in-depth discussions with heads from CCB International and CICC International on financing cooperation of overseas projects.

During the summit, Wang Jian also attended a special reception for Chinese entrepreneurs held by the Organizing Committee of the summit. Mr. Chen Weiqing, Chinese Ambassador to Saudi Arabia, stated at the reception, "In recent years, under the guidance of the heads of the two countries, China and Saudi Arabia have established a comprehensive strategic partnership. The level of practical cooperation in various fields has been continuously improved, the bilateral relations have been full of vitality, and the bilateral economic and trade cooperation has shown a momentum of diversified development pattern of traditional fields plus emerging industries."

Mr. Matrika Prasad Yadav (left) and Mr. Hua Guanglin at Sinosteel Exhibition Hall

Mr. Hua Guanglin Held Talks with Mr. Matrika Prasad Yadav, Deputy Prime Minister and Minister of Industry, Commerce & Supplies of Nepal

In April 2019, Mr. Hua Guanglin, Deputy General Manager of Sinosteel Engineering & Technology Co., Ltd., (abbr Sinosteel E&T) met with Mr. Matrika Prasad Yadav, Deputy Prime Minister and Minister of Industry, Commerce & Supplies of Nepal, at Sinosteel Headquarters, Beijing.

After Yadav visited Sinosteel's exhibition hall, the two sides held a meeting. Mr. Hua Guanglin briefed about the history and the latest development of Sinosteel Corporation around the globe, highlighting the company's business achievements through collaborations with neighboring countries in recent years. Mr. Hua said, "Sinosteel E&T, as a pioneer of Chinese enterprises going global, tapped into the international market in the 1990s, and has accumulated a wealth of experience through projects operations and market expansion."

Yadav expressed his appreciation to Sinosteel E&T. He said, "Nepal is geographically linked to China and the two sides have maintained friendly relations for generations. Nepal welcomes Chinese assistance and investment to boost growth and achieve win-win results."

Following the implementation of *China's Belt and Road Initiative (BRI)*, the two countries' bilateral trade volume reached US$ 1.1 billion and China's investment in Nepal exceeded US$ 300 million in 2018. While both sides joint hand in infrastructure projects such as roads, ports, airports and power stations, BRI plan is in full swing.

On September 2, 2019, Li Lianhe, Ambassador of the People's Republic of China to Algeria, together with Commercial Counsellor Zhao Dongliang, made a tour to the Tosyali 2.3Mtpa Steel Complex, which had been built by Sinosteel Equipment & Engineering Co., Ltd. (abbr Sinosteel MECC) as an EPC contractor.

Located in Oran, a city in the northwest of Algeria, the steel complex is not only Tosyali Group's largest overseas investment project, but also the largest metallurgical investment project in Algeria. The complex, including a pellet plant with an annual output of 4 million tons, a DRI plant with an annual output of 2.5 million tons, an electric furnace steel-making plant with an annual output of 2.3 million tons and two rod and wire rolling mills, started operation on November 18, 2018.

China's Ambassador to Algeria Visited Tosyali Steel Complex

During the visit, Ambassador Li Lianhe met with executives from Tosyali Group and expressed the willing to advance bilateral cooperation in various fields. Mr. Li said, "We look forward to the continued and deepening collaboration between Sinosteel MECC and Tosyali to achieve more fruitful accomplishments." Sinosteel MECC project team accompanied the Ambassador for a project tour. After the tour, Li spoke highly of Sinosteel MECC for its top-tier technology, excellent service as well as spirit of dedication. He pointed out, "As a representative of competitive Chinese enterprises, Sinosteel MECC should continue its step of blazing a trail in manufacturing and technology in overseas market, making greater contributions to push forward the shift from 'Made in China' to 'Created in China' as well as promoting the Belt and Road Initiative."

Sinosteel Tiancheng Academician Workstation Established

On April 23, 2019, Sinosteel Tiancheng Environmental Protection & Technology Co., Ltd. (Sinosteel Tiancheng), a subsidiary of Sinosteel E&T, held ceremony for the establishment of its Academician Workstation.

Mr. Lu Pengcheng, Deputy General Manager of Sinosteel Corporation & Chairman of Sinosteel E&T, Hao Jiming, CAE (the Chinese Academy of Engineering) academician, and officials from Wuhan Municipal Government attended the ceremony. More than 70 representatives from Chinese universities and institutions, such as Tsinghua University, Institute of Process Engineering, Chinese Academy of Sciences(CAS), and Beijing University of Science and Technology, as well as executives from large-scale iron and steel enterprises attended the ceremony.

The ceremony was hosted by Xiong Shaoming, Deputy Secretary General of Wuhan Academician Center & Vice Chairman of Wuhan Association of Science and Technology.

This is the only academician workstation focusing on ultra-low emission technology in the iron and steel industry in China. It aims to breed a group of excellent innovative talents, transform high-tech achievements, improve the overall innovation ability and competitiveness of Sinosteel Tiancheng, and build a truly high-level R&D center. Based on the whole process of iron and steel technology, the academician workstation will tackle some of the most urgent technical problems of iron and steel makers, strive to achieve technological breakthroughs and develop key scientific and technological products with independent intellectual property rights.

Hao Jiming, professor at the School of Environment of Tsinghua University, CAE academician and foreign member of NAE (the US National Academy of Engineering), has long been following closely and supporting the development of Sinosteel Tiancheng. Professor Hao said in his speech, "I have been working closely with Sinosteel Tiancheng on national research programs, talent cultivation and project cooperation for many years, including the recent set up of the 'National Engineering Laboratory of Flue Gas Multi-Pollutant Control Technology and Equipment'. From now on, the Academician Workstation will play a pivotal role in the development of technology of ultra-low emission in non-electric industries and concentrate both on R&D and application."

Sinosteel SEPRI Becomes a Key Technically Supporting Organization of Suzhou Emergency Management Bureau

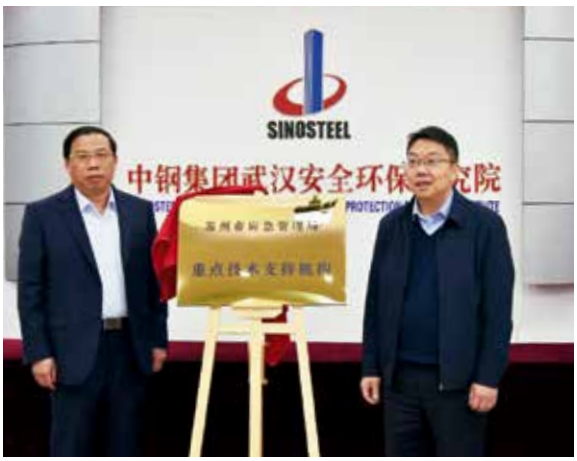
On October 31, 2019, Sinosteel Wuhan Safety and Environmental Protection Research Institute Co., Ltd. (abbr Sinosteel SEPRI), a subsidiary of Sinosteel E&T signed a tripartite strategic cooperation agreement with Suzhou Emergency Management Bureau and Suzhou University of Science and Technology in Wuhan, and held launching ceremony for the "teaching base" of Suzhou University of Science and Technology (SUST), identifying Sinosteel SEPRI's key role as a technically supporting organization.

Xu Guoping, President of Sinosteel SEPRI, Vice President Wang Zhi and Wang Xiao of SEPRI, Wei Feng, Deputy Director of Suzhou Emergency Management Bureau, Xia Yang, Dean of the School of Continuing Education of SUST, and Wang Dongtian, Director of Graduate Work Department attended the signing ceremony.

Aiming to strengthen cooperation among the three parties in the fields of personnel training, discipline construction, scientific research, technology application and academic exchanges related to work safety and emergency management, the three parties will establish a regular communication mechanism for daily information exchanges and organization coordination, and study and explore ways of further cooperation.

Pursuant to the agreement, the three parties, holding the principle of "advantage complementarity, integrated innovation and common development", will join hands on the following aspects: conduct talents training for emergency management, regularly organize exchange activities, enhance the frequency and criteria for risk inspection in terms of emergency management, continuously increase the investigation of emergency management risks and raise the overall capability of emergency management and production safety.

Since 2014, Sinosteel SEPRI has kept providing Suzhou Municipal Government and enterprises with services including training and consulting on HSE technology and management, all of which have generated good results and been highly appraised, bringing about a long-term strategic relationship.




SD

Project Spotlights

Learn about Sinosteel E&T's latest projects in Metallurgy, Mining & Mineral Processing, Coal Chemical as well as Energy industry on the following pages, including one of the world's biggest DRI plant built in Algeria, the very first completed pelletizing plant adopting self-developed tech in China, the record-breaking coke oven project in India and how we proceed on the pillar-to-be Bolivian Mutun steel complex.

04

FEATURE IN OPERATION

A Giant Step Forward: China's First Self-Developed Travelling Grate Pellet Plant in Operation

On December 26 of 2019, the completion ceremony of Fujian Sangang Minguang Pelletizing Project was successfully held. Mr. Li Lizhang, Chairman of Fujian Sangang Group (abbr Sangang) announced that the project was officially in operation, marking a big breakthrough achieved by Sinosteel E&T. Mr. Dong Da, Director & Deputy General Manager of Sinosteel E&T and Mr. Jia Jianping, Deputy General Manager of Sinosteel E&T attended the ceremony.

The 2Mtpa pellet project, EPC contracted by Sinosteel MECC, a wholly-subsidiary of Sinosteel E&T, has adopted the company's independently developed TGIOP (travelling grate iron ore pelletizing) technology. As the very first time of cooperation between Sinosteel MECC and Sangang, the project's successful completion also marks that the very first TGIOP project in China was put into operation. While smooth in operation, the project's environmental and economic benefits stand out. By producing 2 million tons of pellets per year, it offsets the demand of importing pellets and sinters. At the same time, it also reduces dust emissions by 247 tons, sulfur dioxide emissions by 308 tons and nitrogen oxides emissions by 246 tons per year, saving standard coal up to 56,000 tons per year.

At the ceremony, Mr. Dong Da said, "With continuous investment and efforts in technology innovation, Sinosteel MECC has successfully developed TGIOP technology and a complete set of equipment, applying the technology to projects both home and abroad, such as 2.5Mtpa in the Middle East and 4Mtpa for Tosyali in Algeria. Since 2018, Sinosteel MECC has undertaken 2×4.8Mtpa pellet project of HBIS Laoting Co. Ltd., 4Mtpa pellet project of Fangchenggang Iron and Steel Base of Liuzhou Iron and Steel Group and 2Mtpa pellet project of Fujian Sangang.

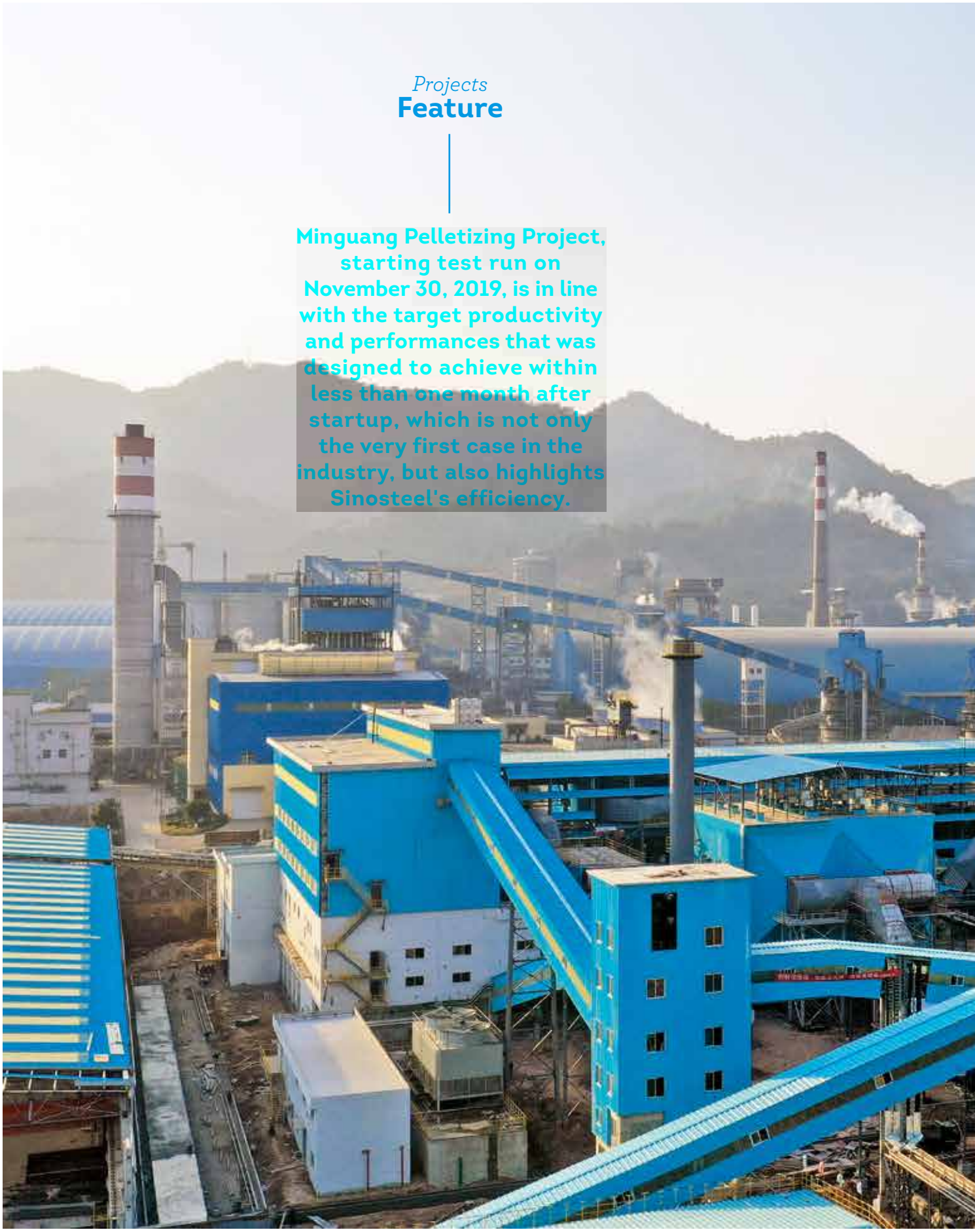
Mr. Dong Da delivering speech ❶

Mr. Jia Jianping receiving an award ❷

FEATURE

Projects
Feature

Minguang Pelletizing Project, starting test run on November 30, 2019, is in line with the target productivity and performances that was designed to achieve within less than one month after startup, which is not only the very first case in the industry, but also highlights Sinosteel's efficiency.



FEATURE IN OPERATION

IN THE FUTURE, WE WILL CONTINUE OUR INPUT IN FURTHER DEVELOPING THE TGIOP TECHNOLOGY VIA COMPUTER SIMULATION AND ARTIFICIAL INTELLIGENCE.

Among them, Sangang Minguang pellet project is the first one being completed and it is a giant step forward for Sinosteel MECC. In the future, we will continue our input in further developing the TGIOP technology via computer simulation and artificial intelligence."

Apart from the advanced technology, Sinosteel MECC was also highly praised by Sangang for its high efficiency and diligent service and was awarded the Excellent EPC Contractor of Pelletizing Project by Sansteel. Mr. Jia Jianping received the Excellent EPC Leader Award of Pelletizing Project; Mr. Cao Pengfei was honored Excellent EPC Project Manager of Pelletizing Project.

Since the start of civil work on September 28, 2018, the Project had confronted with many difficulties. Nevertheless, because always upholding the value of Customer First, Beyond Expectations, Sinosteel MECC team completed the project not only on schedule, but also with high quality.

Projects under Construction in Order at Fangchenggang Steel Base

— The plant is equipped with advanced environmental technology and facility. — The coke ovens & long steel production lines are equipped with the latest state-of-the

-art heating technologies. — The phase I steel-making environmental dedusting project undertaken by Sinosteel Tiancheng is the largest of China's steel industry. — Hot rolling rebars are conform to China's new national standard. — It is the first time, and a fastest manufacturing record in China and even in the world, that the technologies of four-girder six-rail flexible end beam bridge, upper and lower trolleys have integrated synchronization technology on large casting bridge cranes.

PROJECT KICK OFF

Fangchenggang steel production base is located in the southwestern Chinese Guangxi Zhuang Autonomous Region with a designed annual production capacity of 9.2 million tons. The base, owned by Guangxi Liuzhou Iron & Steel Group Co., Ltd., consists of port, material stock yard, sintering plant, pellet plant, coke making plant, blast furnace, steel making plant and steel rolling, of which Sinosteel MECC and its subsidiary Sinosteel Tiancheng are selected to provide complete contracting service for 5 projects.

A

Coke oven battery & coal preparation consists of four coke oven batteries, each comprising 60 large-capacity ovens with a chamber height of 7.5m. The ovens are equipped with the latest state-of-the-art heating technologies including twin flue, air stage heating, waste gas recirculation, coke oven gas under-jet and compound oven. The total annual output is to be 3.5 million tons. On November 28, 2019, coke oven No.3, China's first 7.5m large-capacity top-charging coke oven battery, was officially heated up.

B

Travelling grate pelletizing plant: the state-of-the-art travelling grate pelletizing technology and equipment independently developed by Sinosteel MECC are applied to produce 400 million tons of finished pellet products annually. The plant is equipped with advanced environmental technology and facility which form an independent and complete environmental protection and management system.

C

Long steel production lines: composed of 3 high-speed wire rod production lines and 4 rebar production lines as well as the plant buildings, foundations and auxiliary facilities. The main advanced technologies adopted include continuous casting-direct rolling, controlled rolling and controlled cooling, modular mill, pass-free rolling, gapless rolling and oil-air lubrication, enabling the customer to improve pollution control and production quality and thus reduce cost. The hot rolling and hot cooling technology, independently developed by Sinosteel MECC, used for rebar rolling ensures that martensite and bainite transformation doesn't occur in surface layer, neither tempered martensite nor closed-loop structure different from ferrite-matrix in base circle. The core surface hardness difference will be no more than 40HV. Rebar rolled with no microalloy addition and low manganese content conform to China's new national standard for hot rolled rebar (GB/T1499.2 - 2018). The closed water cooling system prevents the escape of water or steam.

Fangchenggang Steel Complex of Liuzhou Iron and Steel Group is not only a model project of national industrial structural upgrading, but also a key project of China's West Region Development. Marking a new milestone in the history of industrial development of Guangxi province, the steel complex is of great significance.

Projects

Kick-Off

Marking a new milestone in the history of industrial development of Guangxi province

Fangchenggang Iron and Steel Base

Travelling Grate Iron Ore Pelletizing Project

KICK OFF

Projects under Construction in Order at Fangchenggang Steel Base

SINOSTEEL MECC'S SELF-DEVELOPED TMCP (THERMO-MECHANICAL CONTROL PROCESS) WILL BE APPLIED TO THE PROJECT

D

The phase I steel-making environmental dedusting project undertaken by Sinosteel Tiancheng is the largest of China's steel industry. Sinosteel Tiancheng's patented pre-charged bag filtering technology with independent intellectual property rights is applied to totally 10 dedusting systems, including the secondary and tertiary dedusting of four 210t converters, LF furnace dedusting, hot metal pretreatment dedusting and underground bin dedusting. Pre-charged bag filter is a high-efficiency composite filter developed by Sinosteel Tiancheng under the National High-tech R&D Program (863 Program). It is a new type of high-efficiency filter that organically combines pre-charging and straight-through uniform flow bag filter. Upon completion of the project, it will not only meet the ultra-low emission standards of the steel industry and reduce the emission of dust particles by more than 0.1 MTPA, but also contribute to the construction of the green Fangchenggang Project. By December 2019, the design and procurement had been completed, all equipment foundations of the main line at the construction site had been basically constructed, and the main equipment had been installed in an orderly manner as planned. Of which, the main bodies of the filters of the secondary dedusting system for No.4 converter, the tertiary dedusting system for No.2 converter and the dedusting system for underground bins have been installed. The installation of the remaining bag filters is carried on efficiently as planned, and the works of auxiliary line are expected to be completed simultaneously.

