

## 应用业绩:

**红土镍矿高压酸浸湿法冶炼项目**  
巴新瑞木项目/印尼OBI项目/印尼华越项目  
高压釜规格: 760-1000m<sup>3</sup>  
浸出温度: 260℃  
浸出压力: 5400kPa



**铜阳极泥处理项目**  
金川铜阳极泥项目  
高压釜规格: 2×30m<sup>3</sup>  
浸出温度: 160-170℃  
浸出压力: 1000kPa



**高冰镍湿法精炼项目**  
金川公司3万吨镍压力浸出项目  
高压釜规格: 110m<sup>3</sup>  
浸出温度: 160℃  
浸出压力: 1000kPa



**锌冶炼赤铁矿除铁项目**  
华联锌冶炼技改项目  
高压釜规格: 240m<sup>3</sup>  
浸出温度: 200℃  
浸出压力: 2000kPa



**中原冶炼厂铜阳极泥处理项目**  
高压釜规格: 2×25m<sup>3</sup>  
浸出温度: 160-170℃  
浸出压力: 1000kPa



**吉恩镍业压力浸出项目**  
高压釜规格: 20m<sup>3</sup>, 8m<sup>3</sup>  
浸出温度: 150-160℃  
浸出压力: 800kPa



**铜钴矿加压氧浸湿法项目**  
浙江衢州华友钴项目  
高压釜规格: 160m<sup>3</sup>  
浸出温度: 210℃  
浸出压力: 2900kPa



**金矿加压氧浸预处理项目**  
贵州紫金水银洞金矿项目/塔吉克斯坦金铜项目  
高压釜规格: 160m<sup>3</sup>  
浸出温度: 225℃  
浸出压力: 3800kPa



## Applications:

Nickel laterite HPAL hydrometallurgical projects  
Ramu (PNG); OBI (Indonesia); Huayue (Indonesia)  
Autoclave spec: 760-1,000 m<sup>3</sup>  
Leaching temperature: 260 °C  
Leaching pressure: 5,400 kPa

Fe removal for hematite in Zn smelting projects  
Hualian Zn-In Metallurgical Technology Modification Project  
Autoclave spec: 240 m<sup>3</sup>  
Leaching temperature: 200 °C  
Leaching pressure: 2,000 kPa

Co-Cu POX leaching hydrometallurgical projects  
Zhejiang Quzhou Huayou Co Project  
Autoclave spec: 160 m<sup>3</sup>  
Leaching temperature: 210 °C  
Leaching pressure: 2,900 kPa

Au ore POX pretreatment projects  
Guizhou Zijin Mining Au Project; Au-Cu Project (Tajikistan)  
Autoclave spec: 160 m<sup>3</sup>  
Leaching temperature: 225 °C  
Leaching pressure: 3,800 kPa

Cu anode slime treatment projects  
Jinchuan Cu Anode Slime Project  
Autoclave spec: 2×30 m<sup>3</sup>  
Leaching temperature: 160-170 °C  
Leaching pressure: 1,000 kPa

Zhongyuan Smelter Cu Anode Slime Treatment Project  
Autoclave spec: 2×25 m<sup>3</sup>  
Leaching temperature: 160-170 °C  
Leaching pressure: 1,000 kPa

High Ni matte hydrometallurgical refining projects  
Jinchuan Ni Pressure Leaching Project  
Autoclave spec: 110 m<sup>3</sup>  
Leaching temperature: 160 °C  
Leaching pressure: 1,000 kPa

Ji'en Nickel's HPAL Project  
Autoclave spec: 20 m<sup>3</sup>, 8 m<sup>3</sup>  
Leaching temperature: 150-160 °C  
Leaching pressure: 800 kPa

## 冶金装备篇 Metallurgical equipment

# 高温压力浸出系统

High-temperature pressure leaching system

## II 高温压力浸出系统

中国恩菲自主开发的高温压力浸出技术及专利产品, 包括预热器、加压釜、闪蒸装置(闪蒸槽+闪蒸阀)、动态可选择性高效尾气洗涤系统、多介质混合喷管、核液位计保护套管、加酸装置等核心技术装备, 可广泛应用于红土镍矿、硫化矿(锌、铜、钴、镍、钨等)、难处理金精矿、赤铁矿除铁、铜阳极泥、氧化铝等冶炼项目。中国恩菲拥有一支由设计大师牵头的专业团队, 能为项目提供咨询、设计、采购、施工、投产、运营等全方位服务, 已在国内外成功服务多个项目, 保证了项目的稳定达产运营, 并持续盈利。

该系统可处理成分复杂及低品位资源, 迅速有效地浸出原料中的有价金属, 实现常压状态下难以达到的浸出率, 能综合回收资源中有价金属以及实现渣资源化, 具有有效作业率高、稳定可靠、能耗低、低碳环保等特点。可根据工艺介质特点提供整套工艺装备, 满足多种工况条件需求。

## High-temperature pressure leaching system

The high-pressure acid leaching system and patented product that are interdependently researched and developed by ENFI consists of key equipment such as multi-tube heat exchanger (preheater), autoclave, flash vessel, tail gas scrubbing system, multi-medium mixing nozzle, nuclear level gauge casing, acid lance, thickener and agitation equipment. Widely applicable in metallurgical projects including pressure acid leaching of nickel laterite, pressure oxidative leaching of sulfide concentrate (zinc, copper, cobalt, nickel, molybdenum, etc.), pressure pre-oxidation of refractory gold concentrate, iron removal of iron-bearing solution using hematite, copper anode slime treatment and aluminum oxide processing, etc. China ENFI boasts a professional team headed by design masters, which is capable of offering all-round services for customers, such as consulting, design, procurement, construction, commissioning and operation, etc., and has successfully served a number of projects both at home and abroad, ensuring a steady ramp up and a stable production operation of the project according to the relevant standards, and a sustainable profitability as well.

The system can be used for processing resources of complex composition and low grade, quick and effective leaching of valuable metals from raw materials to achieve a leaching rate that is difficult to obtain under atmospheric pressure. Characterized by low energy consumption and environmental friendliness, the system can also be used for comprehensive recovery of valuable metals from the resources and slag recycling. The complete set of process equipment can be supplied according to the characteristics of process media, so as to meet the needs for multi-working-conditions.