E

Supply of 11 casting bridge cranes for steel making: two (380/100t-21.5m) cranes for charging bay No. 1, three (380/100t-21.5m) for charging bay No. 2, two (400/100t-23.5m) for refining bay, and four (400/ 100t-21.5m) for receiving bay, equipped with supporting HV trolley lines and brackets as well as the associated main hook motors. So far, 4 cranes have been delivered completely, and the remaining 7 cranes will be manufactured and delivered in succession. It is the first time, in China and even in the world, that the technologies of four-girder six-rail flexible end beam bridge, upper and lower trolleys are integrated with integrally-built gearbox of low-speed shaft synchronization technology on large casting bridge cranes. A fastest manufacturing record, which was only four months, to deliver one 380t casting bridge crane was made in the end.

2

1.3 MTPA Controlled Bar Rolling Transformation Project Kicked Off

The 1.3Mtpa Bar Production Line Renovation Project of Fujian Sangang Group undertaken by Sinosteel MECC on EPC basis was officially commenced on September 18, 2019.

Sinosteel MECC's self-developed TMCP (Thermo-Mechanical Control Process) will be applied to the project. The continuous casting billets are heated in a reheating furnace and then transported to the entrance of the rolling mills through a roller table when their temperature meets the rolling requirement. After each billet getting rolled in the 6-stand roughing mill train (1H~6V) via the approach of non-twist and micro-tension rolling mode and its head cropped by No.1 fly shear, it enters the 6-stand intermediate mill train (7H~12V) for rolling. And then the rolled piece is head-cropped by No.2 fly shear and enters the 4-stand pre-finishing mill train (13H~16V) for rolling. A looper is installed between every two stands of pre-finishing mills to allow tension-free rolling. A pre-water cooling device is designed after the pre-finishing mill train to control the temperature of rolled pieces, so as to improve their mechanical property and strength grade. Therein, HRB400E deformed bars of φ25 and below are produced by means of thermo-mechanical rolling without adding Nb, V, Ti or other microalloy elements, reducing production cost.

3

FOUNDED IN 1986, JINXI GROUP IS NOW THE WORLD'S LARGEST PRODUCTION BASE OF SECTION STEEL, WITH AN ANNUAL CAPACITY OF 11 MILLION TONS.

Phase II of CDQ Waste Heat Utilization Project Launched

In June 2019, Hebei Risun Coking Co., Ltd. awarded an EPC contract to Sinosteel Equipment & Engineering Co., Ltd. to build the phase II CDQ Waste Heat Utilization Project, covering the construction of one supporting power generation system for a 150t/h CDQ unit. The Project officially kicked off on July 1, 2019.

Once completed, the project will achieve low emission, with dust concentration equal to or less than 10mg/m^3, and SO2 concentration in the desulfurized exhausted gas equal to or less than 50mg/m^3. Red coke is scheduled to be put into the CDQ unit in the second half of 2020.

2x2000m^3 Blast Furnace Project of Jinxi Group Kicked Off

4

The construction of No.1 blast furnace of the Equipment Upgrading and Renovation Project of Jinxi Iron & Steel Group Co., Ltd. was officially commenced on April 1, 2019. The project, handed to Sinosteel MECC on EPC basis, consists of two 2000m^3 blast furnaces involving facilities such as material feeding before stock house, stock house, main feeding belt conveyor, furnace top, furnace proper, tuyere platform and cast house, slag granulation (including slag granulating water pump house), hot blast stoves, raw gas dedusting, pulverized coal preparation and injection, central circulating water pump station, gas bag filters, stock house dedusting, cast house dedusting and main control building.

Dry type gas bag filters and BPRT-based residual pressure recovery system are applied in the project, which is currently the most widely used method for blast furnace gas recovery and utilization in China. Compared with traditional methods, it raises energy recovery and utilization ratio and cuts energy waste. The filters for cast house and stock house are designed with more stringent standard than the ultra-low emission standard so to ensure the concentration of discharged particles be less than 5 mg/Nm^3. Moreover, to achieve the effect of non-visible smoke plume and less environmental pollution, smoke plume eliminating facilities are used for the slag granulating unit to reduce smoke exhaust during slag granulating. Besides, new domestic hot blast stove design is adopted to reduce energy consumption and increase blast temperature.

KICK-OFF

IT IS BELIEVED TO BECOME A PILLAR OF BOLIVIAN INDUSTRIALIZATION

Bolivian Mutun Steel Complex Officially Started


Informe del proyecto de Planta Siderúrgica Integrada del Mutún

The Bolivian very first integrated steel complex constructed on EPC basis by Sinosteel MECC is a key project of Bolivian government's Plan of National Development (PND) Program. It is also the world's only steel complex powered by isolated grid and supplied by long-distance raw water transmission pipeline, with a construction period of 30 months and operation period of 12 months. Recently, the complex was officially kicked off.

Expected to integrate rich iron ore resource and natural gas resource in Bolivia, once completed, the Mutun steel complex will reverse the passive situation that Bolivia had long been dependent on import of steel products. And it is believed to become a pillar of Bolivian industrialization.

Projects

Kick-Off

It is the world's only steel complex powered by isolated grid and supplied by long-distance raw water transmission pipeline

The electric furnace smelting process is applied to the complex. The scope of Sinosteel MECC covers 820,000tpa concentration plant, 400,000tpa pellet plant, 250,000tpa DRI plant, 200,000tpa EAF, 200,000tpa LF, two-strand 150x150mm billet caster, 200,000tpa rolling mill, 100MW isolated grid power generation system as well as the auxiliary system including raw water long-distance pipeline reaching a length of 120 kilometers.

Since it is a DRI+EAF mini mill, the project is expected to be environmental friendly, with low carbon emission and clean production. Besides, the production capacity and equipment configurations of all systems are well selected and carefully organized; the general layout is compatible with the minimum material transfer frequency. The equipment ensures prime quality and reliable configurations.

The project was officially started on January 16, 2019.

Up till now, the introduction of water and electricity, as well as the construction of the concrete mixing plant and camp has been completed, civil construction in the on-spot beneficiation section has been started, and over half of the long-cycle equipment has been processed. Since the project is located in the nature reserve of Bolivia, no sign of modernization can be seen, and quite a number of indigenous people live in the region. Ever since its presence in the region, the project team of Sinosteel MECC has been showing great respect to local culture, protecting natural environment, interacting with local residents via various activities. Meanwhile, local government officials have been invited to join project's celebrations.

Based on both the planning and the current situation, a large number of jobs will be created during both construction period and commercial operation period of the project. And Sinosteel MECC has reached an agreement with the Ministry of Labor of Bolivia that those expected human resources will be chosen through open recruitment and recommended list provided by the ministry, which is believed to improve the employment environment & economic development.

On September 25, 2019, Embassy of The People's Republic of China in the Pluri-national State of Bolivia, together with Rationality News, a Bolivian national newspaper with the largest circulation, jointly published a special issue for celebrating the 70th anniversary of the founding of the People's Republic of China. One full page of the special issue covers the project of Mutun steel complex.

Mutun Steel Complex

Bolivia

Projects

Kick-Off

Ever since its presence in the region, the project team of Sinosteel MECC has been showing great respect to local culture, protecting natural environment, interacting with local residents via various activities.

Sinosteel MECC Set Fastest Construction Record at SDIS Laiwu 480m² Sintering Project

On December 25, 2019, No. 1 Sintering Machine of the Sintering Upgrading Project for Shandong Iron & Steel Corporation Laiwu Branch (abbr. SDIS Laiwu) undertaken by Sinosteel MECC on EPC basis set the construction record by finishing the works in an extremely short time, only half of the scheduled.

IN PROGRESS

The project mainly involves the construction of large-scale environment-friendly, energy-saving, and high-efficiency sintering machines and supporting facilities such as flue gas desulfurization and denitration, environmental dedusting system and utilities, including two 480m^2 sintering machines, a supporting fuel warehouse, finished product screening building, etc.

Though the project team planned to start work by March 2019, delayed by unprepared site leveling and subgrade treatment, the team did not break the ground until May 21. Apart from that, because foundation construction of finished sinter bins started in mid-June, batching building and the fuel crushing building at the end of June, finished screening building in mid-July, it was almost impossible for the team to push forward the project complying with the original schedule.

Nevertheless, facing difficulties and tackling problems, through optimized and refined management, the team managed to proceed with high efficiency.

Designed with the concepts of intelligent manufacturing, environmental-friendly, low carbon and low energy consumption, the project adopted the most advanced technology and equipment in China, such as clean production technology and efficient end treatment technology; annular cooler waste heat recovery power generation, and heat recovery for plant heating. Once completed and put into operation, it is expected to produce sinter with lower emission of pollutants such as particulate matter, sulfur dioxide and nitrogen oxides, as well as recycled byproducts. All of this serves the target of coordinated development of economy and environment.

IN PROGRESS 2

One of World's Largest DRI Project Undertaken by Sinosteel MECC Completed Test Run

On December 2, 2019, Algerian Qatari Steel (abbr. AQS) DRI Project contracted by Sinosteel MECC completed the complete plant integrated test run.

Located in Bellara industrial zone in El-Milia, about 400 km east of the Algerian capital Algiers, the AQS steel complex is designed to produce 2 million tons of steel annually. Once completed, it can not only meet the local demand of steel products, but can export products to surrounding and overseas markets. The complex plays an essential role in boosting economic development of the eastern region of Algeria and improving industrial structure. As an important section of the complex, the 2.5 Mtpa DRI is one of the world's largest DRI project. In 2016, Sinosteel MECC stood out in competitions with many competitive engineering companies and won the bid of AQS DRI project by virtue of its excellent management and execution capabilities. According to the contract, Sinosteel MECC undertakes all the civil engineering, the work of installation of structures, machines, pipelines, and electric instruments as well as material supply, customs clearance and logistics transportation of part of equipment and materials. The major equipment is composed of a reduction furnace with the height of 137 meters, a reforming furnace, compressor, water system, gas analysis system, oxidized pellet conveying system and DRI product cold-state/hot-state conveying system.

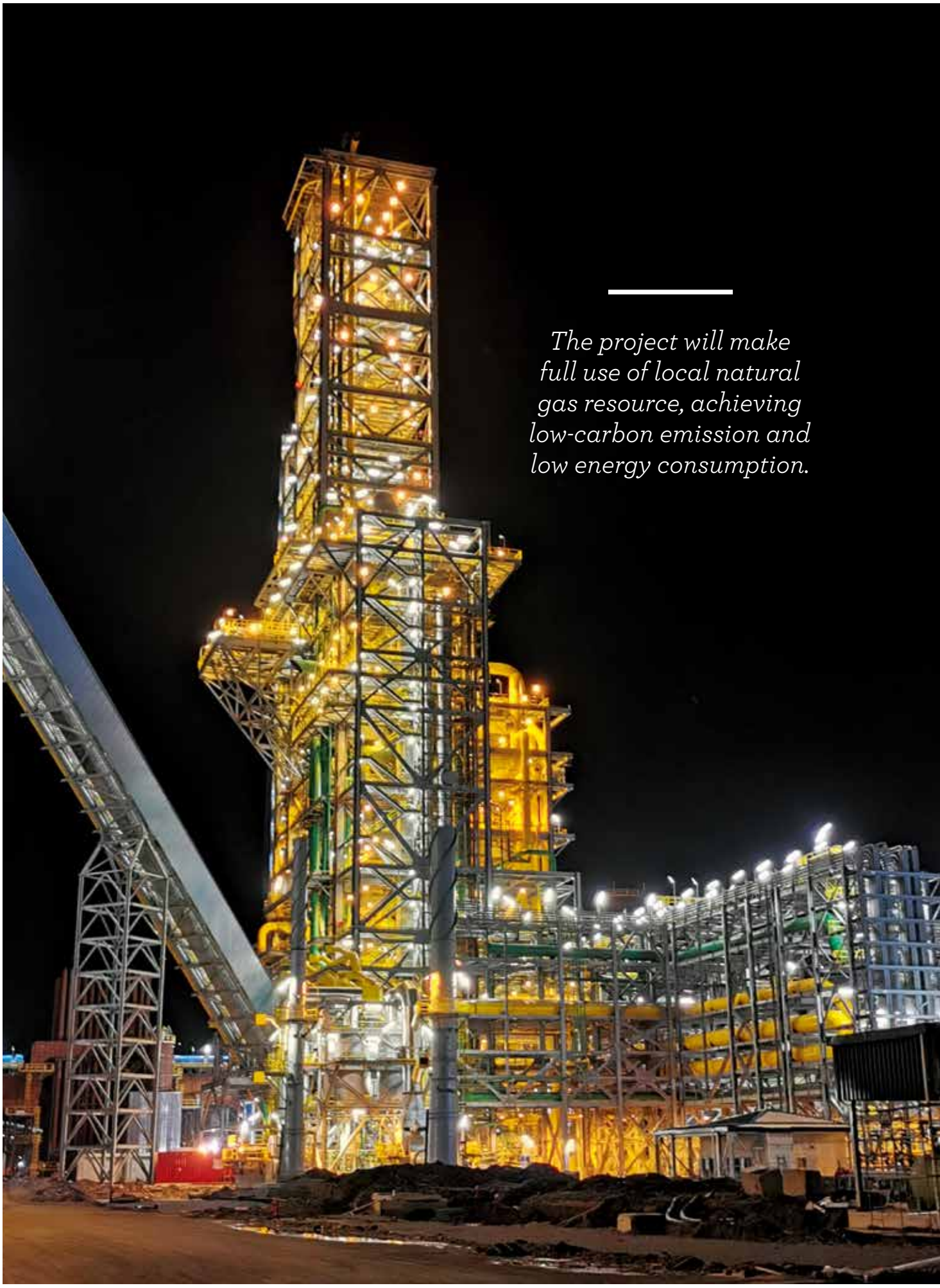
ABOUT 400KM EAST OF THE ALGERIAN CAPITAL ALGIERS, THE AQS STEEL COMPLEX IS DESIGNED WITH THE PRODUCTION CAPACITY OF 2 MILLION TONS ANNUALLY.

By adopting MIDREX process, the project will make full use of local natural gas resource, achieving low-carbon emission & low energy consumption.

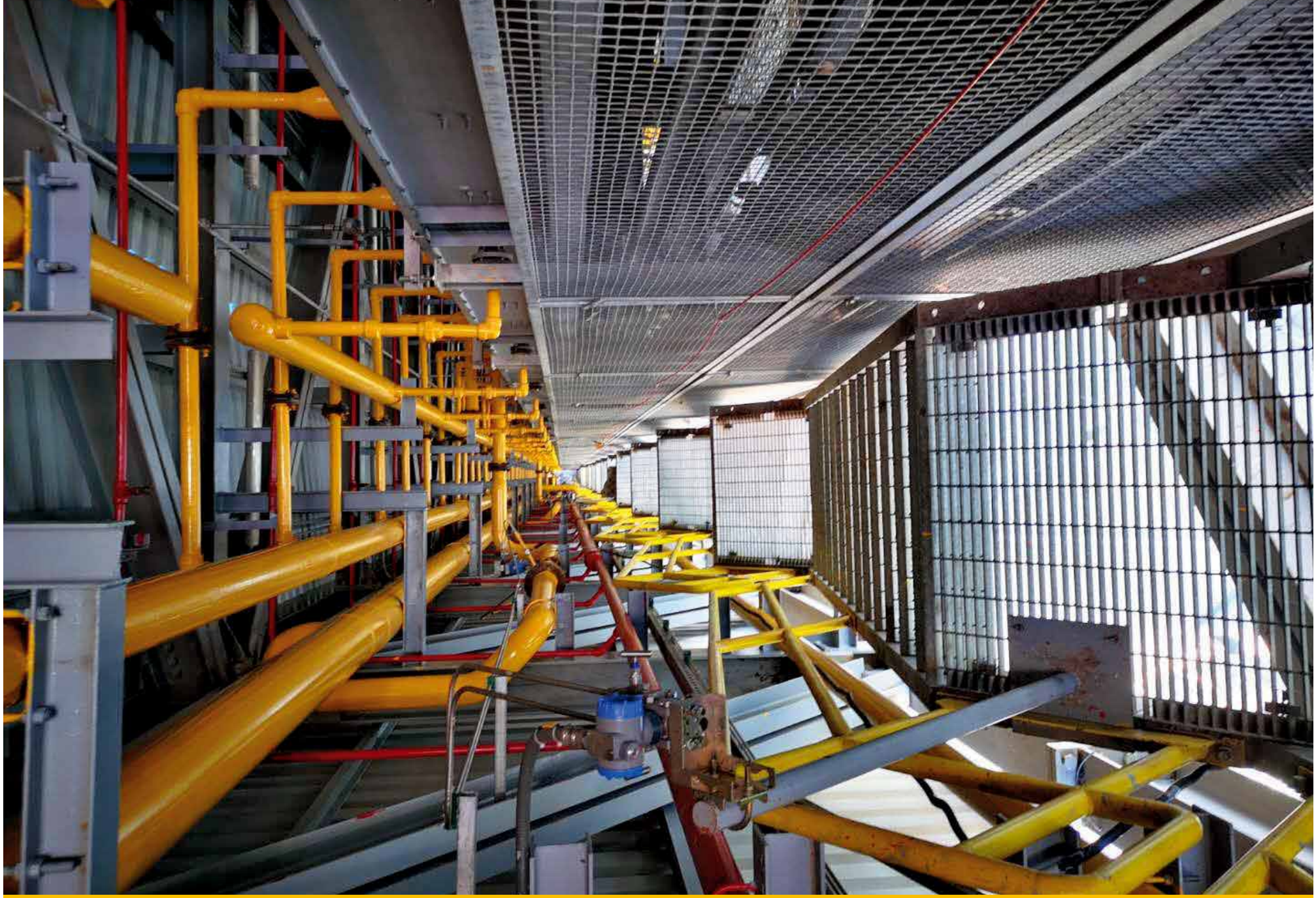
Different from EPC contracting project, the AQS DRI project selects different subcontractors for design, supply and construction. Particularly, Spanish consulting company IDOM was contracted for the overall management of the complete complex project, which requires Sinosteel MECC to coordinate with local resources and global supply chain, other than to orderly implement the project through optimization of manpower, material and resource, worldwide procurement and localized operation.

Projects
In Operation

Sinosteel MECC started civil works on January 8, 2017, conducted complete plant commissioning on May 14, 2019 and completed the integrated test run by December 2 of the same year.



The project will make full use of local natural gas resource, achieving low-carbon emission and low energy consumption.



Algerian Qatari Steel —— DRI Plant

THE FIRST TUBULAR BELT CONVEYOR LINE CONTRACTED BY SINOSTEEL MECC ON EPC BASIS, AND ALSO ALGERIA'S FIRST ONE.

3 BPM Tubular Belt Conveyor Project Started Trial Run

The Tubular Belt Conveyor Project undertaken by Sinosteel MECC for Algeria-based SPA Béthioua Port Minéralier started off-load trial run in November 2019. It is the first tubular belt conveyor line contracted by Sinosteel MECC on EPC basis, and also Algeria's first one.

The Project, aiming to build a 10.89-kilometer-long conveyor system between port Béthioua and the steel complex, consists of 7 ordinary belt conveyors and 4 tubular belt conveyors, among which the LT3 tubular is 3.7 kilometers long. By adopting 500mm-diameter tubular conveyor belt, each conveyor line is capable of two-way conveying of materials: one from the port to the material storage yard in the steel complex, with a conveying capacity up to 4,000 tons per hour; the other from the raw material storage yard to the port, with a capacity up to 2,000 tons per hour.

Sinosteel MECC Highly Recognized by JSW: Finishing Installation and Commissioning of Bodies of 100,000m³ Dry-Seal Gas Holders for BF & LD Converters Ahead of Schedule

Sinosteel MECC was awarded the contract to supply a 100,000m3 dry-seal Wiggins Type Gas Holder for BF and another for LD converter for JSW Dolvi Works on EPC basis. Installation and commissioning of the bodies of two gas holders were completed ahead of schedule.