## | 加压釜

加压釜是中国恩菲加压浸出核心技术的关键设备，是物料混合反应的高压容器，承受着高温、高压、强酸、强磨蚀介质的工作条件，且不受工艺操作波动的影响，是工艺流程中安全性要求最高的设备。该设备主要由釜体、隔室（带搅拌器）、加料装置、检测装置、气体分布装置、自动控制装置等组成，保证高浸出率、低能耗、环境友好，能综合回收资源中有价金属以及实现渣资源化。

主要为卧式和立式两种型式，使用寿命长，处理矿量可达到200万t/台·年；非标设计容积可达850m<sup>3</sup>/台。



高压釜  
Autoclave

### Autoclave

The autoclave is a key equipment in ENFI's core technology for pressure leaching. It is a high-pressure vessel for material agitation and reactions, capable of withstanding high temperature, high pressure, strong acid, and strong abrasive media. It is not affected by process fluctuations and is the equipment with the highest safety requirements in the process flow. It is mainly composed of autoclave body, compartment (with mixer), feeding device, detection device, gas distribution device, automatic control device, etc. It can ensure high leaching rate with low energy consumption and is eco-friendly, it can comprehensively recover the valuable metals in the resources to realize the recycling of slag resources.

Mainly horizontal and vertical, the autoclave has a complex internal structure, long service life and has a processing capacity of up to 2Mt/autoclave-year. Non-standard autoclave design, with a capacity of up to 850m<sup>3</sup>/autoclave.

## | 闪蒸装置

闪蒸装置是加压釜浸出后矿浆减压降温的关键设备，关系到系统的安全、稳定运行，从加压釜排出的矿浆进入闪蒸槽后，压力和温度降至常压，闪蒸蒸汽与矿浆分离，更好地提高加压浸出的热交换效率。该装置结构合理、运行周期长、维修方便、减压降温明显、交换效率高。



闪蒸装置  
Flash vessel

### Flash vessel

Flash vessel is the key equipment for pressure reduction and cooling of ore pulp after pressure leaching, which is related to the safe and stable operation of the entire system. The ore pulp discharged from the autoclave enters flash vessel where the pressure and temperature of material drop to normal states and the flash steam is separated from the ore pulp to better realize the thermal equilibrium of pressure leaching. This device has the advantages of reasonable structure, long service life, easy maintenance, high efficiency for pressure reduction and temperature drop, and the ability of ensuring thermal equilibrium.

## | 预热器

预热器主要应用于加热加压釜进料，预热器本体一般主要由外壳、折流板或管板和管束、封头、各种适用物料性质的内插管以及管口等部件构成，并配套泵、阀门、仪表、管路系统以及爬梯、护栏、平台、钢结构支撑等附属件，组成预热器系统。

该套装置形式简单、效率高、寿命长，操作维护方便，可适应各类加压浸出工艺中物料加热，并能应对加压釜给料泵产生的强烈流量脉动和压力脉动等复杂工作条件；另外，该装置可根据工艺定制，从而精准保障工艺稳定、经济、安全、可靠。



预热器  
Preheater

### Preheater

The preheater is mainly used on the autoclave feed. It is composed of a shell, baffle or tube plate, tube bundle, heads, various types of inserted tubes suitable for different materials, and tube openings. It is also equipped with pumps, valves, instruments, pipeline systems, as well as accessories such as ladders, guardrails, platforms, and steel structural supports.

The preheater system is characterized by its simplicity, high efficiency, long lifespan, and easy operation and maintenance. It can be used for heating materials in various pressurized leaching processes and can withstand complex working conditions such as intense flow and pressure pulses generated by the autoclave feed pump. This system can also be customized according to different process requirements to ensure process stability, cost efficiency, safety, and reliability.

### 发明专利：

#### Patent:



多介质混合喷管 | 核液位计保护套管  
Multi-medium injector | Nuclear level gauge casing

加酸装置  
Acid-adding device

## | 核液位计保护套管

核液位计保护套管用于加压釜内核源的保护及射线的无序发散隔离，维持射线的安全，减少或杜绝射线的散射，保护人身安全。本装置材质特殊，加工精度要求高，全面保护加压釜内的核仪表，彻底杜绝了核仪表腐蚀及核源脱落等严重安全问题。

## | 加酸装置

加酸装置(含酸阀和酸枪)安装在高压釜的隔室侧部或顶部，通过浓硫酸给料泵向高压釜内定量注入浓硫酸，通过搅拌器将矿浆和浓硫酸混合后进行反应。该装置可在高温、高酸、高压工况条件下连续稳定运行，其设计结构灵活、材质特殊、具有耐腐蚀、更换方便、操作安全等特点，根据工艺条件合理选材，能充分保证加压釜内稳定操作，提高反应速率和搅拌效率。

## Nuclear level gauge casing

Nuclear level gauge casing used to protect the nuclear source and isolate the disorderly divergent rays in the autoclave, to maintain radiation safety, reduce/eliminate ray scattering and protect personal safety. The casing is made of special material, with sophisticated structure and high-precision machining requirement. This device can protect the nuclear instrument in the autoclave in an all-round way, which can completely eliminate corrosion of nuclear instrument, nuclear source falling off and other severe safety problems.

## Acid-adding device

The acid addition device (including the acid valve and acid lance) is installed on the side or top of the autoclave. It injects concentrated sulfuric acid into the autoclave in a controlled manner through a concentrated sulfuric acid feed pump, and then mixes the acid into the slurry using an agitator. This device can continuously operate under the conditions of high temperature, high acidity and high pressure; it is designed to be of flexible structure and special materials and has the advantages of corrosion-resistance and wear-proof, easy replacement, safe operation and so on. Reasonable materials can be selected based on process conditions, which can ensure the stable operation in the autoclave, so as to improve the reacting efficiency and agitating efficiency.

## | 动态可选择性高效尾气洗涤系统

动态可选择性高效尾气洗涤系统的主要作用是对加压浸出系统排气中夹带的酸性液滴、固体颗粒、有害杂质等进行有效洗涤，由排气冷凝器、文丘里、分离器、连接管道、工艺阀门及仪表等组成。该系统可调节范围广、洗涤效率高、模块化设计、绿色环保，可保证外排气体达标，实现尾气排放的循环利用。

### 产品特点：

- » 洗涤效率高达99%以上
- » 减碳环保，可实现尾气热量二次循环利用
- » 动态调节，适用于范围波动大的工况；分段洗涤，保证洗涤液合理分配，节约投资
- » 结构简单，维护方便，模块化设计

## | 多介质混合喷管

多介质混合喷管用于向加压釜内通入氧气、蒸汽、冷却液等介质，装置选用特种材料加工而成，适用于高温高酸等各类工况，可保障物料顺利通入有效混合区域内，达到最佳的混合及反应效果；可实现单只喷管高效混合，多只喷管优势组合。设备可靠性高，寿命达5年以上，具有耐冲击、耐腐蚀、防结垢、防堵塞，维修更换便利等特点。

## Dynamically selective high-efficiency tail gas scrubbing system

Characterized by selectivity, dynamics and high-efficiency, the tail gas scrubbing system is specially designed for effective scrubbing of tail gas from the pressure leaching system, to remove the acid droplets, solid particles and harmful impurities therein. The system is composed of exhaust condenser, Venturi, separator, connecting pipes, process valves and instrument, etc. It is featured with a wide adjustable range, high scrubbing efficiency, modular design and environmental friendliness, which can ensure compliant emission of exhaust gas and realize recycling of tail gas.

### Features:

- » Scrubbing efficiency reaching over 99%.
- » It can realize secondary recycling of tail gas heat, fully embodying the advanced design concept of energy saving and environmental protection.
- » The adjustable scrubbing device enables its applicability to working conditions with large-range fluctuation; the staged scrubbing mode guarantees the reasonable distribution of scrubbing liquid and saves cost.
- » Simple structure, ease of maintenance and modular design.

## Multi-medium injector

Multi-medium injector is used to inject oxygen, steam, cooling liquid and other medias into the autoclave. It is made of special materials and is applicable to various working conditions such as high temperature and high acid condition, to ensure smooth flow of materials into the effective mixing zone and achieve optimal mixing and reaction effect; the injector is ENFI's patented product featuring high reliability, over-5-year service life, special materials of construction, sophisticated structure, high-precision machining, ease of maintenance and replacement.



尾气洗涤系统  
Tail gas scrubbing system

## 应用业绩：

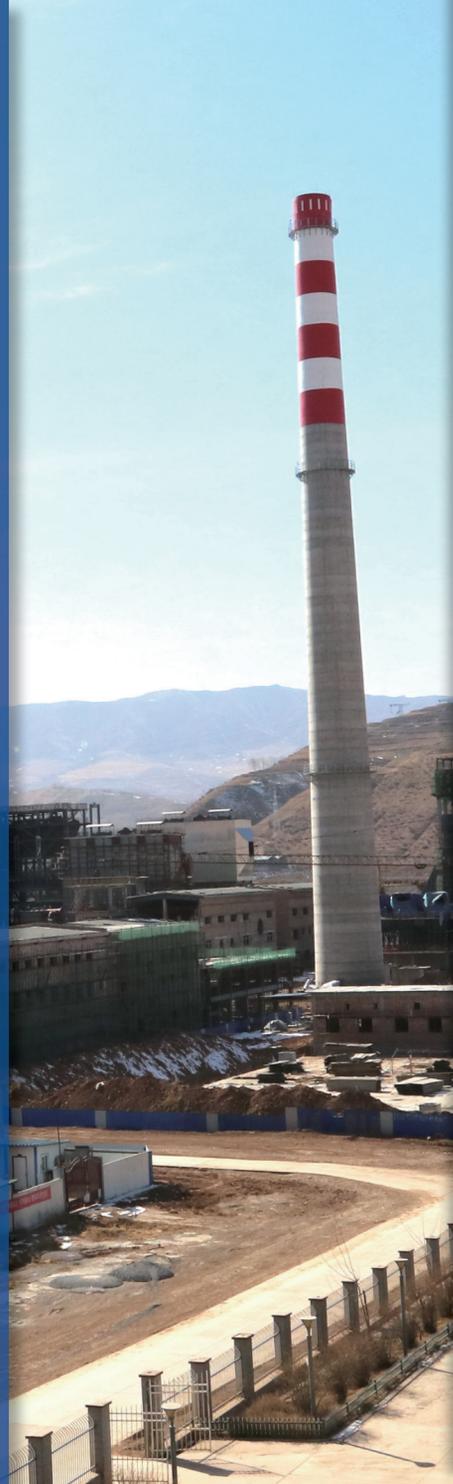
成功应用于30多个铅冶炼项目，20多个铜冶炼项目中。

序号	项目名称	规模(kt/a)	工艺	投产时间
底吹炼铜				
1	越南生权冶炼厂	50	SKS+P-G	2008
2	山东东营方圆有色金属有限公司	400	SKS+P-S	2008
3	山东恒邦冶炼股份有限公司	500	SKS+P-S	2010
4	中条山有色金属集团垣曲冶炼厂	500	SKS+P-S	2014
5	豫光金铅集团玉川冶炼厂	500	SKS+BCC	2014
6	中国黄金集团三门峡中原冶炼厂	1500	SKS+悬浮吹炼	2015
7	包头华鼎铜业	450	SKS+BCC	2016
8	五矿铜业金铜综合回收产业升级项目	550	SKS+P-S	2016
底吹炼铅				
1	河南豫光金铅股份有限公司	80	SKS-鼓风炉还原熔炼	2002
2	湖南水口山有色金属集团有限公司	100	SKS-鼓风炉还原熔炼	2005
3	济源市金利冶炼有限责任公司	200	SKS-侧吹炉还原熔炼	2007
4	江西金德铅业股份有限公司	80	SKS-鼓风炉还原熔炼	2008
5	安阳峨山有色金属有限公司	100	SKS-底吹还原熔炼	2010
6	印度洪斯坦锌业公司	100	SKS-鼓风炉还原熔炼	2011
7	山东恒邦冶炼股份有限公司	100	SKS-底吹还原熔炼	2013
8	蒙自矿冶有限责任公司	60	SKS-底吹还原熔炼	2014

## Application performance:

30+ lead smelting and 20+ copper smelting projects.

S/N	Description	Capacity	Main process	Start of production
SKS copper smelting and converting				
1	Sin Quyen Smelter in Vietnam	50	SKS+P-G	2008
2	Dongying Fangyuan (Phase I)	400	SKS+P-S	2008
3	Shandong Humon (Phase I)	500	SKS+P-S	2010
4	Shanxi Huangqu Smelter	500	SKS+P-S	2014
5	Henan Yuguang Gold-Lead Smelter	500	SKS+BCC	2014
6	Zhongyuan Gold Smelter	1500	SKS+Suspension converting	2015
7	Baotou Huading Converter Modernization	450	SKS+BCC	2016
8	Minmetals Gold and Copper Project	550	SKS+P-S	2016
SKS lead smelting				
1	Henan Yuguang Gold & Lead Co., Ltd.	80	SKS-Blast furnace reduction smelting	2002
2	Hunan Shuikoushan Non-Ferrous Metal Group Co. Ltd.	100	SKS-reduction smelting in blast furnace	2005
3	Jinli metallurgy Co., Ltd.	200	SKS-reduction smelting in side-blowing furnace	2007
4	Jiangxi Jinde Lead Co., Ltd.	80	SKS-reduction smelting in blast furnace	2008
5	Minshan Non-Ferrous Metal Group Co. Ltd.	100	SKS-reduction smelting in bottom-blowing furnace	2010
6	Hindustan Zinc Limited, India	100	SKS-reduction smelting in blast furnace	2011
7	Shandong Humon Smelting Co., Ltd	100	SKS-reduction smelting in bottom-blowing furnace	2013
8	Mengzi Metallurgical Co., Ltd.	60	SKS-reduction smelting in bottom-blowing furnace	2014



河南中原黄金冶炼厂有限责任公司整理搬迁升级改造项目  
Overall Relocation, Upgrade and Modification Project of Henan Zhongyuan Gold Smelter LLC



青海铜业有限公司铜冶炼项目  
Copper Smelting Project of Qinghai Copper Industry Co., Ltd.