The gas holders are single-stage, rubber membrane sealing, large-volume, and also the most flexible, economical, and efficient in the market. They are characterized by simple structure, reliable performance and facilitated operation and maintenance. Besides, with a working pressure reaching nearly 10,000Pa (currently the highest in China is 6,000-8,000 Pa), the BF gas holder's piston members bear a weight of over 500 tons. Meanwhile, the working pressure of the LD converter gas holder is about 2,000 Pa (currently the lowest in China is only 3,000 Pa). A lower working pressure means a lighter piston weight; however, the latter cannot endlessly be reduced due to the restriction of strength. As a result, lowering the working pressure of the LD converter gas holder from 3,000 Pa to 2,000 Pa leads to a reduction of the piston weight by about 260 tons, which also sets challenging requirement on the strength of the piston structure. The successful operation of the facilities is just a solid proof of the advanced design by Sinosteel MECC.Normally, it takes 2-3 years to complete the installation and commissioning of a gas holder. However, Sinosteel MECC's project team completed the installation and commissioning of the main bodies of the BF gas holder and the LD converter gas holder within one year (from November 2018 to November 2019). The high efficiency was highly recognized by JSW as a board member said "Sinosteel MECC successfully completing the work with high efficiency and excellent performance will definitely make the project a model for JSW and even the industry. I believe the project will bring more opportunities to JSW."

IN RESPECT OF SAFETY, SINOSTEEL MECC'S PROJECT TEAM HONORED "BEST SAFETY CONSCIOUS EMPLOYEE 2019" BY JSW.

5 Refractory Bricking for the 3Mtpa Stamp-Charging Coke Oven Batteries & By-Product Project for Indian JSW under Construction

In August 2018, Sinosteel MECC won the bid for the 3Mpta stamp-charging coke oven batteries & by-product project for JSW in India, including 4 coke oven batteries, each comprising 62 cokes with a chamber height of 6.25m, and 2 units of 190t/h CDQ facilities together with by-product plant, auxiliary production facilities, as well as supporting utilities.

Sinosteel MECC is responsible for the design, equipment supply, installation and commissioning.

It is the largest by-product coke making project undertaken by Sinosteel MECC in India, with single-phase production capacity of 3Mtpa coke products. The implementation and completion of the project will not only further consolidate the strategic cooperation relationship between Sinosteel MECC and JSW, but also provide an impetus to the in-depth growth of relations covering the upstream and down-stream of the industry chain. Advanced stamping, charging and pushing machines are used to ensure the stable operation of core mechanical equipment. The raw material and products are transported by mechanized belt conveyors and chutes, and the coke wharf by a scraper coke discharger. Solid sulfur is packaged in bags, and other gas and liquid products are transported through pipelines by pumps.

By the end of 2019, the foundation construction of Oven A and B were completed and the main refractory bricking of coke ovens started.

6

Equipment Procurement & Manufacturing for No.6 Boiler Project of Erdemir Completed

The equipment procurement and manufacturing for the 160t/h multi-fuel fired boiler of Erdemir, contracted by Sinosteel MECC has now been completed. The boiler uses blast furnace gas, coke oven gas, natural gas, coal tar and other medium as fuel, with an evaporation capacity of 160t/h and a boiler efficiency of 89.1%. The temperature of superheated steam is 450℃, the steam pressure is 45 barg, the CO emission concentration is less than 50 mg/Nm³, and the NOx emission concentration is less than 200 mg/Nm³.

The boiler equipment was manufactured in line with ASME standard and has passed the EU's CE certification. Besides, while its installation process is required to get EU's CE certification, its completion needs to obtain the factory's CE certification.

multi-fuel fired boiler evaporation capacity

160t/h

boiler efficiency

89.1%

emission concentrations

CO < 50 mg/Nm³

NOx < 200 mg/Nm³

superheat steam

450℃

Equipment Installation of Shanxi Woneng Chemical Co-Production Project for 300,000 tpa Ethylene Glycol & LNG Completed

7

Sinosteel MECC undertakes the equipment procurement and construction of the CO production project of 300,000 tpa ethylene glycol and LNG, with the aim of coproducing ethylene glycol and LNG fueled by coke oven gas and converter gas. The project adopts the comprehensive tail gas (coke oven gas and converter gas) to make high value-added ethylene glycol. The tail gas will be purified and extracted by applying technology independently developed by Shanxi Woneng Chemical Technology Co., Ltd.

The coke oven gas subjected to H2/CO cryogenic separation after being subjected to tar removal, temperature swing adsorption, fine desulfurization and decarburization to separate out the LNG product, and hydrogen-rich gas produced through cryogenic separation produces H2 after being subjected to PAS-H2 purification to be used for ethylene glycol devices. The CO gas is mixed with the converted gas to PSA-CO after tar removal, temperature swing adsorption, fine desulfurization & decarburization, then the mixture is delivered to PSA-CO, and the product CO is used for DMO devices. DMO is delivered to the ethylene glycol devices and reacts with hydrogen to produce ethylene glycol.

At present, the equipment installation has been fully completed. Once completed, the project will become the world's first plant taking use of comprehensive tail gas to produce high value-added ethylene glycol.

Sinosteel MECC Stood up to Challenges & Delivered Best Performances: Indian JSPL 1.9 Mtpa Coke Ovens & 3 Mtpa By-Product Project in Operation

On November 29, 2019, the last coke oven battery of Indian Jindal Steel and Power Ltd. (abbr JSPL) 1.9 million-ton coke ovens and 3 Mtpa by-product project was completed under EPC contracting of Sinosteel Equipment & Engineering (abbr Sinosteel MECC). With the coke pushing of the last battery under the witness of project teams and Mr. Naveen Jindal, Chairman of JSPL, the project has renewed many records in the coking history of India: the AS process of 3Mtpa by-product plant reaches standard in the shortest time in the history of Indian coke making industry. It only took 9 months from commencement to completion for each single 4.3m 72-hole coke oven battery, setting a new record of India's fastest coking construction. The three coke ovens in operation achieved the designed capacity and over-fulfillment of the daily output of 72-hole coke oven. JSPL felt so grateful and excited and placed a "FASTEST PROJECT EVER" plaque right in front of the coke ovens.

IN OPERATION

Lasting for almost a decade, confronting various unprecedented obstacles and difficulties, it is surely a moment worth memorizing for Sinosteel MECC. The company once again proved itself to be outstanding by meeting strict requirements on project execution, problem solving and coordinating abilities. Earlier at bidding phase, JSPL compared European technology and equipment with Chinese ones, also taking sister companie's feedbacks into consideration, and finally went with the latter. Sinosteel MECC won the bidding. The contract was signed in 2008, yet the project was not started until 2014.

The project was originally located in Petradu, a place about 500 kilometers away from the port. However, with more and more materials and equipment keep arriving, the project site's logistics disadvantages began to reveal. It was not until then did JSPL decide to change location. The acquisition of a piece of large industrial land parcel in India was never easy and time-consuming. Year entering 2012, the project team finally could resume working in the new site, namely Angur. In the process of transferring equipment & materials to the new site, new problems came up. Hand in hand, Sinosteel MECC and JSPL well dealt with financial issues & other problems encountered. In the year of 2014, the project finally went back on track.

Although problems and challenges kept emerging in the whole implementation process, the team of Sinsoteel MECC tackled them one by one. According to the team leader, Sinosteel MECC succeeded in meeting challenges and fulfilling flexible requirements, "we took full consideration of Indian character, like a tailor-make working system, formulate an orderly site schedule, organize personnel training and dispatch in a reasonable manner, and guarantee the logistics of every on-site personnel, all of which helped push the project forward." He said. Taking discrepancy on technical issue as an example, whenever encountering such situation, Sinosteel MECC team assembled directors from design institute, manufacturer, on-site service team and technical support team to offer a proper solution through considerate and overall discussion. Another key factor worth mentioning is that team of Sinosteel MECC always understands the importance of cultural awareness. They believe that respecting and understanding differentiated values and beliefs from the two sides would increase the chance of making insightful decisions and improve mutual-trust. For instance, Indians who are accustomed to holidays always place a high value to "life quality" and they take such habits into project implementation. This made a sharp contrast to the staff of Sinosteel MECC who put work efficiency first. With the unremitting encouragement and help from Sinosteel team, Indian fellows' attitude began to change.

> *Harvinder Pal Singh, assistant general manager, said that thanks to Sinosteel team, our people gradually became more and more motivated, "We tried to keep the same pace with them," he said.*

Projects
In Operation

Standing up to challenges, satisfying strict requirements and maintaining high efficiency of the project, Sinosteel MECC's great performances not only won recognition from JSPL, but also drew attention from Phoenix TV and other media. Reporters from Phoenix visited the project for special program filming. Mr. Bharat Rohra, executive director of JSPL, told Phoenix TV during the interview that by collaboration, Sinosteel MECC proved themselves to be a great partner and "we will definitely cooperate with Sinosteel again," he said.

In addition, not long after the completion of the project, Sinosteel MECC received a letter of appreciation from JSPL. In the letter, K.K. Mishra, project director stated that, "Sinosteel MECC as the engineering and technology supplier has displayed very good expertise in an evident manner while providing guidance for the project. Their team has been extremely dedicated, knowledgeable, and helpful for faster project pace in case of battery №3."

The successful completion of 1.9 Mtpa coke oven batteries of JSPL demonstrates Sinosteel MECC's increasing efficiency, cooperation and reliability, and especially its dedication to support the customers with life-cycle services.

Being one of the pioneers "going global", Sinosteel MECC entered Indian market as early as the 1990s.Through decades of development & collaboration, up to now, Sinosteel MECC has successfully built stable partnerships with well-known steel giants such as JSW, JSPL, JINDAL SAW and Indian state-owned enterprises such as SAIL and NMDC.

Being one of the pioneers "going global", Sinosteel MECC entered Indian market as early as the 1990s.

India Jindal Steel and Power

IN OPERATION

2

HIGH QUALITY, HIGH YIELD,
LOW CONSUMPTION, LONG LIFE
& ENVIRONMENTAL PROTECTION

Shenglong Renovation & Technical Transformation Project Started Operation

On December 16, 2019, all works of the Renovation and Technical Transformation Project built by Sinosteel MECC on EPC basis for Guangxi Shenglong Metallurgical Co., Ltd. was successfully put into operation. The project consists of stockyard, sintering, iron making, steel making, steel rolling and auxiliary facilities of the plant.

Shenglong Technical Transformation Project is one of the large-scale domestic projects undertaken by Sinosteel MECC, sticking to the principle of green, environmental protection, high efficiency and sustainable development for both design and construction. Since the signing of the contract in March 2018, Sinosteel MECC has conducted comprehensive, in-depth and painstaking work for preparation and coordination. All project departments were well equipped with elite expert team, proceeding with refined management sector by sector.

At the same time, the project team pool their know-how using efficient and direct communications to ensure the safety, quality, progress and cost saving of the project. For example, the iron making works are constructed in accodance with the guidance of "high quality, high yield, low consumption, long life and environmental protection". And design of blast furnace is based on the principle of "advanced, reasonable, economical, applicable and safe", ensuring the adoption of advanced smelting technology and technical equipment such as concentrate materials, high blast temperature, high top pressure, oxygen enrichment and pulverized coal injection. As statistics show, the blast furnace reaches a national advanced level in respect of main technical and economic indexes and equipment level. So far, every project unit is in well operation, with indexes conforming to the design specifications and reaching the requirements of evaluation, among which the coefficient of utilization of sintering and blast furnace reaches China's advanced level.

3 Material Supply and Return System Project for No.1 Blast Furnace of Ningbo Steel Running Effectively

On July 25, Hangzhou Iron & Steel Group and Ningbo Iron & Steel Co., Ltd. (Ningbo Steel) held a completion ceremony for No.1 Blast Furnace at its cast house platform, marking the official startup of the trial production stage. The Material Supply and Return System Project for №.1 Blast Furnace was constructed by Sinosteel MECC.

The project is mainly composed of coke feeding system before stock house, newly-built sinter conveying system, material returning system, supporting dedusting system, electrical room and automatic remote control system, telecommunication system, as well as zonal pipelines and the safety and fire protection system.

Since the commencement of the project on April 30, 2018, Sinosteel MECC's project team have been fully dedicated to the steady progress of the whole project and succeeded in fulfilling several key stages: equipment's individual test run on May 21, the off-load integral trail run of the coke supply line on June 23, commissioning on July 1, the off-load integral trail run of ore supply line on July 9, and commissioning on July 18. Additionally, about 8,000 tons of coke, various lump ores and sinter have been successfully transported with equipment working in good order, which laid the foundations for the operation and ignition of No.1 Blast Furnace. Taking advantage of the industry's leading process, the project adopts the advanced and environment- friendly transportation technology of tubular belt conveyor in the newly-built K300 sinter conveying system J300, J302 and J304 coke conveying systems, among which the K300 and J300 tubular belt conveyors are located in the existing plant. In order to bypass the structures of the existing system, Sinosteel MECC has come up with an optimized design, which helped overcoming the difficulties in the process of equipment manufacturing and commissioning.

Sintering Project of Jinnan Steel Put into Operation 4

In October 2019, the whole line of the 2x220m^2 sintering works of the Renovation and Technical Transformation Project contracted by Sinosteel MECC on EPC basis for Shanxi Jinnan Iron & Steel Group was put into operation.

Located in the new plant of Jinnan Steel, Quwo County, Shanxi Province, the newly-built sintering production line includes two 220m^2 sintering machines, with a total annual output of 4.8 million tons of sinter. Sinosteel MECC undertakes the complete line as well as the matching utility and auxiliary facilities such as general layout and transportation, power supply and distribution, water supply and drainage, automation, telecommunication, ventilation and dedusting, waste heat and fuels. In terms of design, the project team has adopted reliable process and technical equipment, in line with a practical automation. The construction was commenced in mid-September 2018 and №.1 sintering machine started operation on July 23, 2019 delivering excellent performances with stable operation and record-high output, which earned Sinosteel MECC recognition and praise from the client.

IN OPERATION

5 The Huoqiu Steel Complex Project Completed

The Huoqiu Iron Ore Deep Processing Project, contracted by Sinosteel MECC on EPC basis is composed of two 1780m³ blast furnaces and supporting utility and auxiliary works, 2x65-oven 5.5m stamp-charging coke ovens as well as by-product and supporting utility and auxiliary facilities, with an annual output of 1.3 million tons of total CDQ, two high-speed wire production lines with an output of 600,000 t/a and two bar production lines (with an output of 1 mtpa and 0.8 mtpa respectively) and supporting utility and auxiliary facilities. Both blast furnaces and coke ovens were put into operation in December 2019, and the high-speed wire and bar production lines were completed & started operation on June 30, 2019.

SINOSTEEL MECC MADE A DETAILED BREAKDOWN OF EACH PROCESS AND USED CNC MACHINE TOOLS FEATURING HIGHER EFFICIENCY FOR PROCESSING.

6 1.2Mtpa Metallurgical Limestone Production Line of Liunan Flux Put into Operation

Contracted by Sinosteel MECC on EPC basis and invested by Liuzhou Shanhai Technology Co., Ltd., the 1.2Mtpa Metallurgical Limestone Production Line Project employs Maerz parallel flow regenerative lime kiln with a suspended cylinder structure, which is the up-to-date lime kiln production technology. The technology, which not only calcines standard particles of 40-90mm, but also in smaller or larger sizes, is becoming increasingly important in China due to the growing shortage of natural resources (including limestone). The project construction was officially commenced on November 1, 2017, and the ignition and hot test started on January 26, 2019. By the end of June 2019, the hot commissioning of all 6 kilns were completed, followed by successful performance test. The lime kilns are currently boasting the highest output among similar Maerz lime kilns around the globe, reaching the design capacity rapidly with quality products and setting a record of completing hot test of three Maerz kilns within one month.

7 Successfully Delivers All 210 Straight-Grate Cooler Pallets for No. 4 Production Line of Liberty Ostrava Steel Mill in Czech

In July 2019, Sinosteel MECC signed a contract with Liberty Ostrava Steel Mill for manufacturing 210 straight-grate cooler pallets for its No. 4 Sintering Line. This project marks the first contract between Sinosteel MECC & Liberty Ostrava Steel Mill, and it is also the first time that Liberty Ostrava purchases Chinese made straight-grate cooler pallet products.

Given that there is no direct conversion standards for manufacturing, while based on the customer's technical requirements and took into consideration the customer's previous standards and designations, Sinosteel MECC's technical team has done comparative analysis of the chemical compositions of the materials and selected the matching standard Chinese designation of RTCr. After several rounds of efficient and detailed consultations,

Sinosteel MECC ~
Liberty Ostrava Steel Mill in Czech

Liberty Ostrava finally agreed to use the conversion scheme proposed by Sinosteel MECC on the premise that chemical compositions, heat treatment and others reaching the required standards. The whole project involves large number of components and parts, mainly including 840 grates, 420 chain rings and 210 frames, covering all links of mechanical processing and manufacturing such as casting, flaw detection, welding, heat treatment, machining, painting and assembly. In order to ensure a well-organized production, Sinosteel MECC made a detailed breakdown of each process and used CNC machine tools featuring higher efficiency for processing, together with the assembly carried out by multiple teams and shifts. As a result, Sinosteel MECC delivered the project on time.

Since it is the first cooperation between the two companies, Liberty Ostrava has visited the manufacturer twice for inspection and acceptance check during commissioning and pre-delivery acceptance stages respectively. Each time, Sinosteel MECC' team was there to guarantee on-site communications, providing solutions whenever a technical question was raised by the customer. Besides, its workmanship, production capacity and patient communications were highly appraised by the customer, and team member from the two companies even became good friends. During New Year's Day, Chinese Spring Festival and other holidays, Sinosteel MECC's project team has always received emails full of sincere wishes from the customer. When the project passed the acceptance with good quality on schedule, Sinosteel MECC also gained trust from Liberty Ostrava by virtue of its perfect organization, professional production capability and excellent product quality. In November 2019, Sinosteel MECC won a new order on a total of 305 Type-C pallets from the customer. Ostrava Steel Mill, originally affiliated to ArcelorMittal Group and sold to Liberty Group in 2019, is Czech's largest steel complex.

8

Sangzhang 15MW VAM and Low Concentration CMM Oxidization Power Generation Project for Yangquan Coal Industry Group Was Formally Put into Production

In 2016, Sinosteel MECC was awarded the Sangzhang VAM and Low Concentration CMM Power Generation Project for Yangquan Coal Industry Group in 2016. The project, consisting of 6 Regenerative Thermal Oxidation (RTO) devices, 53.5t/h waste heat boiler and 15MW turbine generators, covers the scope of engineering, equipment and material supply, construction, equipment installation and commissioning, as well as technical service. The project combines VAM mixing system, VAM oxidization system and waste heat power generation system. Drained low concentration CCM is captured and mixed into VAM, resulting in mixed methane concentration of 1.2%. The mixed methane is transported to RTO devices and totally oxidized, exporting 950°C hot air. High temperature and pressure (9.8MPa, 540°C) water steam is generated from the hot air after heat exchange in waste heat boiler, for power generation. Heat-electricity co-generation enables the replacement of coal fired boilers for heat supply in winter. With the oxidization utilization of VAM, the project reduces greenhouse gas emission by 830,000 tons CO2 per year. Under the national policy of energy saving and emission reduction, this project will become a new development direction for coal mining enterprises.