包头华鼎铜业有限责任公司冶炼厂三期  
Phase 3 Project of the Smelter of Baotou Huading Copper Industry Development Co., Ltd.



灵宝金城矿业有限公司铜冶炼项目  
Copper Smelting Project of Lingbao Jincheng Metallurgical Co., Ltd.

## 冶金装备篇 Metallurgical equipment

# 氧气底吹炉工艺装备及控制系统

SKS furnace process equipment and control system

## || 氧气底吹炉工艺装备及控制系统

氧气底吹炉是中国恩菲以拥有自主知识产权的氧气底吹冶炼技术为依托，自主研发的新型冶金炉型，也是目前国内唯一具备世界水准的有色冶金装备。该炉型为非水冷卧式回转炉，富氧空气通过炉体底部的喷枪直接吹入熔体，与物料发生化学反应。

在铜冶炼领域，中国恩菲已设计20余座应用氧气底吹炉工艺装备的工厂，年精矿处理量超过10Mt/a。在铅冶炼领域，该工艺装备处于行业领先水平，产能占中国铅冶炼80%，是国家九部委联合发文指定的我国首选炼铅工艺，是世界上应用最广泛的铅冶炼工艺装备。

主要应用于炼铜、炼铅工艺。

### 处理能力：

- » 铅冶炼(粗铅)：3 ~ 40 10<sup>4</sup>t/a
- » 铜冶炼(铜精矿)：5 ~ 150 10<sup>4</sup>t/a



## SKS furnace process equipment and control system

SKS furnace is a proprietary new type metallurgical furnace independently developed by ENFI based on oxygen bottom-blowing smelting technology, and is also the only world class nonferrous metals smelting equipment ever developed domestically in China so far. This furnace is a type of non-water-cooling horizontal revolving furnace, where oxygen enriched air is directly blown into the melt by lance fitted at bottom of the furnace, inside of which the air has chemical reaction with the feed materials.

In the field of copper smelting, China ENFI has designed more than 20 plants using SKS furnace process equipment, with an annual concentrate throughput capacity of more than 10Mt/a. In the field of lead smelting, this process equipment is in the forefront of the industry, accounting for more than 80% of the lead smelting capacity in China. It is the preferred lead smelting process in China designated by nine organizations of China State Council jointly, and it is the most widely used lead smelting process equipment in the world.

Scope of application: mainly used in copper smelting and lead smelting process.

### Processing capacity:

- » Lead smelting (lead bullion): 3-40 10<sup>4</sup>t/a
- » Copper smelting (copper concentrate): 5-150 10<sup>4</sup>t/a





河南豫光金铅冶炼厂  
Henan Yuguang Gold-Lead Smelter



云南蒙自铅冶炼厂  
Yunnan Mengzi Lead Smelter



越南生权一期  
Vietnam Birth Right Phase 1

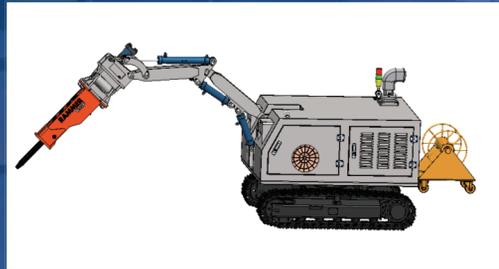
## II 炉前多功能机械手

中国恩菲开发了炉前多功能机械手，可进行工业炉衬拆除、整修，氧枪更换时围砖清理工作等，该设备模拟人工操作过程对工业炉及其周边进行整修，实现减人增效。

规格尺寸：3000mm×1050mm×1300mm（长\*宽\*高）  
装机功率：15kW  
冲击能力：200焦耳及以上

### 产品特点：

- » 设备作业效率相对传统人工提高4倍，且机器可在恶劣环境连续作业，适用于受限空间，高温及高湿、噪音、放射性、密闭等环境；可在视距范围内无线遥控操作，有效减少操作人员受职业高温、粉尘、有害气体、噪音等伤害
- » 模拟人工作业，可以上、下360°范围内灵活作业，便于斜面清理及精准化作业
- » 拆除设备可在破碎锤、液压剪、铣刨头等间快速更换



炉前多功能机械手  
Multi-function mechanical arm in front of the furnace

### Multi-function mechanical arm in front of the furnace

The multi-function mechanical arm in front of the furnace developed by ENFI can be used for the work such as the removal and repair of industrial furnace lining, and brick cleaning during oxygen lance replacement. The device simulates manual operation process to repair the industrial furnace and its surroundings, achieving the increase of efficiency by downsizing payrolls.

Specification and dimension: 3000Mm×1050mm×1300mm (L×W×H).  
Installed power: 15kW  
Impact capacity: 200J and above

### Features:

- » The equipment productivity is 4 times higher than that of traditional manual operation, and the machine can operate continuously in severe environment, limited space, and high-temperature, high-humidity, noisy, radioactive and closed environment, etc.; It can be operated by wireless remote control within the range of sight, effectively protecting operators from occupational high temperature, dust, harmful gas, noise and so on.
- » It can simulate manual operation, realizing flexible operation in an up and down range of 360°, which is convenient for the clean the slope and fining work.
- » During equipment removal, it can realize quick replacement of the breaking hammer, hydraulic shear, milling machine head, etc.



氧枪

## II 氧枪

氧枪系中国恩菲自主开发的底吹炉关键供氧装置，也是底吹炉内流动过程的动力来源，由特种耐热材料加工而成，通过调节供氧使底吹炉达到最佳工作状态。该装置可与底吹炉成套或单独供货，专业团队可提供定制化配件方案。

采用特种材料和槽缝式多层套管专利结构，具有寿命长、便于安装，可实现热修热换；喷出的气流的气泡直径小、弥散度高、搅拌力强、传热传质效果好；供气通道面积大，供氧能力强等优点。

### Oxygen lance

Oxygen lances are the key oxygen supply devices of the SKS furnace which is independently developed by China ENFI, and also the power source of the flow process in the furnace. They are made of special heat-resistant materials, making the furnace reach the best working condition by adjusting oxygen supply. Oxygen lances can be provided in package together with SKS furnace or supplied independently, customized supply scheme of which can be offered by the professional team.

Special materials and a patent structure of slotting-type multi-layer casing pipe are adopted, which has the advantages of long service and easy installation, and hot repair and replacement can be realized; the ejected airflow has the features of small-diameter bubbles, high dispersity, strong mixing power, and good heat and mass transfer effect; and advantages of large area of air supply pass, strong oxygen supply capacity, etc.

## 氧气底吹炉炼铅

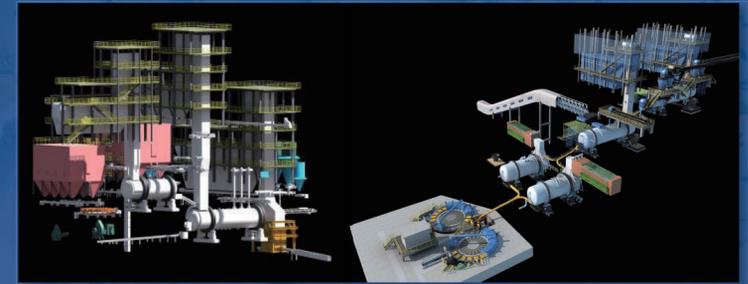
该产品具有原料适应性强，能耗低，环保好，故障率低、操作简单、投资少等优点，有价金属元素Au、Ag的回收率达到99%以上，炉衬寿命长，实际生产炉寿达3年以上，系统作业率>90%。

中国恩菲设计或供货的氧气底吹炼铅炉，已投产了40多台，分布在国内外众多冶炼厂。

## 氧气底吹连续炼铜

氧气底吹连续炼铜工艺装备具有建设投资成本低、金属回收率高、资源综合利用水平高，综合能耗低、碳排放少等优点，是世界上先进的炼铜工艺。

熔炼采用高铁硅比渣型，对比同等规模的工厂具有熔炼物料量及渣量较少优势；吹炼采用底吹连续吹炼模式，脱杂能力强、粗铜质量高；采用自流配置，避免了铜铤倒运，车间布局紧凑，生产清洁；铜总回收率可达98.5%以上。



### Lead smelting by SKS furnace:

The product has the advantages of strong adaptability of raw materials, low energy consumption, environment friendly, low failure rate, simple operation, less investment, etc. The recovery of valuable elements Au and Ag is greater than 99%, the service life of furnace lining is long, the actual service life of furnace is more than 3 years, and the system's availability is more than 90%.

More than 40 SKS furnaces designed or supplied by China ENFI have been put into production, which are distributed in many smelters at home and abroad.

### Continuous copper smelting by SKS furnace:

The process equipment of bottom blowing continuous copper smelting technology has the advantages of low investment and construction cost, high metal recovery, high comprehensive utilization level of resources, low comprehensive energy consumption, less carbon emissions, and so on. It is one of the most advanced copper smelting processes in the world.

The smelting process can produce slag with a high Fe-Si ratio, and the quantity of treated feed materials and produced slag is relatively smaller compared with other plants of the same size; continuous converting is adopted, which has strong ability of impurities removal and can produce high-quality blister copper; gravity flow is employed to avoid copper matte transfer and the compact plant arrangement can realize clean production; the total recovery of copper can reach above 98.5%.

# 超大型侧吹炉 (SSC) 工艺装备及控制系统

Super-large side-blowing converting (SSC) technical equipment and control system



## 应用业绩

序号	项目名称	主要工艺	项目阶段
1	湖北金洋废铅酸蓄电池低温连续熔炼工程	富氧侧吹浸没燃烧熔池熔炼	2013年投产
2	河南豫光金铅股份有限公司熔炼厂烟气深度脱硫改造工程	富氧侧吹浸没燃烧熔池熔炼	2016年投产
3	祥云飞龙锌冶炼硫酸铅渣湿法处理资源化循环利用示范项目	氯化体系浸出回收	2016年投产
4	山东恒邦冶炼股份有限公司湿法黄金冶炼废渣无害化处理工程	富氧侧吹浸没燃烧熔池熔炼	2018年投产
5	云南驰宏资源综合利用有限公司160kt/a废旧铅酸电池无害化综合回收项目	富氧侧吹浸没燃烧熔池熔炼	2018年投产
6	太原华贵100t/a煤化工废催化剂处置及5000kg/a铂铑钯系列催化剂加工项目	火法预处理湿法浸出树脂吸附	2018年投产
7	云南驰宏锌锗股份有限公司会泽冶炼分公司锌浸出渣处理环保节能技改工程	富氧侧吹浸没燃烧熔池熔炼	2019年投产
8	河南豫光金铅股份有限公司再生铅资源循环利用及高效清洁生产技改项目	底吹熔池熔炼+烟化	2020年投产
9	骆驼集团新疆再生资源有限公司年处理10万t废旧铅酸蓄电池项目	富氧侧吹浸没燃烧熔池熔炼	2020年投产
10	浙江金泰莱环保科技有限公司贵金属资源再生技改项目	富氧侧吹浸没燃烧熔池熔炼	2020年投产
11	江西兴南环保科技有限公司10万t/a含铜二次资源综合利用项目	富氧侧吹浸没燃烧熔池熔炼+底吹熔池熔炼	2021年投产
12	白银有色集团股份有限公司西北铅锌冶炼厂锌冶炼资源综合利用项目	富氧侧吹浸没燃烧熔池熔炼+烟化	2021年投产
13	汉源四环锌锗科技有限公司15万t/a电解锌冶炼及综合回收利用技改项目	富氧侧吹浸没燃烧熔池熔炼+烟化	2021年投产
14	中色锌业浸出渣处理项目	富氧侧吹浸没燃烧熔池熔炼+烟化	2024年投产
15	广西飞南资源利用有限公司象州县铜资源环保再生利用项目	富氧侧吹浸没燃烧熔池熔炼+转炉	建设中
16	江门市金属污泥资源化利用项目	富氧侧吹浸没燃烧熔池熔炼	建设中
17	江西巴顿环保科技有限公司多金属二次资源综合回收利用项目	侧吹预处理+浸出+萃取+电积	建设中
18	江西和丰环保科技有限公司多金属固废资源综合利用项目	富氧侧吹浸没燃烧熔池熔炼+烟化	建设中
19	山西亿晨环保科技有限公司6万t/a再生铅技术改造项目	富氧侧吹浸没燃烧熔池熔炼	建设中