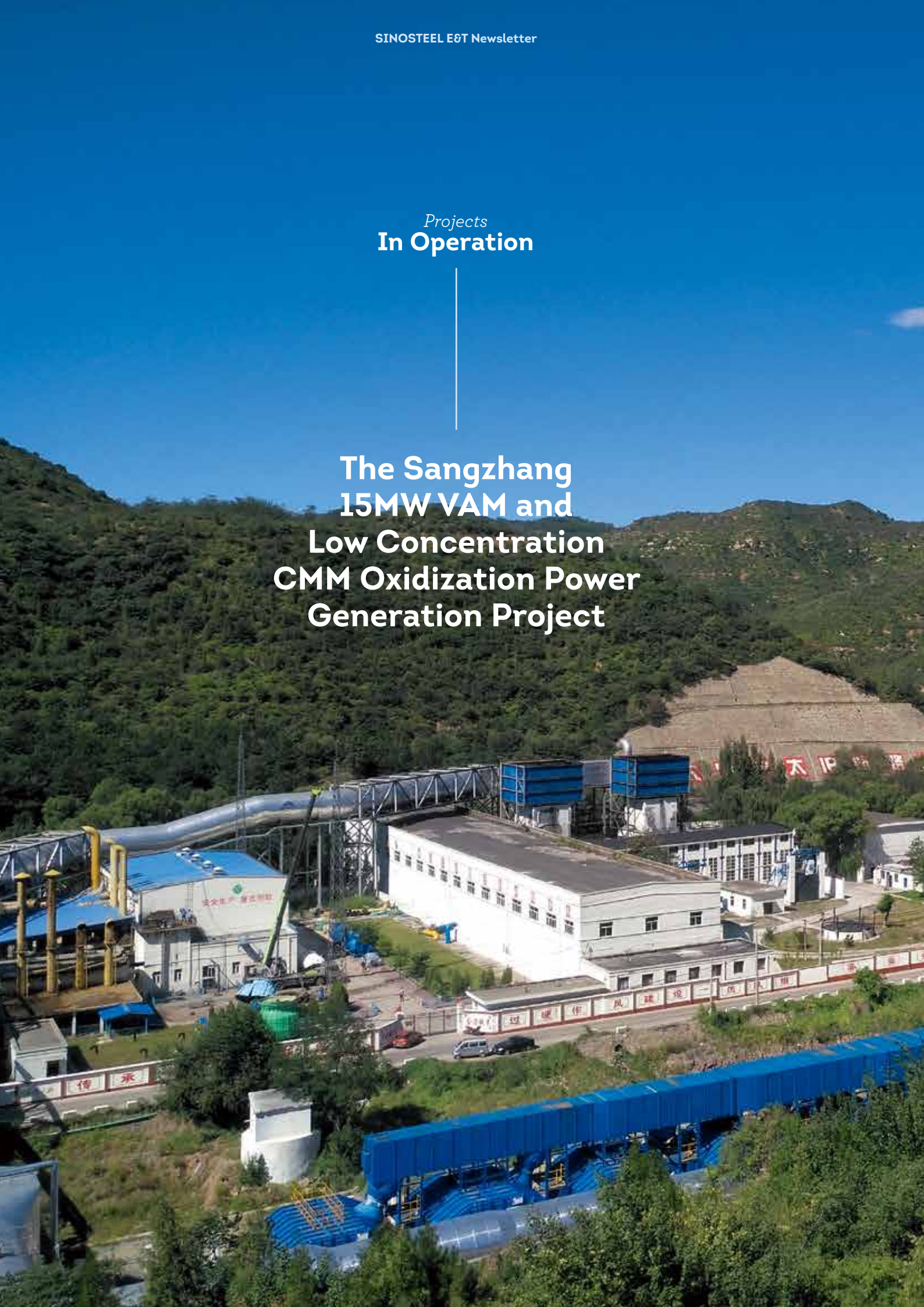
Heat supply started in November 2018. In 2019, the project was formally handed over in June. Before then, the power generation commissioning took place in February and grid connection was done in May. According to the testing result of SGS China, the destruction rate of methane reached 99.92%.

destruction rate of methane

99.92%

Projects
In Operation

The Sangzhang 15MW VAM and Low Concentration CMM Oxidization Power Generation Project



Yangquan Coal Industry Group

IN OPERATION

THE FIRST CASE OF DESULFURIZATION, DENITRATION & DEDUSTING OPERATION BY SINOSTEEL TIANCHENG IN THE SUBDIVISION FIELD OF GAS-FIRED BOILERS.

9

Sinosteel Tiancheng Successfully Handed-over Desulfurization and Denitration Technical Renovation Project of Fulun Steel

The dedulfurization and denitration technical renovation project contracted by Sinosteel Tiancheng Environmental Protection Science & Technology Co., Ltd. (abbr Sinosteel Tiancheng) for Shandong Fulun Iron & Steel Co., Ltd. (Fulun Steel) started operation with flue gas treatment on August 29, 2019 and handed over after 168h continuous trial running on October 2.

Sinosteel Tiancheng reformed the desulfurization and denitration devices and supplied new dedusting device for three 100t/h gas-fired boilers, so as to meet the emission standard stipulated for the phase IV of 2020 (SO2 < 35mg/m^3, NOx < 50mg/m^3, and dust < 5mg/m^3). Apart from that, SCR denitration technology is adopted for denitration devices and DRT technology (patented) for desulfurization devices and membrane bag filter technology for dedusting devices.

66

The whole project was successfully put into operation, reaching contractual requirements and gaining customer's recognition. Denitration, desulfurization and dedusting systems have been running smoothly for nearly half a year.

99

Projects
In Operation

Sinosteel Safety and Environmental Protection Research Institute Co., Ltd. (Sinosteel SEPRI), a subsidiary of Sinosteel E&T has succeeded in providing HSE consultation services for four overseas mine projects of Wanbao Minerals Co., Ltd. in 2019.

10 Sinosteel SEPRI Succeeded in Providing HSE Services for Overseas Projects

Sinosteel Safety and Environmental Protection Research Institute Co., Ltd. a subsidiary of Sinosteel Engineering & Technology Co., Ltd. has succeeded in providing HSE consultation services for four overseas mine projects of Wanbao Minerals Co., Ltd. in 2019.

Services include the followings:
Ⓐ to identify and analyze risks and weaknesses of current HSE systems in overseas projects and come up with targeted control measures.
Ⓑ to assist HSE management teams of overseas in fulfilling the work of "duty performance and empowerment" and promoting the implementation of HSE management system by a series of trainings.
Ⓒ to summarize, compare and refine the current situation of projects' HSE management and to form a tailor-made management mode for Wanbao Minerals. Sinosteel SEPRI conducted refined organization and arrangement in the first place, with the expert-team, which included Vice President Wang Xianhua as the chief in charge, paying visits to each site of the four mine projects during August to December 2019. Those projects included Kamoya Copper-Cobalt Mine of Comika Mining and Pumpi Copper-Cobalt Mine of Lamika Mining in Congo (DRC), and Monywa Copper Mine L and S&K Mine of Yangtze Mining Limited in Myanmar. During each inspection, on-site consultation and technical services were provided as well.

Identification of comprehensive risks and hazards and investigation of potential dangers in respect of safety management, mining methods, slope management, blasting management, road transportation, gravel processing, electrical equipment, occupational hazards, environmental pollution and others were made, with a total of 385 potential dangers and problems found during the consultation. Moreover, they exchanged views and answered various difficult questions raised by mine owners regarding the policy and technical levels. Furthermore, a series of 14 trainings were conducted for different levels, covering a total of 358 participants. After the on-site consultation, led by Vice President Wang Xianhua, Sinosteel SEPRI presented a special report to Wanbao Minerals and brought forward solutions to the issues of major concern in the four mines.

Wanbao Minerals is a wholly-owned subsidiary of China Norinco Co., Ltd. Owning a number of subsidiaries of mining entities overseas, it has gradually developed into an international mining company with advanced technologies in exploration, mining, mineral processing and smelting as well as first-class management capabilities. The successful cooperation with Wanbao has laid Sinosteel SEPRI a solid foundation for building new technical service and operation model.

Sinosteel SEPRI Successfully Implementing the First Directional Blasting Demolition of A Cable-Stayed Bridge in China

In December 2019, the Jinwu Bridge, located at the intersection of Jinhua Development Zone, Wucheng District and Jindong District, collapsed to the direction as planned with the main tower towards downstream, marking that Sinosteel Safety and Environmental Protection Research Institute Co., Ltd. (SEPRI), a subsidiary of Sinosteel Engineering & Technology Co., Ltd., has successfully fulfilled the first directional blasting demolition of a cable-stayed bridge in China.

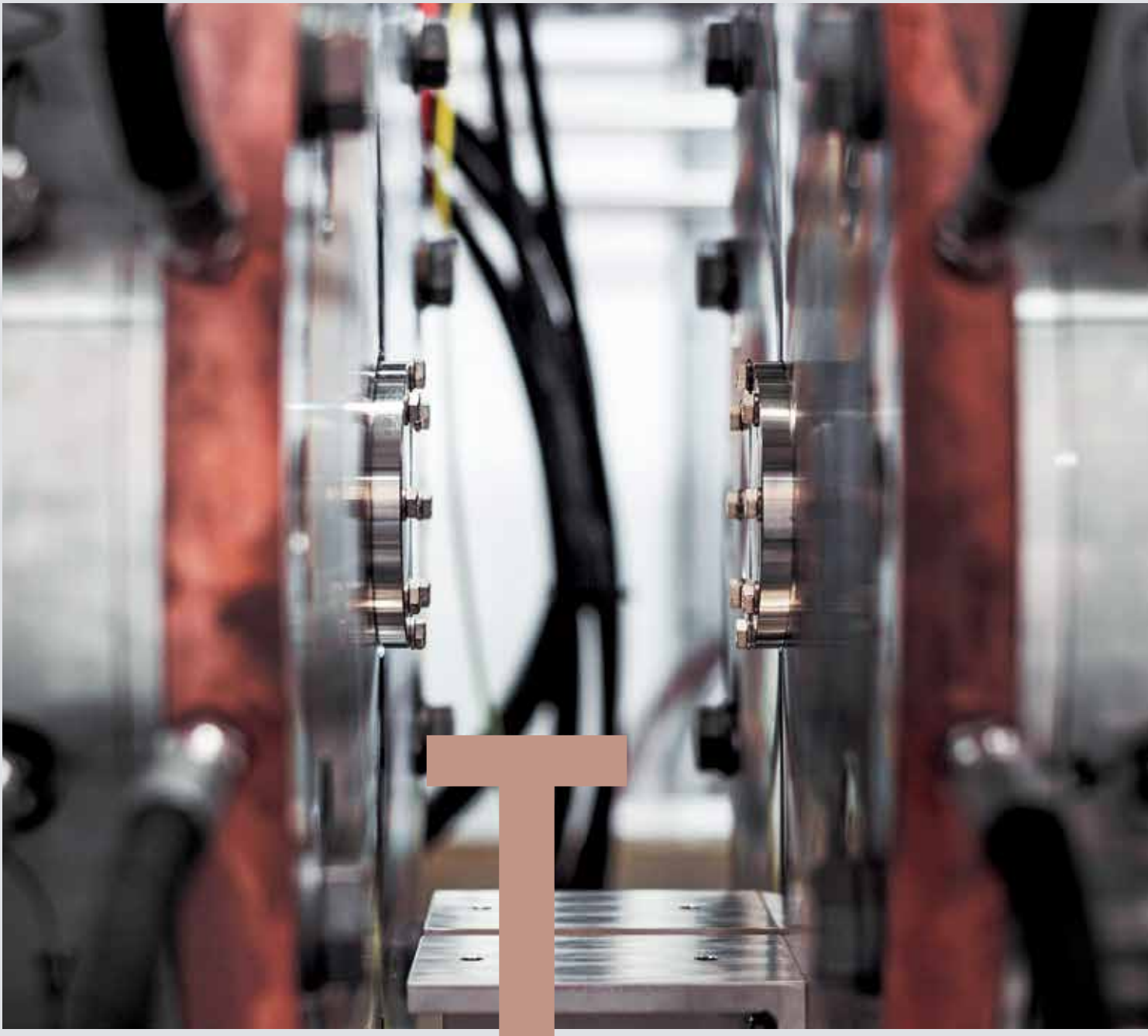
IN OPERATION

The Jinwu Bridge, located over the Wuyi River in Jinhua City, Zhejiang Province, was completed and opened to traffic in December 1997. The bridge, 260 meters in length, 24.7 meters in deck width and 64 meters in tower height, was the first cable-stayed bridge in Jinhua. Operating for two decades and bearing long-time excess load, the bridge is now subject to potential risks. Worse still, the rolling of overloaded vehicles and the scouring of floods in rainy season have caused much damage to the bridge structure to varying extents. Although getting repaired and reinforced many times, the bridge still cannot meet the surging needs of traffic flow. To this end, the project of bridge demolition has been launched and the task was assigned to Sinosteel SEPRI.

The whole blasting project is the first blasting demolition of a single-tower and single-cable-plane prestressed cable-stayed bridge in China. The blasting environment is particularly complicated – a newly-built temporary steel bridge 19 meters upstream, a main river-crossing water pipeline 27 meters downstream, and a number of residential and business districts locating on both sides. Meanwhile, to ensure a safe blasting stands for extremely high technical requirements – in the case of large -unit-consumption blasting, the absolute safety of the upstream temporary steel bridge and the downstream main tap water pipe must be guaranteed, and anxiety and concern of nearby citizens must be soothed. Given the complicated situation, the expert team from Sinosteel SEPRI Blasting Institute have had several times of in-depth discussions and successfully solved the key technical problems by theoretical calculation, numerical simulation and making similar models. Taking into account the structural characteristics, surrounding environment and engineering requirements of the bridge and for the purpose of ensuring the safety of the surrounding buildings and the full collapse of the upper structure, the main technical approaches taken are specifically as following:

- **A** *in-hole and out-of-hole delayed initiation technology is adopted to realize initiation in one time and make the main tower collapse perpendicularly to the bridge deck and towards the north (downstream).*
- **B** *collapse blasting scheme of main piers and bridge deck in situ.*
- **C** *set the blasting sequence from main tower to beam block & to the main piers.*

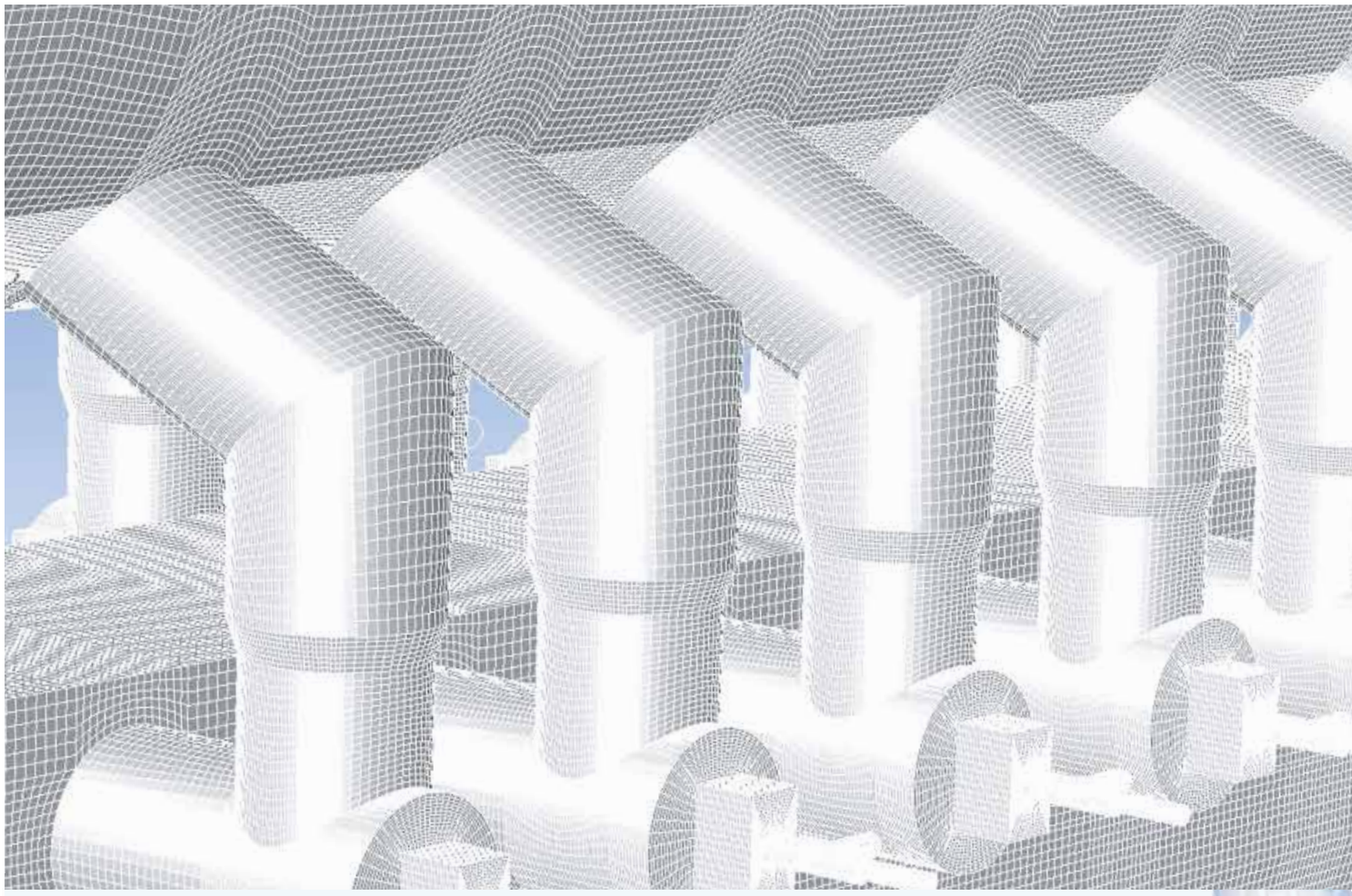
The successful completion of the blasting project of the Jinwu Bridge manifests Sinosteel SEPRI's strong research and innovation capability in blasting technology, and also marks the commencement of the reconstruction project of the new bridge. In possession of key technologies such as blasting demolition and protection of high-rise structures, sinking well assisted underwater blasting, safe blasting equipment, response of steel medium to explosion load and large chamber blasting, Sinosteel SEPRI has completed more than 1,000 blasting projects of all types up till today.



Technology Solutions

As a leading technology-driven engineering company, Sinosteel E & T always places great value of technology innovations. In the section of Technology & Solutions, we are outlining some of our recent breakthroughs on metallurgical process such as TMCP, TGIOP and Coke Oven Battery, environmental protection and additive manufacturing. These technological breakthroughs have well served the needs of our customers and provided them the best solutions.

05



R&D TECHNOLOGY UPDATES

Application of Numerical Simulation in Pellet Production Process of Travelling Grate

Abstract

Sinosteel Engineering & Technology Co. Ltd. (Sinosteel E&T) has independently developed Travelling Grate Iron Ore Pelletizing (TGIOP) Technology, including software and main process equipment which is manufactured completely in China.

As a whole equipment, travelling grate can effectively shorten the distance between each process section and greatly reduce the resistance of material transfer and energy transfer. At the same time, the working conditions of each process section and the operation of the whole furnace are highly coupled. Therefore, it is very difficult to predict the influence of the parameter variation of a certain process section on other sections of the furnace. In order to better understand the production performance and coupling effect of travelling grate, Sinosteel E&T has introduced computational fluid dynamics (CFD) into R&D. Through establishment of a complete, three-dimensional steady-state travelling grate model, simulation of the temperature and flow field distribution under actual working conditions, the rationality of the production process were verified and the technical parameters of the process were optimized.

Introduction

The production process of travelling grate is the main process of pellets production. In recent years, China has put forward a series of new environmental protection strategies and thus set stricter standards for iron and steel production. Under such background, travelling grate machine plays a pivotal role in pellets production by virtue of its green production features. At present, in the world's oxidation pellet market, the pellet production capacity of travelling grate is 205 million tons per year, accounting for 66.07% of the world's total, the pellet production capacity of grate kiln is 80.6 million tons per year, accounting for 26.57%, and the pellet production capacity of shaft furnace is 23 million tons per year, accounting for 7.36%.

fig.1

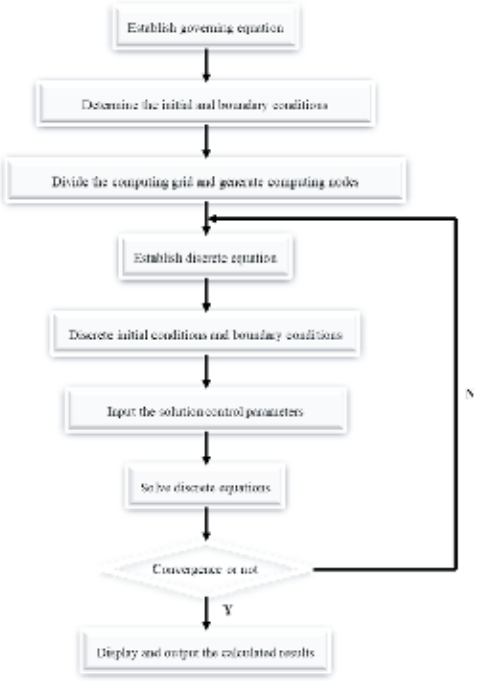
Production capacity of different process in the world

Sinosteel E&T has been committed to the research and application of the travelling grate technology in recent years. Following the successful application of the technology and its matching equipment in Middle East and Algeria, several domestic travelling grate pellet projects have been awarded to the company. With the continuous development of the project, the technical advantages of Sinosteel E&T's TGIOP technology becomes increasingly prominent. The achievements are the reward of the company's long-term focus on technology research & development, as well as its continuous introduction of new research methods and instruments. Based on the theoretical models of heat transfer, heat and mass transfer in porous media and hydrodynamics, the CFD simulation technology is used to solve problems related to the flow field, temperature and combustion reaction in the travelling grate, as well as pelletization process of travelling grate.

CFD Technical Idea and Solve Loop

The travelling grate is a closed system which can realize the circulation of hot air. The drying, preheating, firing, after firing and cooling of pellets are all completed in one equipment. It is very difficult to monitor and collect the data in the production process. However, such shortcoming can be complemented via CFD. The basic idea of using CFD to analyze mass and heat transfer phenomena is to use a set of variable values on a series of finite discrete points to replace the continuous physical quantity field in space domain, such as velocity field and temperature field. Then, the algebraic equations of the relations between the field variables of these

T.U. Technology Updates



CFD solution flow chart

fig.2

The idea of using CFD to analyze mass and heat transfer phenomena is to use a set of variable values on a series of finite discrete points to replace the continuous physical quantity field in space domain, such as velocity field and temperature field.

discrete points are established in a certain way, and the approximate values of the field variables are obtained by solving the algebraic equations. CFD can be regarded as the numerical simulation of flow under the control of basic flow equations (mass conservation equation, momentum conservation equation, energy conservation equation). Through this numerical simulation, the distribution of basic physical parameters (such as velocity, pressure, temperature, concentration, etc.) in the flow field is obtained. The solution process is shown in *Fig. 2*.

Governing Equations Solved by CFD

The governing equations are a set of equations that must be satisfied in the process of numerical simulation, including continuity equation, momentum equation and energy equation, which correspond to the laws of mass conservation, momentum conservation and energy conservation respectively. For the partial differential equation established in the solution domain, the analytical solution can be obtained theoretically, but the problems to be dealt with are often quite complex, which makes it hard to obtain the analytical solution. Therefore, it is necessary to divide the continuous solution domain into grid or element sub region by numerical method, transform the partial differential equation as the control equation into the algebraic equation (discrete equation) connecting the relationship between the function values to be solved on the nodes, and solve the established algebraic equation to obtain the node values of the solution function. The values of other positions in the calculation domain are determined according to the fractional assumption between nodes and the discretization equation.The main difference between different numerical methods lies in the way of solving regional discretization and the way of controlling equation discretization. Finite difference method, finite element method, boundary element method, finite volume method and finite analysis method are widely used in the numerical method of fluid mechanics. In the process of calculation, the value of each discrete point variable representing the field variable is calculated iteratively under the condition that the above three sets of equations are met, until the error between two immediate iterations reaches the allowable range, it is regarded as the calculation convergence, that is, the equation group has obtained the effective solution.

Continuity Equation: (1)

$$\frac{\partial \rho}{\partial t}+\frac{\partial(\rho v_x)}{\partial x}+\frac{\partial(\rho v_r)}{\partial x}+\frac{\partial(\rho v_x)}{\partial x}=0$$

Momentum Equation (N-S Equation): (2)

$$\frac{dv_x}{dt}=X-\frac{1}{\rho}\frac{\partial p}{\partial x}+\eta\left(\frac{\partial^2 v_x}{\partial x^2}+\frac{\partial^2 v_x}{\partial y^2}+\frac{\partial^2 v_x}{\partial z^2}\right)$$

$$\frac{dv_y}{d\tau}=Y-\frac{1}{\rho}\frac{\partial p}{\partial y}+\eta\left(\frac{\partial^2 v_y}{\partial x^2}+\frac{\partial^2 v_y}{\partial y^2}+\frac{\partial^2 v_y}{\partial z^2}\right)$$

$$\frac{dv_z}{d\tau}=Z-\frac{1}{\rho}\frac{\partial p}{\partial x}+\eta\left(\frac{\partial^2 v_z}{\partial x^2}+\frac{\partial^2 v_z}{\partial y^2}+\frac{\partial^2 v_z}{\partial x^2}\right)$$

Energy Equation: (3)

$$\rho c\frac{\partial t}{\partial \tau}=\lambda\left(\frac{\partial^2 t}{\partial x^2}+\frac{\partial^2 t}{\partial y^2}+\frac{\partial^2 t}{\partial z^2}\right)+q_v$$

Discretization Model of Travelling Grate

When using numerical method to solve the control equation, we must use some means to discrete the control equation in the space, and then get the discrete equations. In the domain, the grid must be used to discretize the control equations, and the discrete points correspond to the grid nodes one by one, so the good grid quality determines the accuracy and speed of the solution. Generally speaking, the structural grid is more regular in space, and the calculation accuracy and efficiency are higher than the un- structured grid, so the structured grid is used to obtain the accurate simulation results. *Fig. 3* shows portion of the discrete grid in the travelling grate model.

fig.3

Structural grid used in travelling grate model

Streamlines of flow in travelling grate

fig.4

Numerical simulation can be used to calculate the amount of pollutants produced in the pellets production process by travelling grate, which is of great significance in the context of achieving low emission and protecting environment.

Calculation Model & Boundary Conditions

Because of symmetric distribution of burners on both sides of the travelling grate and the parameter characteristics of the natural gas at the inlet, K-ω turbulence model is selected to calculate the flow field. The boundary conditions are based on the actual working conditions, mainly including the air volume, air pressure,composition and temperature at the inlet & outlet of the updraft drying section, downdraft drying section, the primary cooling section and the secondary cooling section as well as the inlet of the circulating fan. In addition, the parameters, such as pellets bed resistance, pellets heat transfer coefficient and porosity, are all based on the experimental data. While setting the pellets bed as porous medium, convection heat transfer is taken into consideration.

Simulation Results

❶ *Flow field*

The internal flow field of the travelling grate is a whole device, and the energy is recycled among the process sections with the air flow as the carrier. The flow field distribution inside the travelling grate can be obtained by simulation calculation, and the flow field is represented by streamline as shown in *Fig. 4*.

At the same time, the velocity and pressure of the air flow in any position of the travelling grate can be analyzed through the post-processing of the flow field. Based on this, the reasonable optimization of the internal structure of the travelling grate can be carried out, so as to reduce the loss of air flow resistance and improve the utilization coefficient of air fan.

❷ *Temperature field*

After calculation, the temperature distribution in any position inside the travelling grate is obtained. In the post-processing, the temperature distribution can be characterized by cloud chart, as shown in *Fig. 5*. According to the temperature distribution to guide the selection of refractory materials and structural design, 'targeted' design reduces the consumption of high-quality refractory materials and saves the manufacturing cost.

❸ *Combustion flame*

The main energy of the pellet production by the travelling grate comes from the combustion reaction of natural gas or mixed gas. The gas is injected through the burners on both sides and mixed with heated air from primary cooling section. Then the hot fume flows through the material layer from above and heats the material layer to the firing temperature. In this process, it is necessary to strictly control the shape of the flame to prevent the pellet from overburning due to the local high temperature. Therefore, the flame shape shall be be simulated by CFD, as shown in *Fig. 6*, to guide the control of gas composition, injection speed and pressure.

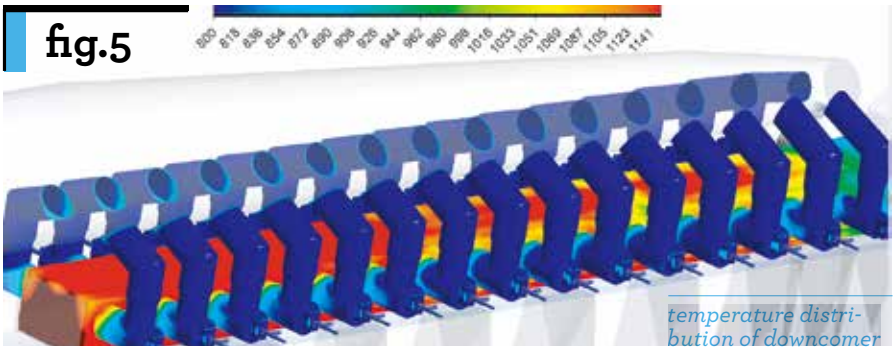
Conclusion

>>>>>>>> *Through the flow field simulation of the travelling grate, the zone with large air flow resis- tance loss can be calculated, which is conducive to the optimization of the equipment structure and the reduction of kinetic energy loss.*

>>>>>>>> *Through calculation of the temperature field, it can guide the material selection and structure design of the refractory, effectively reduce the amount of the refractory and save the cost.*

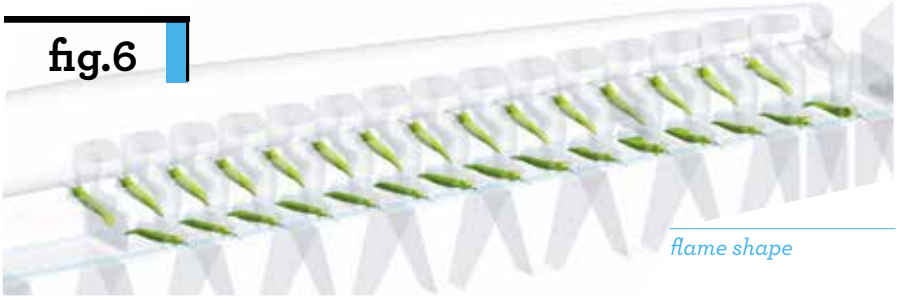
>>>>>>>> *The calculation of combustion flame is helpful to control the temperature distribution above the bed and improve the quality of pellet.*

fig.5



temperature distribution of downcomer of travelling grate

fig.6



flame shape

T.U. **Technology Updates**

Development and Application of Thermal-mechanical Controlled Processing and Matched Key Equipment for Long Product

Innovation

With years of study and technological innovation, Sinosteel E&T has developed the state-of-the-art Thermal-mechanical Controlled Processing (TMCP) and core equipment with independent intellectual property rights for rebar and wire rod production.

Controlled rolling and controlled cooling process:

Improve the steel properties whilst reduce its alloy content as well as the cost and consumption, and consequently enhance its competitiveness.

Key Equipment:

Individually-driven reducing mill. Compared with conventional centralized driven mill, high rolling force of modular mill can achieve low-temperature rolling process, high rolling stability, high speed, flexible control, high accuracy of product, high yield and low cost.

Controlled Rolling & Cooling

The key of controlled rolling and controlled cooling is to control the temperature of stock in different stages of production. In heating stage, the heating shall be uniform, and heating temperature as well as heating time shall be controlled strictly according to steel grades. At start of rolling stage, temperature shall be controlled strictly according to steel grades. Water cooling unit is arranged after pre-finishing mill — to control the temperature of stock entering into finishing mill, and finishing mill — to control the cooling rate after rolling. Thus controlled rolling and controlled cooling are achieved with temperature control of the whole rolling line so as to improve internal structure and property of product.

For conventional wire rod and bar rolling, the rolling start temperature will be taken as 1000~1050°C as normal temperature, and the roughing mill and intermediate mill will adopt conventional rolling. The temperature of stock will be cooled to the temperature zone (780~ 850°C) of two-phase zone through the pre-cooling unit before finishing mill; sufficient total deformation will be applied through rolling passes of finishing mill, and fine grain size will be obtained through strain-induced ferrite reaction and strain-intensified phase transformation mechanism to improve tensile strength of ribbed bar and improve final structural property. Microalloy elements such as Nb, V and Ti will not be added or will be added with less amount on basis of 20MnSi to meet the requirement specified in newly-revised national standard GB1499.2-2018.

Intensive pressure water cooling process is applied quickly after rolling to limit the quick growth of austenite grain after last finishing pass. Meanwhile, through quick cooling after rolling, ribbed bar will quickly enter into phase transformation preparation zone to improve mechanical property of finished product and prevent the occurrence of closed martensitic structure. The difference between surface hardness and core hardness will not exceed 40HV. At the same time, it can meet the requirement of Quenching and Self-Tempering Ribbed Bars for the Reinforcement of Concrete (GB 13014-2013) and British standard BS1499 for export product.

Currently intensive pressure water cooling equipment is regarded as necessary equipment for the wire rod and bar rolling line. It is the most effective means for controlling incubation phase of phase transformation, and adjusting properties of bar and wire rod, and it is also necessary equipment for production of ribbed bar of 400MPa - 500MPa grade (including 460MPa grade in British standard). The water cooling equipment which is independently researched and developed by Sinosteel E&T adopts the latest spray nozzle design instead of the conventional venturi cooling method of bar, and it is capable of adjusting cooling capacity. With the combination of flexible cooling and homogenization control, it can ensure quick drying and uniform temperature restoring after stock comes out of water tank, high uniformity of entire bar. Meanwhile, it features stably controllable head end non-cooling function to ensure successful application of downstream low temperature rolling process.

Currently this equipment has been successfully applied in several steel plants in Shanxi and Guangxi of China, and it features considerable cost and consumption reduction effect. It is estimated through operation practice that, the application of advanced controlled rolling and controlled cooling technology can lead to grade promotion of product grain size by 2 grades. Moreover, it cancels the addition of expensive microalloy elements such as Nb, V and Ti, the specific Mn alloy consumption per ton of steel is reduced from 1.4% to 0.6%, and the specific production cost per ton of steel can be reduced by 100 Yuan approximately, featuring considerable cost and consumption reduction effect.

II

Core Equipment of Modular Mill

Modular mill is the one which is independently researched, developed and manufactured completely by Sinosteel E&T, and currently only a few foreign top companies grasp relevant technology and equipment. Research and development team of Sinosteel E&T conquers series of technology difficulties of inter-stand tension control to realize individual drive and eventually develops and manufactures modular mill which is the core equipment of the company. In modular mill, two stands share one roll magazine. The drive of two stands includes two types: individual drive, or one common drive for two stands. The structure characteristics of modular mill are described as follows:

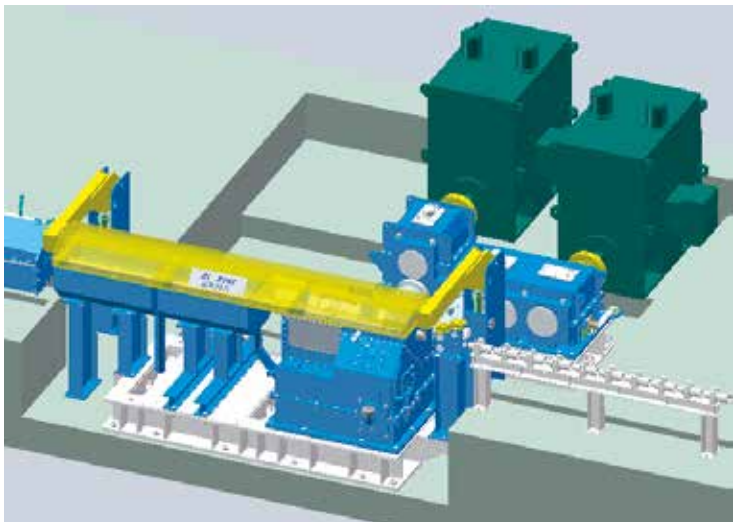
- **The roller box** adopts insert structure and cantilever roll collar. Inside the roll magazine eccentric sleeve mechanism is installed to adjust roll gap. Oil film bearing and roll shaft are installed inside eccentric sleeve, and the roll collar is fixed by taper socket at the cantilever roll shaft end.
- **Bevel gearbox** consists of housing, drive shaft, helical bevel gear pair, skew axis gear pair and input gear pair. All gears adopt ground gear with hard tooth flank, with tooth modification, and the accuracy is class 5 to ensure high-speed smooth running.
- **Roller box** is directly connected with bevel gearbox through bolt. For assembling, part of roll magazine extends into bevel gearbox so that the gears of roll shaft are engaged with two synchronous gears in bevel gearbox respectively. Roll magazine and bevel gearbox are retained through two locating pins.
- **Axial endplay** of roll shaft is effectively eliminated through thrust bearing at end of roll shaft to ensure size accuracy of stock.
- **Roll gap** is adjusted by rotating one lead screw with left and right screw threads and nut so that two units of eccentric sleeves rotate relatively. The interval of two roll shafts symmetrically moves relative to rolling line with the eccentricity of eccentric sleeve to change gap and the positions of the original rolling line and guide are maintained unchanged.
- **Each unit** is individually driven by two sets of main motors through gearbox. The gearbox adopts welded housing, and the gear inside adopts gear with hard tooth flank. Gear and shaft are subject to surface magnetic particle, ultrasonic flaw test and dynamic balance test.

300t/d

capacity of the rolling line

50M

annual economic benefit in Yuan



Compared with conventional finishing mill with centralized drive, the modular mill features the following advantages:

Optimization of process technology:

Modular mill adopts individual drive and is capable of achieving low temperature rolling. All finished products are rolled from the last two stands of modular mill and it is capable of realizing controlled rolling and controlled cooling process.

High product accuracy & high yield:

Individual drive of modular mill can realize rolling with controlled tension. The size deviation of stock tail end is reduced through tension after entering into modular mill, featuring small size deviation, less cutting of tail end and high yield.

Low Production cost:

It is achieved in two ways: one is reduced power consumption (it will not start when is dummied for some sizes), and the other one is reduced roll consumption. Modular mill adopts individual drive, and roll can be used from the biggest size to the smallest size to reduce consumption of carbide roll.

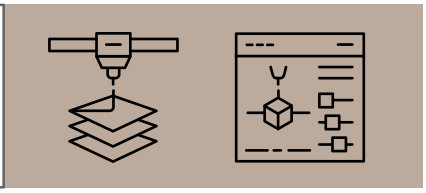
High Production efficiency:

Roll magazine and bevel box are interchangeable, featuring fast change and consequently high production efficiency.

The modular mill was successfully tested in a plant in Shanxi in 2017, and since then, the equipment operation has been smooth, and the capacity of the rolling line has been increased by 300t/d; the alloy addition has been reduced, production cost has been reduced, and product properties have been improved. Through its application, an economic benefit of 50 million Yuan is gained annually.

The successful application and verification of the modular mill in Shanxi has laid a solid foundation for Sinosteel E&T's cooperation with other steel plants in China. It is not a surprise that the company has obtained several equipment supply contracts from a good many steel giants in China, and it is highly praised by different owners.

T.U. **Technology Updates**



Research and Development of 7.66m High-Capacity Top-Charging Coke Oven Battery

Development Background

With the development of iron and steel industry in China, the trend of large-scale blast furnace, shortage of high-quality coking coal and stricter requirement of environmental protection leads to the demand for coke oven battery technology development:

1. *High-capacity coke oven battery*
2. *High quality coke*
3. *Mechanized and automatic coke making*
4. *Advanced energy-saving & environmental protection technology.*

At present, the only ultra-large coke oven batteries over 7 meters, the 7.63 meter coke oven batteries, that have been put into operation in China are introduced from Germany with the designed capacity of 2 million t/a per operating unit. Whilst, the maximum designed capacity of 7m coke oven independently in China can only reach 1.5 million t/a per operating unit limited by coke oven machine operation time. The frequent charging and pushing also leads to increased emission of intermittent dust. Given the above situation, Sinosteel E&T has developed the 7.66m high-capacity top-charging coke oven battery with coke output of 2Mtpa per operating unit in 2016.

Technical Characteristics of 7.66m Coke Oven Battery

The 7.66m high-capacity top-charging coke oven battery, with complete intellectual property right by Sinosteel E&T, integrates various up-to-date technologies of different types of coke oven batteries in China and abroad with simulation calculation and experiment study, with consideration of actual operational experiences of coke producers.

1 *Coke Oven Structure*

The 7.66m high-capacity coke oven battery, a modernized jumbo combination battery with the largest single oven volume in China, adopts twin flue, waste gas recirculation, coke oven gas under-jet, side feeding of lean gas and air, compartmented regenerator, and section-wise supply of lean gas and air.