## Applications:

S/N	Project name	Main techniques	Project Stages
1	Continuous low-temperature smelting of waste lead-acid batteries in Jinyang, Hubei Province	Oxygen-enriched SSC furnace smelting	Commissioned in 2013
2	Smelter offgas deep desulfurization modification project of Henan Yuguang Gold & Lead Co., Ltd.	Oxygen-enriched SSC furnace smelting	Commissioned in 2016
3	Recycling demonstration project of the utilization of lead sulfate residue hydrometallurgical treatment of Xiangyun Feilong Zinc smelting	Leaching recovery of chloride system	Commissioned in 2016
4	Harmless treatment of metallurgical coal and gold refining residue project of Shandong Hengbang	Oxygen-enriched SSC furnace smelting	Commissioned in 2018
5	160kt/a used lead-acid batteries harmless recycling project of Yunnan Chihong Resources Integrated Utilization Co., Ltd.	Oxygen-enriched SSC furnace smelting	Commissioned in 2018
6	100t/a waste metal catalyst disposal of coal chemical industry and 5000kg/a platinum-rhodium-palladium catalyst processing project of Taiyuan Huagui Metal Co., Ltd.	Pyrometallurgical pretreatment + Hydrometallurgical leaching + Resin absorption	Commissioned in 2018
7	Zinc Leaching Residue Treatment and Environmental Performance Enhancement Project of Huize Smelting Branch of Yunnan Chihong Zn&Ge Co., Ltd.	Oxygen-enriched SSC furnace smelting	Commissioned in 2019
8	Secondary lead recycling and high efficiency clean production modification project in Henan	Bottom-blowing smelting+fuming	Commissioned in 2020
9	100,000t/a waste lead acid battery disposal project by Camel Group Xinjiang Renewable Resources Co., Ltd.	Oxygen-enriched SSC furnace smelting	Commissioned in 2020
10	Precious metal resource regeneration technical renovation project of Zhejiang Jintailai Environmental Protection Technology Co., Ltd.	Oxygen-enriched SSC furnace smelting	Commissioned in 2020
11	100,000t/a copper-bearing secondary resources recycling project of Jiangxi Xingnan Environmental Protection Technology Co., Ltd.	Oxygen-enriched SSC smelting + bottom-blowing smelting	Commissioned in 2021
12	Resource comprehensive utilization project of Northwest Lead-Zinc Smelter of Baiyin Nonferrous Metals Company	Oxygen-enriched SSC furnace smelting+fuming	Commissioned in 2021
13	Technical renovation project for 150,000t/a electrolytic zinc smelting and comprehensive utilization of Hanyuan Sihuan Zn&Ge Technologies Co Ltd	Oxygen-enriched SSC furnace smelting+fuming	Commissioned in 2021
14	Chifeng NFC Zinc Co., Ltd's Leach Residue Treatment Project	Oxygen-enriched SSC furnace smelting+fuming	Commissioned in 2024
15	Secondary copper resources recycling project of Guangxi Feinan Resources in Xiangzhou County	Oxygen-enriched SSC furnace smelting+converter	Under construction
16	Metal Sludge Recycling Project in Jiangmen City	Oxygen-enriched SSC furnace smelting	Under construction
17	Polymetallic secondary resources recycling project of Jiangxi Barton Environmental Protection Technology Co., LTD	Side-blowing pretreatment+ leaching+ extraction+ electrowinning	Under construction
18	Comprehensive utilization of polymetallic solid waste resources of Jiangxi Hefengduo Environmental Protection Technology Co., Ltd.	Oxygen-enriched SSC furnace smelting+fuming	Under construction
19	60,000t/a Secondary lead technical renovation project of Shanxi Yichen Environmental Protection Technology Co., Ltd	Oxygen-enriched SSC furnace smelting	Under construction



河南豫光再生铅资源循环利用及高效清洁生产技改工程  
Secondary lead recycling and efficient clean production modernization project of Henan Yuguang Gold & Lead Co., Ltd.



云南驰宏会泽6万t/a粗铅10万t/a电锌及渣综合利用工程  
Continuous low-temperature smelting of waste lead-acid batteries in Jinyang, Hubei Province



湖北金洋废铅酸蓄电池低温连续熔炼工程  
Continuous low-temperature smelting of waste lead-acid batteries in Jinyang, Hubei Province



浙江金泰莱环保科技有限公司贵金属资源再生技改项目  
Continuous low-temperature smelting of waste lead-acid batteries in Jinyang, Hubei Province

## 工业固废（危废）综合处理成套装置

工业固废（危废）综合处理成套装置目前已应用于含铜镍工业固废（危废）、熔融高铅渣、再生铅膏、锌浸渣等综合回收及处置领域。其优点在于采用侧吹喷枪直接向熔体供热，强化传质传热过程，且产生的高温烟气易于脱硝和除二噁英，环保条件好，可实现含铜镍等工业固废（危废）的无害化、资源化处置。

- 可处理固废（危废）原料：**
- » 液态铅渣、废铅酸电池等二次铅杂料
  - » 含铜二次资源
  - » 二次锌杂料
  - » 城市矿产（废线路板、含铜镍污泥、废活性炭、废催化剂等）

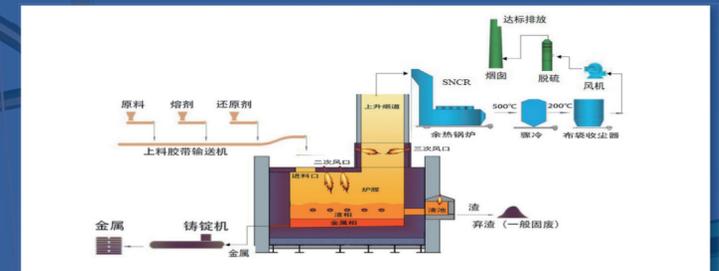
- 产品特点：**
- » 工艺适应性强、原料准备简单、有机金属回收率高、燃料适应性强、安全性好、环境友好

### Large-scale industrial solid waste proposal equipment package

The integrated industrial solid waste (hazardous waste) proposal equipment package is currently applied to comprehensive recovery and disposal of industrial solid waste (hazardous waste) containing Cu and Ni, molten lead-rich slag, secondary lead paste, zinc leaching residue, etc. Its advantages are that side-blowing lances directly supply heat to melt to intensify the process of mass and heat transfer, the produced high-temperature off-gas is prone to denitration and dioxins removal, beneficial to environment protection, as well as the harmless treatment and recycling of industrial solid waste (hazardous waste) containing Cu and Ni.

- Disposable raw materials of solid waste (hazardous waste)**
- » Secondary lead materials such as liquid lead slag, waste lead-acid cells, etc.
  - » Secondary resources containing Cu
  - » Secondary zinc materials
  - » Urban mineral resources (waste circuit board, Cu-Ni containing slurry, waste activated carbon, waste catalyst, etc.)

- Features:**
- » High adaptability to process flowsheet, simple preparation of raw materials, high recovery of organic metals, high adaptability to fuels, which is much safer and environmentally friendly.