No.	Description	Unit	Value (Last Stage)
1	Height of coking chamber	mm	7630
2	Length of coking chamber	mm	15980
3	Avg. width of coking chamber	mm	540
4	Center distance of coking chamber	mm	1750
5	Effective volume of coking chamber	m³	70.45

Table 1: structural parameters of coke ovens

2 *Process Equipment*

Coke ovens are equipped with bracings, gas collecting system, heating reversing system, coke quenching system and coke oven machine.

No.	Description	Unit	Value (Last Stage)
1	Oven number	oven	70+2
2	Cycle time	h	25.2
3	Dry total coke output of coking chamber of each oven	t	44.1
4	Maintenance time	h/d	2
5	Operation time	min	10
6	Annual coke output	10⁴t/a	214.6

Table 2: main technological parameters of coke ovens

① *Bracings*

Oven door adopts spring-loaded knife edge, adjustable web, spring-loaded latch, and suspension air-cooled door, while leveler door is movable and detachable top-opening type. Flashing plate is I-beam large type. Longitudinal anchor and top cross tie rod are equipped with hydraulic unit for adjustment.

② *Gas collecting system*

Ⓐ U-shaped collecting main, provided with automatic adjusting system and bleeding ignition device, and 3 aspirators are arranged at pusher side of ovens. Single oven chamber pressure adjustment device is available subject to customer's requirement.

Ⓑ Ascension pipe is equipped with waste heat recovery device and water-sealed lid. Gooseneck is connected with water-sealed valve by water-sealed structure.

Ⓒ Opening and closing of water-sealed lid and valve of ascension pipe as well as switching of HP and LP ammonia are controlled by pneumatic actuator.

③ *Heating reversing system*

Ⓐ The coke ovens are provided with two heating systems fueled by COG and mixed gas respectively. Automatic gas flow adjustment device and LP emergency nitrogen makeup system are equipped. Additional heating system with independent adjustment is arranged for end flue.

Ⓑ Waste gas reversing valve is controlled by rising stem, enabling COG and mixed gas to be reversed automatically. Branch flue is adjusted by automatic damper and main flue is equipped with automatic opening closing gate in coordination with desulfurization and denitration system.

Coke Oven Machine

The machines are equipped with automated operation management system and oven identification system. Sophisticated interlocking control and fault alarm system are used for internal operations. Unattended operation will be achieved with further technical development and improvement of automation level (only one monitoring operation personnel at pusher).

① *Coke charging car*

Dust-free coal charging is realized by the combination of HP ammonia jet and ground dedusting station of coal charging. Coke charging car is functioned with automatic coal weighing.

② *Coke pusher car*

The coke pusher car is equipped with end dust collecting device for pusher side. Position detection and memorizing system is available for door opening mechanism which also features door and door frame cleaning. Pusher car is capable of weighing residual coal which is collected during coal leveling of each oven chamber.

③ *Coke guide car*

Coke guide car, combined with pushing ground dedusting station, collects the end dust of coke side to reduce pollution. The door opening mechanism features position detection and memorizing.

④ *Door servicing car*

The coke ovens are equipped with door servicing car for door repairing, which eliminates fume and flame escaping due to untight door under particular conditions.

Technology Innovation of 7.66m Coke Oven Battery.

① *Increase in Coke Output*

The output of single oven is 44.1 tons and annual output of coke per operating unit can reach 2.1 million tons.

② *Improved Coke Quality*

Ⓐ Air stage heating technology is incorporated with waste gas recirculation system. As shown in *fig. 1*, the partition wall of combustion chamber is provided with staged air and gas feeding holes and the arrangement of section height and opening size are optimized through experiment and simulation calculation. By adjusting the distribution ratio of air-gas flow of each section, combustion temperature is effectively controlled and NOx generation is decreased while heating uniformity is achieved at coke oven height.

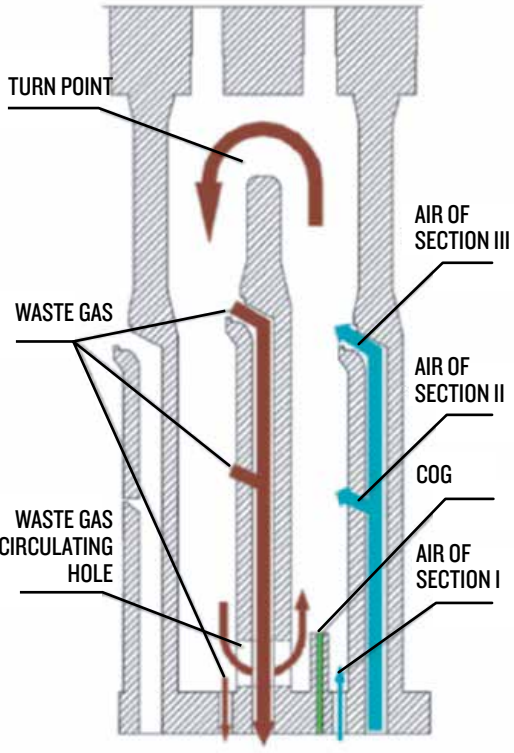
Ⓑ Regenerator adopts adjustable compartment and checker brick. Adjustable checker brick is arranged at bottom of the regenerator, and heating uniformity along coke oven length is realized by adjusting section size of checker brick hole. Compartmented regenerator rationalizes air flow distribution, reduces air flow segregation, improves heat exchange efficiency of checker brick and decreases waste gas temperature.

Ⓒ The 7.66m coke oven battery adopts double-side waste gas duct to ensure even air flow distribution of regenerator and facilitate control and adjustment in operational production.

Ⓓ CDQ or total CDQ is matched to reduce coke crack, improve coke strength, ensure uniform grain size, reduce coke moisture content and completely improve coke quality.

With the application of the technologies, coke produced from the 7.66m coke oven meet the criteria of grade I metallurgical coke to satisfy the demand of high quality coke for 3000m^3 blast furnaces and above.

fig.1



Schematic diagram of section-wise heating and waste gas circulation

③ *Comprehensively Improved Automation Level of Coking Production*

❶ *Heating reversing system*

Equipped with two heating systems fueled respectively by COG and mixed gas, which can be automatically switched over at any time, the coke owens optimize the utilization of the BFG and COG in steel complex.

❷ *Gas collecting system*

The opening and closing of water-sealed lid and valve in ascension pipe as well as the reversing of HP and LP ammonia are controlled completed automatically by pneumatic. Automatic pressure adjusting system for gas collecting ducts ensures the even pressure of coking chambers. Automatic bleeding ignition device is equipped for gas collecting ducts.

❸ *Auto positioning system*

Capable of automatic travelling, equipped for coke oven machine enables position detection of coke oven machine, oven identification, automatic positioning and interlocking control. Information sent from different cars are collected, analyzed and processed by central control room where control command is generated according to the coke pushing schedule to direct cars operation.

④ *Energy Saving and Environmental Protection*

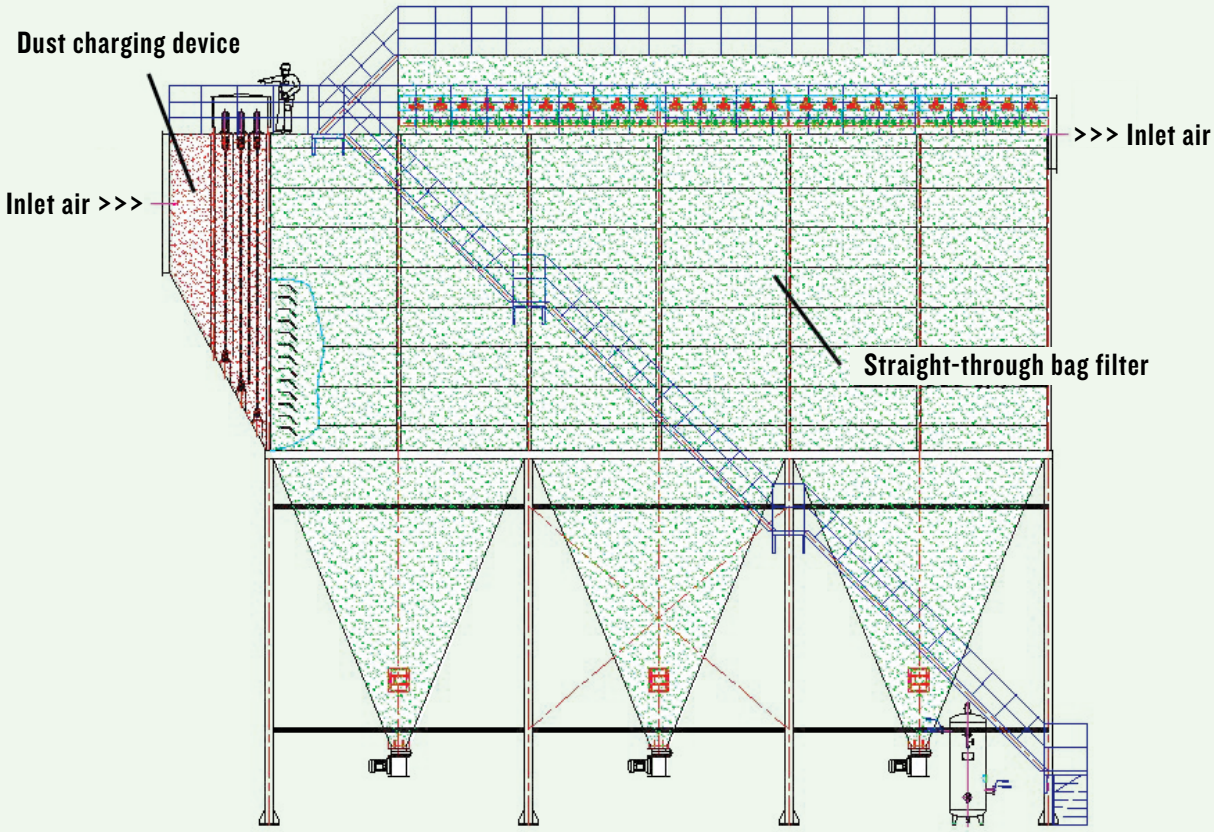
Ⓐ The ultra-high capacity coking chamber considerably reduces the pollutant emission by decreasing the number of pushes, charges and quenching as well as their pollutant emissions generated.

Ⓑ The combination of waste gas recirculation and air stage heating optimizes combustion and effectively reduces generation of NOx while improving heat efficiency and saving gas consumption. The optimization of bracings extremely improves the sealing of coking chamber and eliminates the pollutant leakage at door.

Ⓒ Dry type ground dedusting station is used for dedusting flue gas of coal charging, coke pushing and pusher side end block. The efficiency of bag filter dedusting reaches 99.5% and dust collection rate reaches 95% for end block dust exhaust.

Ⓓ CDQ or total CDQ recovers the sensible heat of hot coke, improves energy utilization efficiency and prevents the pollutant generated from coke wet quenching process.

Ⓔ Waste gas desulfurization and denitration further reduce the pollutant emission of in waste gas including sulfide and NOx so as to meet the requirements of regulations and standards for pollutant emission.


Dust charging device
Inlet air >>>
>>> Inlet air
Straight-through bag filter

Technology and Equipment for Controlling PM 2.5 Emission in Kiln Dust of Iron & Steel Industry

GREEN&TECH

Introduction

Sinosteel Tiancheng Environmental Protection & Technology Co., Ltd. (abbr. Sinosteel Tiancheng), a subsidiary of Sinosteel Engineering & Technology Co. Ltd., is a leading environmental protection company with a cluster of model projects and also ranked as a front runner in developing green solutions for iron & steel makers.

Sinosteel Ticheng has undertaken the 863 Project of "Technology and Equipment for the Control of PM2.5 from Iron and Steel Kilns" in China national 12th Five-year Plan and has achieved significant results, making a breakthrough in the ultra-low emission technology and application for controlling PM2.5 emissions in kiln dust of iron and steel industry.

To help steel producers meet needs of environmental protection and ultra-low emission of flue gas from kilns, Sinosteel Tiancheng has conducted several key study programs focusing on the capture of PM2.5. As a result, technologies such as pre-charging technology, PM2.5 filter with superfine fiber layer, pre-charged bag filters and the operating condition test on PM2.5 of industrial flue gas have all been developed and strengthened, and also quickly applied in the industry. Among them, the 180t BOF Gas De-dusting Revamping Project of Ansteel Group, EPC contracted by Sinosteel Tiancheng and put into production in Dec. 2014, has become a model project. Being a symbol of the technology application and outstanding operation, the project was honored the second prize of the Environmental Protection Award by the Ministry of Ecology and Environment of the People's Republic of China in 2017 and the Second Prize of 2018 Hubei Technology Progress Award.

Background

The emission of PM2.5 in iron & steel industry causes air pollution in cities and regions of China. Compared with the control of ordinary particles, the capture of PM2.5 is relatively more difficult, with much lower efficiency. Coupled with the new requirements of environmental protection transformation and technological upgrading, developing technology and equipment for controlling PM2.5 has become a major issue. In this context, with strong technical strength and outstanding engineering performance, Sinosteel Tiancheng undertakes the R&D task.

fig.1

Dust precharging equipment

Major Study Results

The results of the study mainly include the following four aspects:

1 ***Pre-charged high-efficiency PM2.5 control technology and equipment***

According to the study, the dust layer forms on the surface of the filter bag is porous sponge-like, with obvious mushroom-shaped accumulation of fine particulates. Such special structure strengthens the capturing effects during filtration, such as screening and diffusion. As a result, the efficiency of capture is improved and the dust layer bears strong permeability, which can reduce the resistance of filtration.

The process of equipment development includes not only the confirmation of key elements such as equipment structure, method of power supply and technical parameters, but also the manufacturing.

Upon the successfully application of both technology and its matching equipment for the first time at home and abroad, operation results show that the equipment, installed at the inlet of the bag filter is relatively small and achieve excellent charging effect. *See Figure. 1*

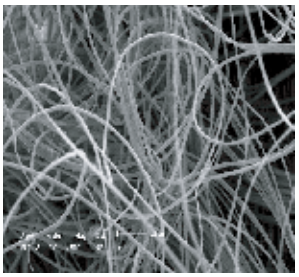
G.T. Green Technology

❷ PM2.5 filter material with ultra-fine fiber layer

Filter material is the core component of bag filters. Study shows that the finer the fiber of the filter material, the higher the purification efficiency. Sinosteel Tiancheng has come up with a superfine fiber, namely "sea-island fiber" and continued the design work of a three-dimensional filter material structure with ultra-fine high-density surface. Upon overcoming issues of spinnability in the blending of different fibers, the filter material with ultra-fine layer based on sea-island fibers has been developed, and related products successfully produced. Test shows that by using such ultra-fine filter material, capturing rate of PM2.5 reaches up to 96.9%, and capturing efficiency of fine particulate is significantly improved. Consequently, large-scale production and industrial application of the filter material products have been achieved, meeting market demand in time.
See Figure 2 - 4

fig.2~4

fig.2



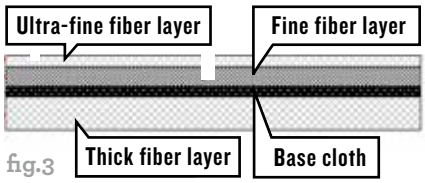


fig.3

fig.4

***fig. 2**: Sea-island fibers | **fig. 3**: Structure of the filter material with ultra-fine surface*
***fig.4**: Filter material with ultra-fine surface.*

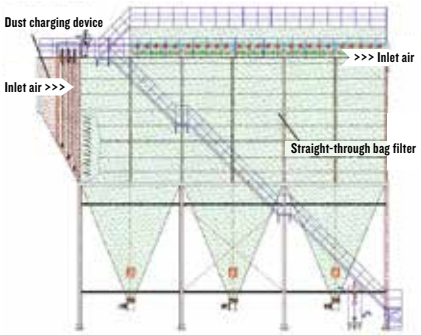
❸ Composite pre-charged bag filter

The research finding is a combination of the dust pre-charged technology, filter material with ultra-fine surface, the bag filter, air distribution technology and dedusting technology, forming an integrated device.

In order to solve the problems such as complex structure, high operation resistance, high valve failure rate and high air leakage rate, Sinosteel Tiancheng has innovatively re-designed the structure of traditional bag filter, and come up with a straight- through uniform-flow new structure, featuring advantages of short flow, low flow resistance and longer life span, as well as reduction of energy consumption by 40% and failure points by 70%.

fig.5

Outline drawing of the pre-charged bag filter



❹ Model project & application

All the research findings have been applied in various iron & steel projects, achieving a quick industrialization. In December 2014, the technology was applied in Ansteel Group's 2x180t BOF Gas De-dusting Revamping Project, with an air processing volume of 2x600,000m³/h. During three years of operation, all equipment were in good performance and running stably. The third-party test showed that emission of PM2.5 was less than 10mg/m³, with a capturing efficiency over 99%, reaching the requirement of ultra-low emission. Meanwhile, the equipment resistance fell between 700 ~ 950Pa, and the operating energy consumption was reduced by 40%, compared with the traditional bag filter. >>>

While achieving ultra-low emission and energy-saving, Sinosteel Tiancheng's self-developed technology and equipment have been verified. The project has also become the very first case of industrial application of the study result, both home and abroad, under China National 863 Program. It marks not only technical and equipment support, but also a successful case for Chinese steel makers for achieving green development in the future.

As the project, adopting Sinosteel Tiancheng's technology and equipment, running smoothly, it keeps making a stir within the industry. With more and more steel producers paying visit, the technology enjoys greater and greater popularity.

By the end of 2019, Sinosteel Tiancheng's technology and equipment have been successfully applied in various projects of enterprises including Rizhao Steel Holding Group Co., Ltd., HBIS Group Tangsteel Company, Xinyu Iron & Steel Group Co., Ltd., Fangda Special Steel Tech. Co., Ltd., Liuzhou Iron & Steel Group Co., Ltd.

Promotion and application cases of pre-charging technology

№	Name of Entity	Application Object and Scale
1	Integral Steelmaking Plant of Anshan Iron & Steel Co., Ltd.	Purification of the flue gas of 180T converter
2	Rizhao Steel Holding Group Co., Ltd. of Shandong Iron & Steel Group Co.,Ltd.	Purification of the flue gas of 210T converter, a total of 11 pieces (sets)
3	Qinglong Furnace Material Co.,Ltd. of HBIS Group Tangsteel Company	Purification of the flue gas of 2 millions t/a sintered pelltizing
4	Xinyu Iron & Steel Group Co., Ltd.	Dedusting and flue gas purification of the tail of the sintering machine and finished products
5	Xinyu Iron & Steel Group Co., Ltd.	Dedusting and modification of the 360m² tail of the sintering machine
6	Xinyu Iron & Steel Group Co., Ltd.	The upgrading and reconstruction project of the secondary dedusting system of №1 Steelmaking plant
7	Steelmaking Plant of Fangda Special Steel Technology Co., Ltd.	The transformation project of the tertiary dedusting system for 180T converter
8	Liuzhou Iron and Steel Group Co., Ltd.	Secondary dedusting of №4 ~ №5 converters of the converter plant
9	Fangchenggang Iron & Steel Base of Liuzhou Iron & Steel Group Co., Ltd.	Dedusting project for the steelmaking environment

fig.6

Model project of Anshan Iron & Steel Co., Ltd.

fig.7

Pre-charged bag filter installation of dedusting system for 180T converter of Fangda Special Steel Technology Co., Ltd. Jiangxi Province

Technical and Economic Analysis

Based on air processing volume of 600,000m³/h, the following table shows the comparing results between Sinosteel Tiancheng's technology with the traditional one in terms of technical economy. Obviously, the emission content of the pre-charged bag filter is far lower than that of the traditional one, and energy consumption is reduced by 54%. Besides, the filtering installation has achieved significant economic benefits by saving electricity cost of 1.1 million CNY/year, so that investment cost can realize its return within 3 years.

Comprehensive comparison of the two technical schemes

No.	Item	Sinosteel Tiancheng's pre-charged bag filter	Traditional bag filter
1	air processing volume (m^3/h)	60×10^4	60×10^4
2	Emission content (g/Nm^3)	4~9	Less than 15
3	Operating resistance (Pa)	700~950	Less than 2,200
4	PM2.5 capturing efficiency (%)	99.3	——
5	Total dedusting efficiency (%)	99.8	
6	Average annual maintenance cost (CNY)	100,000	180,000
7	Price of the equipment (CNY/piece)	4,500,000	4,300,000
8	Energy consumption of the filter (KW)	233	513
9	Electricity cost (CNY/year)	1,140,800	2,511,600

Environmental, Economic, and Social Benefits

1 ***Promote the improvement of technology for PM2.5 controlling in China***

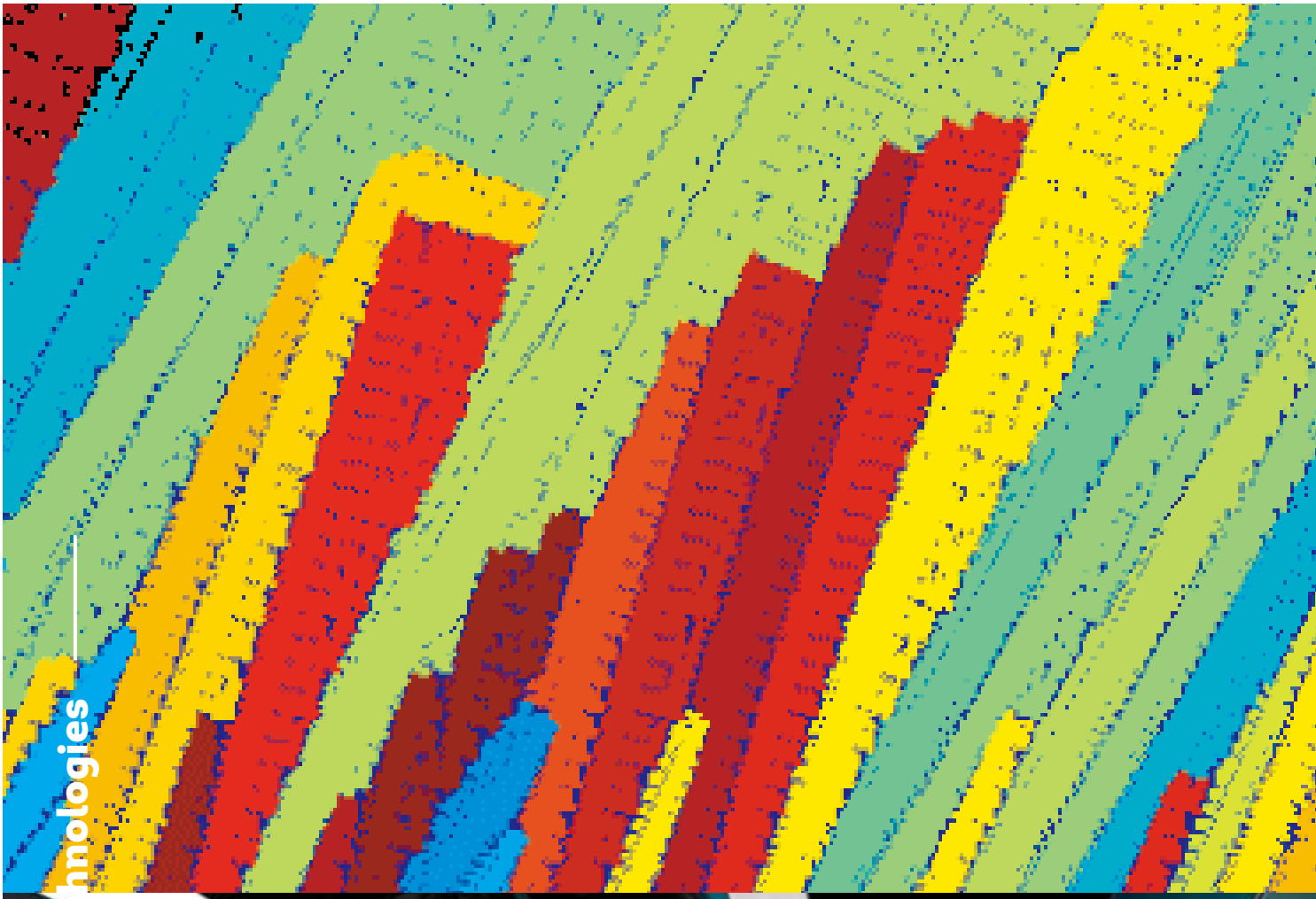
The technology and equipment developed by Sinosteel Tiancheng is an effective way of controlling flue gas particulates. As a new research finding with intellectual property, the technology holds more than 8 patents while reaching world's leading level. It is also expected to push forward the development of technology in air pollution control and enhance China's competitiveness in the field.

2 ***Solve prominent environmental issues in the steel industry and achieve environmental benefits***

The upgrading and reconstruction of dust filter as well as realization of ultra-low emission in the steel industry have become urgent needs in recent years. They are also hard-nut problems in the industry. Sinosteel Tiancheng's study has developed technical equipment with advanced technology, significant energy saving performance, stable operation, and fair price to meet the demands of the market in time. The application of the achievement can reduce the emission content from the current 30-50mg/m³ to below 10mg/m³, reduce total PM2.5 emission by about 75%, and reduce operating energy consumption by more than 40%, bringing significant benefits in terms of environmental protection and energy-saving.

3 ***Bring significant economic benefits and promote the development of environmental protection industries***

As steel enterprises facing a new round of reconstruction and upgrading, the research findings can be used not only in the steel industry, but also in nonferrous, cement, mechanical and chemical industries. The demand of the steel industry for PM2.5 filtering equipment is expected to be four billion CNY/year, and the demand of the non-electric industries in China is over ten billion CNY/year. Therefore, Sinosteel Tiancheng's PM 2.5 emission controlling technology has a broad market prospect.



Technologies

THE

CASTING — FORGING — MILLING COMPOSITE — ADDITIVE MANUFACTURING TECHNOLOGY

INTELLIGENT MANUFACTURING

Abstract

Tianyu Intelligent Manufacturing Co., Ltd. a hi-tech company focusing on metal 3D-printing and parts repairing, is invested and founded by Sinosteel E & T.

Given the fact that current metal additive manufacturing has several drawbacks, such as poor performance in producing forgings, low accuracy and efficiency, and high-cost, Tianyu independently developed a new technology, known as casting forging-milling composite (CFMC) additive manufacturing, which uses the efficient and cheap arc as the heat source, well solve the present shortcomings. Synchronous arc welding and continuous semi-solid in-situ forging is achieved with micro-roller. Milling is incorporated into this process to remove defects and complete the part. Workpieces with equiaxed fine-grained microstructure and better performance than forgings have been obtained using CFMC. Testing shows that the mechanical performance exceeds the standards for forgings and most indicators are above average levels. Trial products include titanium alloy aero- nautical parts, a stainless steel propeller, and an aeroengine transition section which has passed the European standard x-ray inspection and test. The streamlined and low-cost manufacturing process achieved by using metal wire, integrated equipment and low pressure makes CFMC a green manufacturing model.

Manufacturing Process

The CFMC additive manufacturing process includes the following steps:

1. *Welding deposition*
2. *Micro-rolling*
3. *Milling*

First, proper process parameters are determined by process analysis of parts. *Fig. 1* shows the flowchart of CFMC additive manufacturing. Slicing and path planning for the model are conducted using computer software. A movement mechanism with a welding torch, which is controlled by the forming path code, is employed to perform welding deposition. Appropriate values are assigned to the process parameters, including wire feed rate, voltage, current, etc. Then deposition by wire-fed arc welding is performed, with argon being used as a shielding gas. During welding deposition, heat is rapidly transferred to the substrate and the microstructure of the molten metal then evolves into a dendritic crystal or columnar crystal structure.

I.T. Manufacturing process

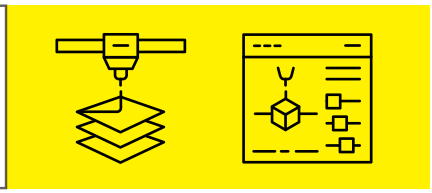
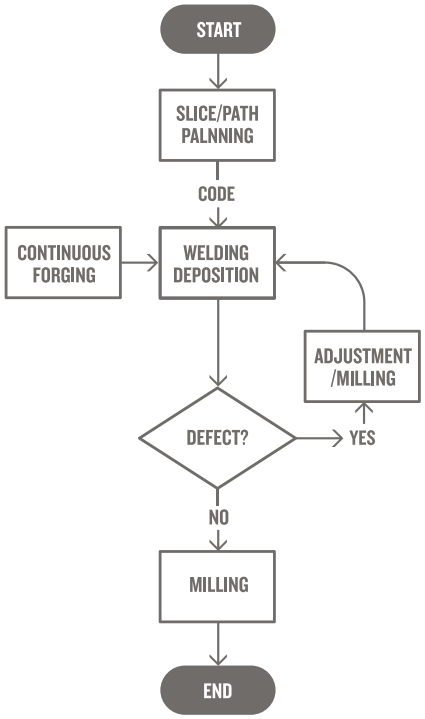


fig.1



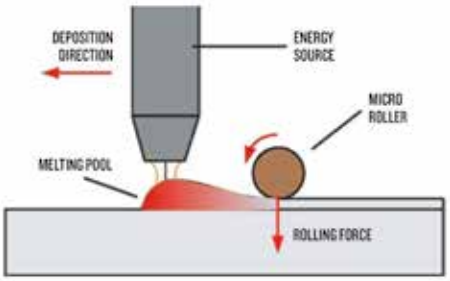
Flow chart of CFMC additive manufacturing

The second step is in-situ rolling, which uses a computer-controlled micro-rolling mechanism to apply a rolling force to the metal *Fig. 2.* Then the metal undergoes plastic deformation and its columnar crystals break into fragments. Due to the effects of plastic deformation and heat input, the metal recrystallizes into equiaxed fine grains, and forgings are then obtained. Meanwhile, the on-line monitoring system performs data acquisition via the camera and data analysis and then feedbacks the results to the defect treatment module. Next, the defect treatment mechanism treats the defects by means of automatic adjustment of process parameters, milling, etc. Then milling is performed to improve forming accuracy and roughness. The composite manufacturing process employs two cooling sources: micro-roller and substrate. Normally, the first layer cools at the fastest rate and the rate of cooling decreases as the layer number increases. In order to ensure the cooling rate does not vary across layers, additional cooling equipment is needed as a complement. This technology applies to a variety of metals, such as titanium alloys, stainless steels, nickel-based superalloys, austenite-bainite steels, and medium-carbon steel which has relatively low weldability.

The CFMC additive manufacturing process includes the following steps:

- **Welding deposition**
- **Micro-rolling**
- **Milling**

fig.2



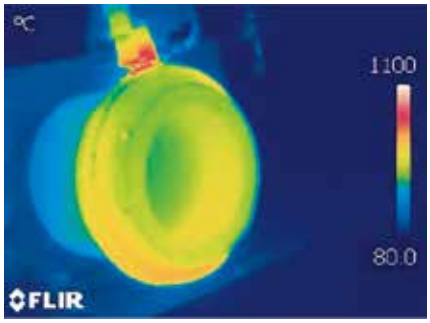
Schematic of casting and forging

Equipments & Devices

The equipment used in this technology includes a gantry-type arc welding and casting-forging-milling system equipped with numerical control system, an automatic positioning system with two executable units and an external control shaft, an automatic tool changer, and a hydraulic micro-forging system. The whole manufacturing system is highly flexible: it can perform welding deposition, forging, milling, and other operations, and the maximum dimensions and weight of workpiece that can be processed are 5000mm*3000mm*2000mm and 15 tons, respectively *Fig. 3.* To guarantee the stable performance and reliable? quality of the high-end parts fabricated by additive manufacturing, online non-destructive testing must be conducted during welding deposition to examine the welding parameters and surface morphology of welding bead. During forming, infrared thermography and ultrasonic testing can be used to identify the size, location, nature, and quantity of defects in workpiece, such as surface and near-surface cracks, lack of fusion, voids, and slag inclusions. The characteristics of arc column and shape of welding pool can be detected by using a system for image capture and computer graphic analysis and diagnosis. A real-time data acquisition system is used to monitor forming process parameters like arc current, voltage, track and velocity of motion of tool /workpiece, and wire feed rate. We have used cameras and infrared devices to track and monitor the whole process of CFMC additive manufacturing *Fig. 4* shows the thermograms produced. It is clear from the figure that the specimen's temperature field had a uniform distribution.

fig.3&4

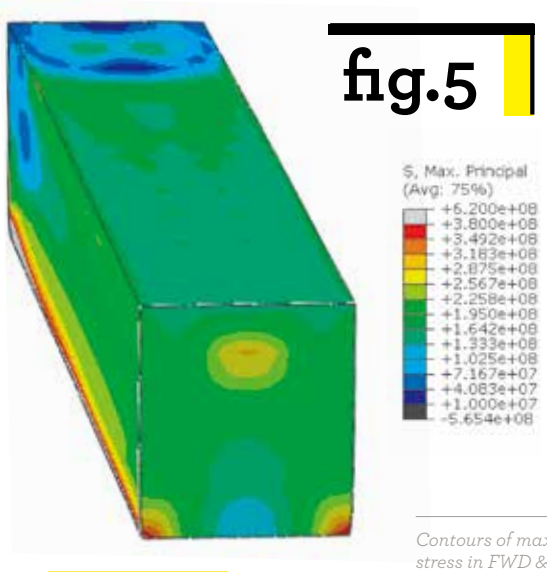
- *Equipment for CFMC additive manufacturing*
- *Monitoring of CFMC additive manufacturing by infrared thermography*



Numerical Simulation

The stress variations in the free-form welding deposition (FWD) and Casting- Forging-Milling composite additive manufacturing technology (CFMC) specimens were simulated by ABAQUS. *Fig. 5* shows the contours of maxi- mum principal stress in the two specimens. It is clear from the figure that the maximum principal stress in the welding deposition specimens was primarily distributed in its central part and along the two long edges at the bottom. The CFMC additive manufacturing specimen had a greater surface area after forging and the deformation region created by forging mainly experienced compressive stress. The central part of the surface of the welding bead experienced compressive stress, while tensile stress occurred in the lateral parts. After forging, compressive stress arose in the region that was originally under tension after welding deposition. Vertically, plastic deformation occurred throughout the height of CFMC additive manufacturing. Given that tensile stress is the major cause of crack initiation and growth, it is reasonable to infer that micro-rolling can effectively inhibit initiation of cracks. The evolution of the microstructures of the two specimens was modeled using MATLAB simulation program and the results were illustrated in *Fig. 6*. The rolling process increased dislocation density and induced dynamic recrystallization, which generated ultra-fine grains. This altered the developed columnar crystal structure resulting from welding deposition.

fig.5



Contours of maximum principle stress in FWD & CFMC specimens

It performs casting and forging simultaneously and can produce forgings with a hyperfine aquiaxed grain structure.

Microstructural Properties

Medium-Carbon Steel

The microstructures of FWD and CFMC specimens were compared. *Figs. 7 & 7C* show the morphology of crystals in the FWD specimen. X-section image *Fig. 7a* reveals the initial distribution pattern of crystal grains along the height of deposition: crystals grew from the vicinity of fusion lines, along the direction indicated by maximum temperature gradient, towards to the central part, resulting in a columnar microstructure. Along the fusion line, the columnar crystals became coarser with increasing height. They were approximately perpendicular to the fusion lines. Temperature gradients were large during welding cooling. Grains that were oriented in the same direction as the maximum temperature gradient grew rapidly. As crystals oriented in other directions grew at slower rates, they met the adjacent rapidly-growing grains before they developed well, so their growth was restrained. Ultimately, the columnar crystals showed roughly the same orientation. The coarse columnar crystals revealed in the figure were arranged in a dendritic pattern and had a diameter of nearly 150 μm. As displayed by the Y-section of the FWD specimen *Fig. 7c*, the initial crystal grains in different welding beads were largely columnar, but only those in the same welding bead were uniform in orientation, i.e. perpendicular to the corresponding fusion line. The orientation of columnar crystal in the Y-section varied between welding beads and the grains near each fusion line differed significantly in size. *Figs. 7b & 7d* show the morphology of grains in the CFMC specimen. In the X-section *Fig. 7b* the original columnar crystals nearly disappeared, because most of them had been shaped by micro-rolling to equiaxed grains. Compared to the initial grains in the X-section of the FWD specimen *Fig. 7a*, the crystal grains in the CFMC specimen had much smaller sizes. The image of the Y-section

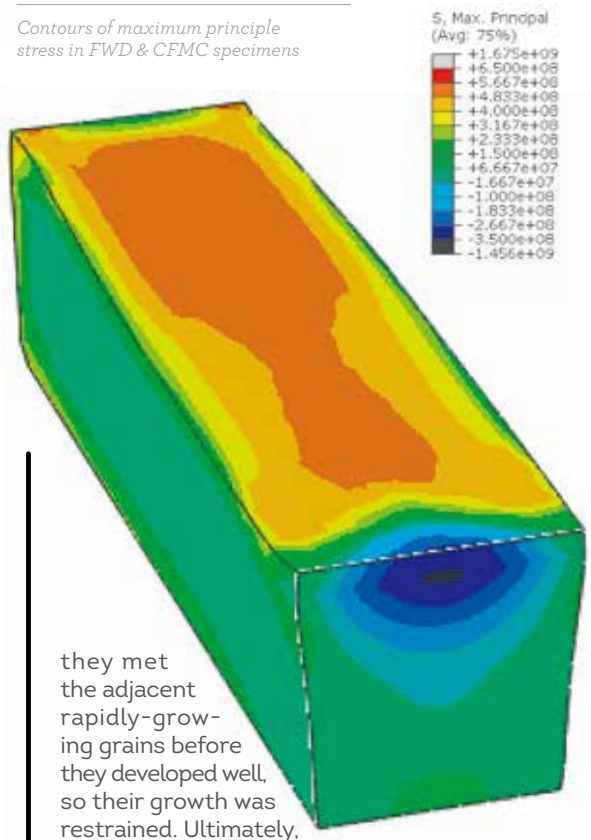
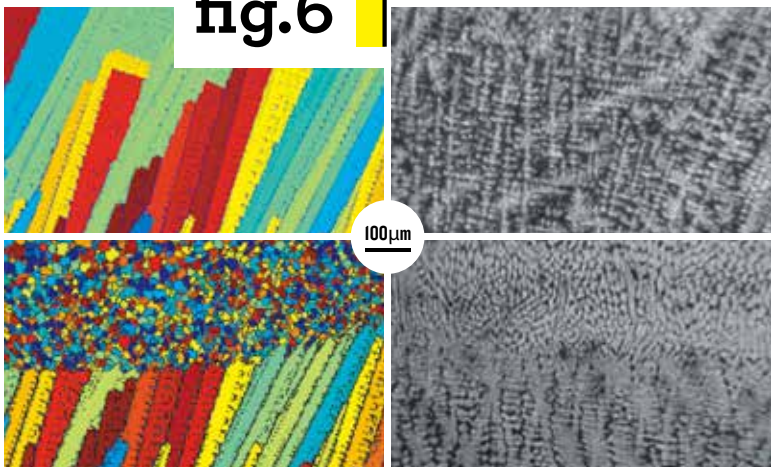


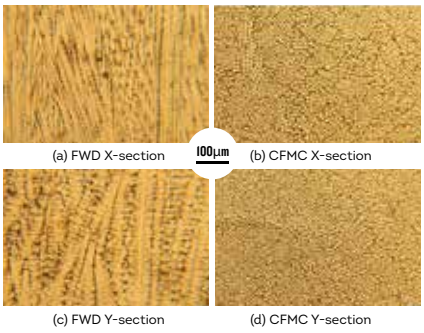
fig.6



Microstructural Properties, Medium-Carbon Steel

Fig. 7d reveals that the original crystal growth pattern in which the parallel grains were perpendicular to the fusion lines had been heavily damaged, leaving a few small-sized columnar grains locally in the CFMC specimen. While the crystal grains in the regions within about 200 μm of the fusion lines maintained their initial columnar shape, crystals outside these regions were all broken and some of them exhibited shear distortion. A comparison of the Y-section images of the two specimens also reveals finer grain sizes in the CFMC specimen.

fig.7



Comparison of crystal grains in the FWD and CFMC

Titanium Alloys

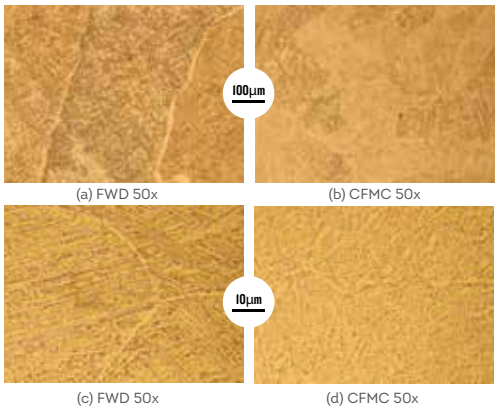
In arc welding, repeated heating can easily cause structural heterogeneity of welding beads. Therefore, proper heat treatment and deformation amount can play a significant role in ensuring structural homogeneity. Titanium has two crystal structures: hexagonal close-packed structure, or α form, and body-centered cubic structure, or β form. The former structure occurs at room temperature and then changes to the latter at 882Cº or above as a result of phase change. The microstructures of titanium alloys split into the following types: α+β equiaxed microstructure, α+β duplex microstructure, and α+β basketweave microstructure, and Widmanstatten microstructure. The experimental research found that titanium alloy specimen that remained undeformed after annealing at 850Cº had Widmanstatten and locally basketweave microstructures. The specimen that was deformed by rolling did not exhibit α phase at crystal boundaries, but increased equiaxed α phase; its interior part showed a α + basket-weave + transformed β triplex microstructure, which can give the alloy good comprehensive performance. *Fig. 8* demonstrates that the undeformed specimen had a coarse columnar crystal microstructure and the columnar crystal had a thick α phase boundary. In terms of microstructure, the continuous α phase along this boundary contained parallel α clusters that grew inward, a typical Widmannstatten microstructure. The main contributor to this micro-structure is the insufficient heat treatment of the β phase titaniumalloy or inadequate amount of deformation. As each heating process during welding is equivalent to a post-heat treatment, the welding area's temperature tended to exceed the point at which the β-phase transformation began, thus facilitating the formation of the Widmannstatten microstructure. In contrast, the temperature in the heat-affected region was far below the phase transformation point, allowing the crystal grains within it to continue growing. Therefore, Widmannstatten microstructure was not distributed throughout undeformed specimen. The annealing at 850Cº only homogenized the interior microstructure, but did not remove the β-phase coarse grains that spread throughout the height of the specimen and the Widmannstatten micro-structure. Since the Widmannstatten microstructure has poor plasticity, it is necessary to remove it during heat treatment of titanium alloys. The CFMC specimen displayed finer equiaxed β-phase grains but not continuous α phase along grain boundary. Its micro-structures included uniformly distributed equiaxed α and transformed β micro-structures. The α microstructure outnumbered the transformed β microstructure and the latter showed smaller inter-layer spacing. Overall, the CFMC specimen consisted primarily of duplex microstructures, which combined the advantages of equiaxed and basketweave microstructures and guaranteed high plasticity and toughness.