SSC工业固废工艺流程  
Technical flowsheet of SSC industrial solid waste proposal

## 超大型侧吹炉（SSC）工艺装备及控制系统

超大型侧吹炉是侧吹浸没燃烧熔池熔炼技术（Side-Submerged Combustion Smelting Process, SSC）的核心设备。SSC是将富氧空气或燃料通过浸没于熔池的风嘴或喷枪直接鼓入金属熔体或炉渣中，加入熔体的物料由于受到鼓风的强烈搅动，快速浸没于熔体之中，完成物料化学反应的强化熔池熔炼技术。因其氧浓度高、燃料适应性强、炉体结构合理，与同类技术相比，具有热利用率高、作业率高、安全性好、环保好、能源节约等突出优势，是中国恩菲全新开发的具有自主知识产权的资源化绿色冶炼工艺。

重点应用于热态高铅渣直接还原、大型工业固废处理和再生铅领域。

- 产品特点：**
- » 工艺适应性强，适应多种不发热物料，对原料入炉水分要求低；原料准备简单，不需要严格的制粒或压砖等措施；侧吹喷枪可适用不同燃料，可使用天然气、发生炉煤气、焦炉煤气、粉煤、柴油、裂解油、废矿物油等
  - » 有针对性地设置沉淀区，有价金属回收率高
  - » 作业率高，低维护检修，喷枪附近区域砖寿命1年以上；耐火材料的寿命3年以上；年平均有效作业率300天以上
  - » 废渣资源化，熔池熔炼渣为玻璃态渣，属于一般固废，可用作建材，不存在二次污染

### SSC furnace

SSC furnace is one of the core equipment of Side-Submerged Combustion Smelting Process (SSC). SSC is an intensive smelting technology where the oxygen-enriched air or fuel is directly blown via the tuyere or lance that is submerged in the bath into the metal flux or slag, with the intensive stirring of blast, the feed with flux added is fast immersed into the flux where chemical reactions occur. Due to its high oxygen concentration, strong adaptability to fuel, reasonable furnace structure, and when compared with similar technology, SSC outstands and differentiates itself by of higher heat utilization rate, higher operation efficiency, being more safer, environmental friendly and energy saving among others, it is a new development of ENFI with independent intellectual property rights of a kind of advanced technology, low construction cost, environment friendly and recycling smelting process.

It is mainly applied in direct reduction of molten lead-rich slag, large-scale industrial solid waste treatment and secondary lead field.

### Features:

- » **High adaptability.** The SSC furnace is adapted to a variety of materials without self-heating characteristics, which means it has a low requirement on the feed moisture content; no strict pelletizing or brick pressing is required, the preparing of feed is simple; side-blowing lance is adapted to a variety of fuels, including natural gas, generator gas, coke oven gas, pulverized coal, diesel oil, pyrolysis oil, used mineral oil, etc.
- » **Targeted settling zone is arranged.** The recovery of valuable metals are high.
- » **High availability and low maintenance and repair burden.** The service life of bricks surrounding the oxygen lance is 1 year above. The service life of refractory materials is 3 years above. Annual average efficient availability is more than 300 days.
- » **Waste slag recycling.** The smelting slag is in a form of glassy slag, which is of general solid waste that can be used as building materials, hence secondary pollution can be avoided.

# 新型大功率电炉工艺装备及控制系统

New High-power Electric Furnace and Control System



## 热料输送系统

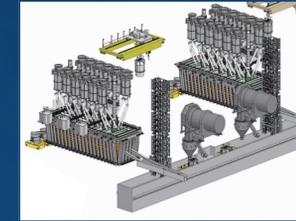
热料输送系统是中国恩菲自主研发机电一体化系统产品，用于800~1000℃的高温焙砂密闭立体空间输送（由回转窑出料口输送到电炉料仓），该系统可减少运输过程中的热量损失，保证热料不被氧化。

热焙砂温度：不大于1000℃；额定输送能力：92t/h；最大输送能力：136.8t/h

双层保温料罐有效容积计产品系列：1.4m<sup>3</sup>，7.5m<sup>3</sup>，9m<sup>3</sup>，10m<sup>3</sup>，16.2m<sup>3</sup>，19m<sup>3</sup>

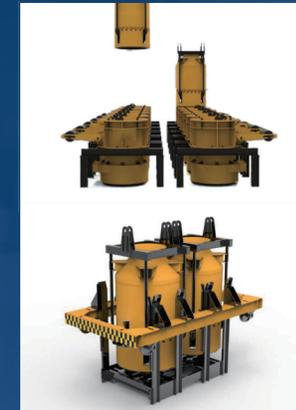
适用于颗粒、粉状热料的输送，应用于镍铁冶炼、电石领域、具有高温散料输送需求的领域。

- » 镍铁领域：镍铁冶炼行业。33MVA、39MVA、42MVA/48MVA、72MVA镍铁生产线，如力勤镍铁项目8条48MVA电炉镍铁生产线、缅甸达贡山2条72MVA镍铁生产线。
- » 电石（碳化钙）领域：主要是矿热炉生产电石行业，转运高温电石。
- » 其他具有高温散料输送环境的领域。



新型大功率镍铁电炉工艺装备及热料输送控制系统

New high-power FeNi smelting EF and hot material conveying control system



### 产品特点：

- » 跨空间、长距离、高位差立体运输，范围20m~200m
- » 热损少，最高可运输1000℃高温物料，保温效果好，百米距离温降约50℃
- » 环保好，运输过程热料全密闭，下料过程与通风联锁，无热料烟尘逸散
- » 智控运行，称重、运输、转运、选择料仓加料等全过程自动化，系统智能控制运行

### 应用业绩：

应用于缅甸达贡山镍矿工程、力勤OBI镍铁项目、印尼CNI镍铁项目、广西金源镍业防城港镍合金项目、内蒙古和谊镍铬复合材料工程项目、福建鼎信实业公司福安镍铁项目等多项目。

### Hot material conveying system

As a product of mechanical-electrical integration system independently developed by ENFI, the hot material conveying system is used to transport 800~1000℃ high-temperature calcine in sealed 3D space (from the discharge end of rotary kiln to the bin of EF), reducing heat loss during transport and protecting hot materials from oxidation.

Temperature of hot calcine: ≤1000℃; rated conveying capacity: 92t/h; maximum conveying capacity: 136.8t/h.

Series of effective capacities of double-walled heat-insulated containers: 1.4m<sup>3</sup>, 7.5m<sup>3</sup>, 9m<sup>3</sup>, 10m<sup>3</sup>, 16.2m<sup>3</sup>, and 19m<sup>3</sup>.