Nickel-based superalloys

Nickel-based superalloy wires were tested by arc welding deposition and CFMC separately. The specimens produced by the two processes were compared in terms of structural and mechanical properties. *Fig. 9* reveals that the dendritic crystal structure in the interior of the CFMC specimen was damaged and the slender columnar grains that were observed in the FWD specimen were replaced by equiaxed grains as a result of dynamic recrystallization.

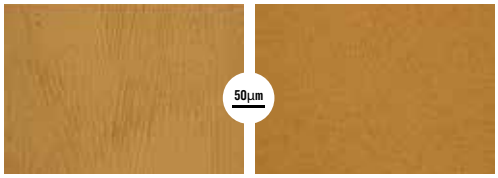
Comparison of crystalline phases of titanium alloys

fig.8



Comparison of crystalline phases of nickel-based superalloy specimens produced by FWD & CFMC

fig.9



Mechanical Properties

❶ *Medium-Carbon Steel*

The mechanical properties of forgings listed in the table above are sourced from the Chinese standard "Steel forgings for aviation" (HB 5024-89). The rolled parts outperformed those obtained by welding deposition in mechanical properties. Compared to the standards for forgings, the rolled parts had significantly improved mechanical properties, with a 16.5% increase in tensile strengh, +31.4% in yield strength, +80% in elongation, +8.1% in hardness, +15% in shrinkage and +8.0% in impact toughness.

❷ *Titanium Alloy*

After annealing at 850Cº, the titanium alloy attained optimal mechanical properties. As shown in the table below, the mechanical properties of the titanium alloy specimens created by FWD were above the standard values for forgings except yields trength. The specimens obtained from CFMC + heat treatment (annealing at 850Cº) exhibited the best mechanical properties. Their tensile strength, yield strength, elongation, and impact roughness increased by 18.3%, 16.7%, 57%, and 61.1% respectively, compared with the standard for forgings, and were up by 8.5%, 17.8%, 37.7%, & 39.2% from the FWD specimens.

The mechanical properties of forgings presented above are sourced from the Chinese standard "GH4169 alloy bars, forgings and rings" (GB/T 25137-2010), except the value of impact roughness, which is provided by the standard "GH4169 alloy rods for aerospace".

The high tensile & yield strengths of the FWD specimens of nickel-based superalloy suggest relatively high plasticity. Their average impact roughness was 7.7% higher than the standard value for forgings. The specimens obtained from CFMC+heat treatment showed substantial improvements in comprehensive mechanical properties. The heat treatment process included heating at 1090Cº for 1-2 hours, air cooling at + 950Cº for 1 hour, air cooling at + 72Cº for 8 hours, furnace cooling at a rate of 50Cº/h to 620Cº, and air cooling for 8 hours. In this process, the specimen went through homogenization, solution hardening, and two-stage aging treatment. After the heat treatment, the interior crystal grains in the CFMC specimens changed to aquiaxed grains of varying sizes through recrystallization. The recrystallization process was accompanied by crystal twinning. Due to the presence of aquiaxed crystals, the specimens can attain excellent comprehensive mechanical performance with higher tensile strength, yield strength, toughness, and hardness than corresponding standards for forgings.

Mechanical properties of medium-carbon steel

Specimen	Tensile strength σ_b (MPa)	Yield strength $\sigma_{0.2}$ (MPa)	Elongation δ (%)	Hardness (HBS)	Shrinkage ψ (%)	Impact toughness (J·mm^{-2})
Standards for forgings	835	490	10	229-285	40	44
FWD	688	382	13	290	-	-
CFMC	973	644	18	301-308	46	47.5

Mechanical properties of titanium alloy

Specimen	Tensile strength σ_b (MPa)	Yield strength $\sigma_{0.2}$ (MPa)	Elongation δ (%)	Impact toughness (J·mm^{-2})
Standards for forgings	895	828	10	35
FWD	976	820	11.4	40.5
CFMC + heat treatment	1059	966	15.7	56.4

fig.10

The mechanical properties of forgings listed in the table are sourced from the Chinese standard "Titanium & titanium alloy forgings" (GB/T 25137-2010).

Mechanical properties of titanium alloy

Specimen		Tensile strength σ_b (MPa)	Yield strength $\sigma_{0.2}$ (MPa)	Elongation δ (%)	Shrinkage ψ (%)	Impact toughness (J·mm^{-2})
Standards for forgings	X-axis	1253	1034	12	15	
	Y-axis	1241	1034	10	12	39*
	Z-axis	1241	1034	6	8	
FWD	X-axis	724	446	19	-	43
	Y-axis	740	450	15	-	41
	Z-axis	674	449	18	-	42
CFMC + heat treatment	X-axis	1302	1108	16	26	51
	Y-axis	1343	1137	17	21	56
	Z-axis	1347	1165	16	-	53

Conclusions

>>>>>>> *It performs casting and forging simultaneously and can produce forgings with a hyperfine aquiaxed grain structure.*

CFMC can reduce the anisotropy of parts' interior structures and increase their toughness, which guarantee uniformity of materials and thereby improve components' fatigue life and reliability. It is able to produce not only thin-walled metal parts, but also parts with non-uniform wall thicknesses.

>>>>>>> *Less or no use of huge traditional casting and forging equipment*

CFMC will combine the separate units for casting, forging, welding, and milling in conventional heavy equipment manufacturing into an integrated manufacturing unit, thus achieving light-equipment manufacturing with shorter processes, higher energy efficiency, and lower pollutant production.

>>>>>>> *High Rate of Material Utilization*

Using metal wires as the raw material, CFMC can guarantee a rate of material utilization higher than 70%. The prices of wire materials are about only 1/10 of those of powder materials, which are widely used in common additive manufacturing techniques that involve laser melting of powder.

>>>>>>> *High Efficiency & Low Cost of Arc*

The most popular techniques of metal additive manufacturing all use laser and powder based methods. Lasers are the most expensive devices used in metal additive manufacturing and most lasers need to be imported. For a given power level, using arc as the heat source can reduce cost by 90% compared to the cost of laser-based manufacturing.

>>>>>>> *Shorter Production Cycles*

Because CFMC can control parts' dimensions, shape, microstructures and properties, it can offer a deposition rate of 5-15 kg/h and a double-wire deposition rate of 20-30 kg/h. Thus a record decrease of 60% in lead time can be achieved.

>>>>>>> *Energy-efficient Green Manufacturing*

As the production equipment needs a power supply of only 50 kW, its energy consumption per unit time is about only 2‰ of that of a huge pressing machine. Therefore, CFMC can provide an effective solution to the problems of huge energy consumption and high pollutant emissions in traditional MACHINERY MANUFACTURING.

>>>>>>> *Future work will focus on forging & milling optimisations, manufacturing titanium alloy & nickel-based superalloy parts in for the aeronautical industry.*

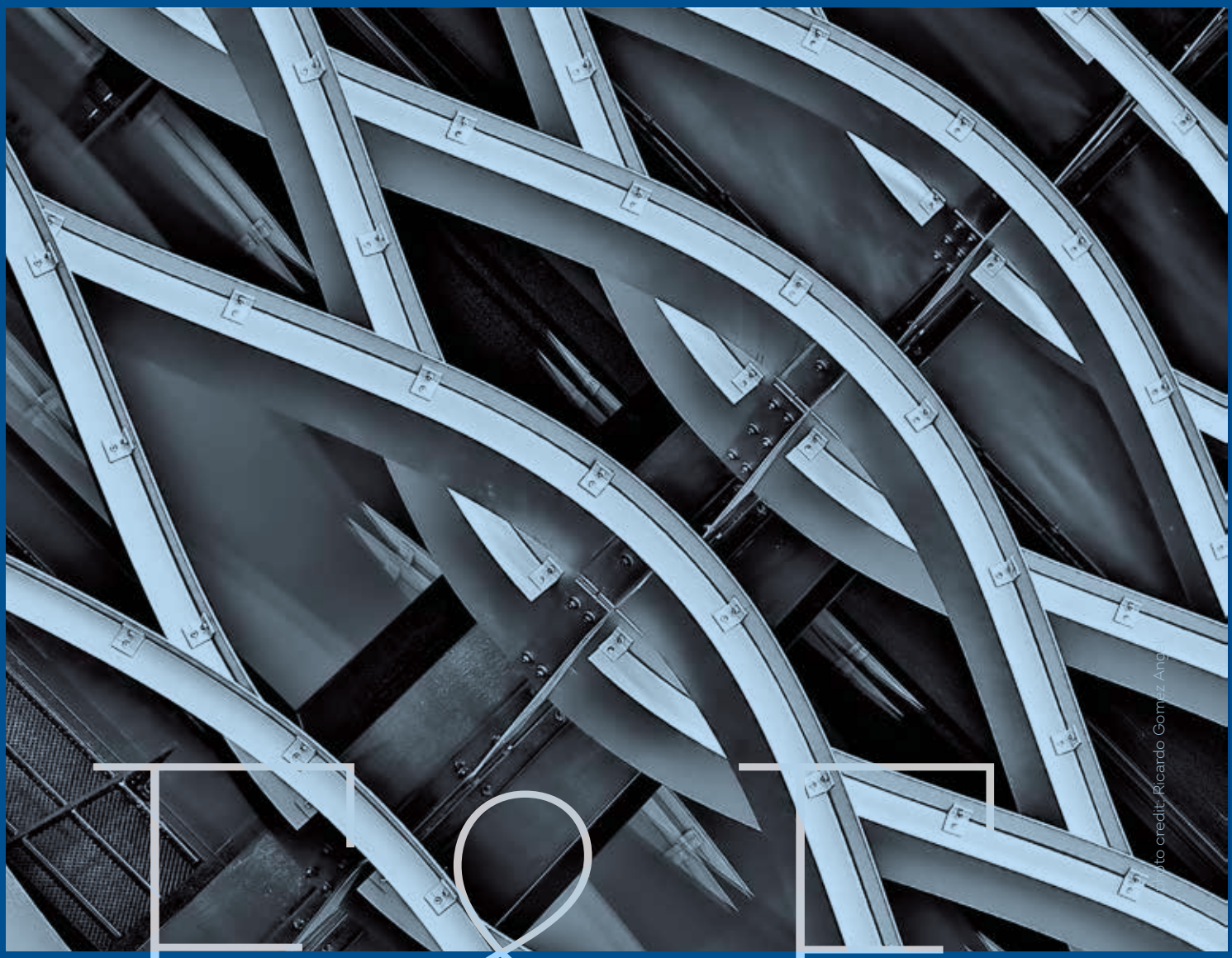


Photo credit: Ricardo Gomez Ang

E&F

Events & Fairs

Get a glimpse of our booths in the coming trade shows. Our best team of technology specialists will make your visit worthwhile and help your business operations smarter. Our top sales team, with their passion for the industry, deep domain of knowledge and multi-faceted expertise, are looking forward to meeting and discussing with you for any potential collaborations.

06

Events & Fairs

PREVIEW

TUBE & WIRE 2020: Sinosteel E&T Brings Innovative Technologies to Dusseldorf

Dusseldorf - Germany
Dec. 07 > Dec. 11, 2020
Booth F16, Hall 7A

The Tube & Wire trade fair, a key international event in the wire, tube and pipe industry held every two years, will take place in Dusseldorf from Dec. 7 to 11, 2020. Sinosteel Engineering & Technology Co.Ltd. (abbr Sinosteel E&T) will show up as a leading solution supplier at Booth F16, Hall 7A.

Experts from Sinosteel E&T will present the latest developments and applications of long product rolling technologies. Visitors will have the opportunity to have an overall information about the service and business of Sinosteel E&T. We look forward to seeing you there.

Sinosteel E&T Will Attend The **MMMM 2020**, India

Pragati Maidan
New Delhi - India
Dec. 17 > Dec. 19, 2020
Stand M090, Hall A3

The International Exhibition and Conference on Minerals, Metals, Metallurgy & Materials (abbr MMMM) is India's largest comprehensive exhibition in the field of metallurgy. Began in 1996, the biennial international trade fair has been successfully held for 12 times. MMMM has become a prestigious trade show and gained widespread recognition in the industry. It also serves as an important B2B platform in the field of global steel metallurgy. MMMM 2020, the 13th edition in the series of the event, is scheduled on 17 - 19 December 2020 at Pragati Maidan, New Delhi, India. Marking its 10th time of participation, Sinosteel Engineering & Technology Co., Ltd. will be at Stand M090, HALL A3 by the time and look forward to seeing everyone.

REVIEW

EYE-CATCHING: Sinosteel E&T at METEC 2019

METEC 2019
Dusseldorf - Germany
June 24 > June 29, 2019

The 10th International METEC 2019 was held in Düsseldorf, Germany. Sinosteel E & T participated in METEC 2019, demonstrating its latest technological development. The company also attended the European Steel Technology and Application Days (ESTAD) held at the same time, with its self-developed technology on TGIOP & TMCP attracting great attention. METEC, held every four years together with International Trade Fair for Foundry, Foundry Technology and Melting Furnace (GIFA), International Therm Process Summit and NEWCAST Casting Trade Fair, is the most influential and largest international casting and metallurgy exhibition in the world. Under the theme of *The Bright World of Metals*, METEC 2019 emphasized the concepts of intelligent manufacturing (industry 4.0), ecological metals, sustainable development as well as the integration of traditional industries with new technologies and concepts, so as to keep abreast with the times while being mankind-oriented. The trade fair covered a total area of more than 40,000 square meters, bringing together more than 2,000 enterprises from 120 countries and attracting more than 80,000 professionals.

During the six-day trade fair, led by Director and President Mr. Wang Jian, Sinosteel E&T's delegation demonstrated the metallurgical full-process engineering technology and services guided by scientific and technological innovation, covering energy-saving and environmental protection solutions, intelligent manufacturing technology, etc., attracting a large number of professionals in the metallurgical and related industries. The participants had in-depth exchanges and discussions with more than 40 companies from Germany, Italy, Russia, South Africa, India, Switzerland, Austria, Angola, Japan, etc. At the fair, Mr. Wang Jian met with senior executives of JINDAL Group and TOSYALI Group, of whom were partners and old friends, exchanging views on future cooperation.

At ESTAD, technical experts from Sinosteel E&T gave speeches on two advanced technologies which were independently developed by the company, known as travelling grate iron ore pelletizing process (TGIOP) and Thermo Mechanical Controlled Processing (TMCP) technology. One expert of Sinosteel demonstrated TGIOP technology from its technical characteristics to performance and highlighted the application prospect.

The process is a well combination of several processes, advanced computer simulation and optimization design. Along with the in-depth development of computer modeling and artificial intelligence for pelletizing, Sinosteel E&T will provide steel makers, both home and abroad, with optimized pelletizing technology to achieve safer, environment friendly, & more economical results.

While deliberating the TMCP technology and its matching equipment, the other expert showed to the audience that on the basis of reducing the addition of microalloy elements (cancel Nb and V, and lower the content of Mn), it realized fine grain rolling through deformation induced ferrite transformation and deformation-enhancing transformation, to improve the internal structure and strength of the products, as well as reduce production cost. At the same time, with the matching equipment, the rolling speed & output could be increased. TMCP, together with the relevant equipment, could not only reduce the global consumption of alloy minerals, energy such as mining & smelting and carbon emissions in the entire production chain, but also help promote green, environmental friendly and high-quality development of metallurgical industry both in China and around the globe.

Events & Fairs

REVIEW

Gained A Full Basket Of Accomplishments At The **METAL EXPO 2019**

Metal Expo 2019

Moscow - Russia

Nov. 12 > Nov. 15, 2019

Metal Expo 2019, the 25th International Industrial Exhibition was held on at VDNHa Fairgrounds, Moscow, Russia, during which Sinosteel MECC, a wholly-owned subsidiary of Sinosteel E&T, showcased a brand new look. This was also the 14th year that Sinosteel MECC attended the Russian Exhibition. Being increased yearly by scale, the jubilee exhibition has become one of the world's significant platforms for exhibiting key products, technologies and solutions of steel producers, equipment manufacturers, service and raw materials providers and engineering companies. This year, 600 exhibitors from 34 world countries (nearly 90 from China) exhibited their best solutions on the exhibition space of more than 27k sqm, attracting more than 40,000 steel professionals. Besides, numerous seminars, conferences, roundtables and other forms of professional and technical communications were held in parallel to the exhibition.

During the four-day exhibit, Sinosteel MECC demonstrated its latest development and technology to the audience, highlighting the company's strength, capability and experience in sintering, coking, blast furnaces and other process before iron making. The exhibition booth has attracted a large number of professionals from metallurgical industries. The delegation also met with executives from MMK Group, with the two sides exchanging views on the proceeding coking and sintering projects as well as plans for further cooperation. The two companies not only shared a long-standing cooperation history, but also become old friends of mutual reliance. The delegation also held in-depth exchanges and negotiations with customers from more than 10 countries and regions, including Russia, Kazakhstan, Ukraine, Uzbekistan and the Middle East. Guided by ***China's Belt and Road Initiative***, Sinosteel MECC will continue to seize development opportunities, reinforce communications and connections, and consolidate cooperation with partners in the years to come.

BEYOND EXPECTATIONS

SINOSTEEL ENGINEERING NEWS TECHNOLOGY LETTER

Learn more about us on our website:
http://mecc.sinosteel.com/EN/

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