This system is suitable for conveying hot granular and powdery materials, and applicable to FeNi smelting, calcium carbide industry, and fields with scenarios of conveying hot bulk materials.

FeNi smelting: it can be used for FeNi production lines of 33MVA, 39MVA, 42MVA/48MVA and 72MVA, such as eight 48MVA FeNi production lines in Lygend FeNi Project and two 72MVA FeNi production lines in Tagaung Taung Nickel Mine Project in Myanmar.

Calcium carbide: it is mainly used to convey hot calcium carbide produced by submerged arc furnace.

Other fields with scenarios of conveying hot bulk materials.

### Features:

- » Long-distance 3D conveyance across space, with a large elevation difference and a conveying range between 20m and 200m.
- » Less heat loss and good thermal insulation effect: it can convey hot materials at a temperature of up to 1,000℃, and the temperature drops by around 50℃ over 100m.
- » Eco-friendliness: hot materials are fully sealed during conveyance, and the material unloading procedure is interlocked with ventilation without escape of hot materials and dust.
- » Intelligent control and operation: processes of weighing, conveying, transfer, selection of bins and feeding are all automatic, and the system is under intelligent control and operation.

### Applications:

It has been successfully applied to Tagaung Taung Nickel Mine project in Myanmar, Fangchenggang Nickel Alloy Project of Guangxi Jinyuan Nickel Industry Co., Ltd., Inner Mongolia Heyi Ni-Cr Composite Material Project, Fu'an FeNi Project of Fujian Dingxin Industry Co., Ltd., Lygend OBI FeNi Project, CNI FeNi Project in Indonesia, etc.

## 新型大功率电炉工艺装备及控制系统

该装备是中国恩菲RKEF火法镍铁冶炼技术的核心装备，填补了我国镍铁冶炼空白，使我国镍铁冶炼工业迈入世界领先水平。中国恩菲设计并供货的72000kVA镍铁电炉，是目前国内自主设计的大容量镍铁电炉。

电炉为倒梯形炉体结构，由整体弹性骨架及电极装置组成，具有高效、节能、环保等诸多优势。电炉容量高达72MVA，寿命达到10年以上，可生产品位为10%~37%的镍铁产品；同时配置电炉一体化智能控制系统，实现电炉低能耗高效运行。

适用于镍、铜冶炼，硅、磷提纯，铜钴、镍铁、钒钛制备等。目前，已成功应用于福建福安、缅甸达贡山、金源镍业等大型项目。



电炉产品图  
EF drawing

### 应用业绩：

功率	用途	台数	渣线面积	投产时间（年）	应用地区
33000kVA	镍铁电炉	2	134.4m <sup>2</sup>	2010	福建
72000kVA	镍铁电炉	2	288m <sup>2</sup>	2012	缅甸达贡山
36000kVA	镍铁电炉	2	196m <sup>2</sup>	2013	广西防城港



### 缅甸达贡山项目

缅甸达贡山镍铁项目采用72MVA大功率、高电压、全密封、低能耗、六电极矩形电炉，打破了国外对先进大型镍铁电炉的垄断。

### Tagaung Taung Nickel Mine Project in Myanmar

The Tagaung Taung Nickel Mine Project in Myanmar adopts a fully sealed rectangular EF with 72MVA high power, high voltage, low energy consumption and 6 electrodes, breaking the monopoly of foreign countries on advanced large-scale FeNi smelting EF.

### New high-power electric furnace and control system

The core equipment of pyrometallurgical FeNi smelting technology with RKEF process developed by ENFI has filled the gaps in FeNi smelting in China, making the Chinese FeNi smelting industry at the forefront of the world. The 72,000kVA EF for FeNi smelting which is designed and supplied by ENFI is hailed as the FeNi smelting EF with the largest capacity independently designed in China for the present.

The EF is comprised of a furnace body of inverted trapezoidal structure, overall elastic framework and electrode assemblies, characterized by high-efficiency, energy saving and eco-friendliness. The EF boasts a capacity of up to 72MVA, a service life of over 10 years and a capability to generate FeNi products with a grade of 10%-37%. Meanwhile, an integrated and intelligent control system for EF is developed to accomplish efficient operation with low energy consumption.

The EF is applicable to smelting of various metallic or non-metallic raw materials, including nickel, copper, industrial silicon, copper-cobalt alloy, FeNi, vanadium-titanium, phosphorus, etc. So far, it has been successfully applied to many large projects such as Fu'an FeNi Project in Fujian, Tagaung Taung Nickel Mine in Myanmar and Jinyuan Nickel Industry.

### Applications:

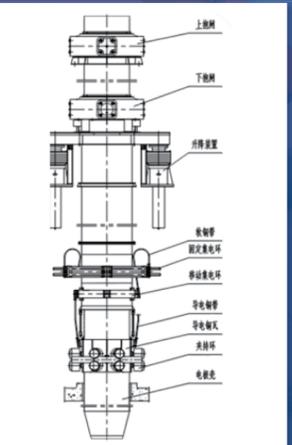
Power	Usage	Qty	Slag line area	Startup year	Client
33000kVA	FeNi smelting EF	2	134.4m <sup>2</sup>	2010 year	Fu'an, Fujian
72000kVA	FeNi smelting EF	2	288m <sup>2</sup>	2012 year	Tagaung Taung, Myanmar
36000kVA	FeNi smelting EF	2	196m <sup>2</sup>	2013 year	Fangchenggang, Guangxi

### 自焙电极装置

自焙电极装置为中国恩菲专利技术 (ZL201310071583.2)，用于电炉供电。该装置电极的升降与压放作业均与工艺操作相结合，采用计算机控制，自动化操作，电极升降幅度小，速度变化平稳，能有效降低工人的作业强度并提高电热效率。

### Self-baking electrode

As a patented product of ENFI, self-baking electrode is used to supply electricity to EF. The lifting and slipping operations of electrodes are related to process operation and automatic operations are controlled by computer programs. The lifting range of electrodes is small and the speed changes stably, which can effectively reduce labor intensity and improve electrothermal efficiency.



冶金装备篇  
Metallurgical equipment

# 大型流态化焙烧炉及控制系统

Large fluidized-bed roaster and control system



应用业绩:

序号	应用企业	规模	备注
1	株冶集团	30万t/aZn 13万t/a直浸 32万t/a净液	投产
2	白银西北铅锌冶炼厂	(10+15)万t/aZn	投产
3	云南驰宏锌锗	(14+15+10)万Zn (10+6)万t/a Pb	投产
4	巴彦淖尔	(10+10)万t Zn	投产
5	赤峰中色	22万t/aZn	投产
6	内蒙古兴安铜锌	10万t/aZn 10万t/aZn	投产 部分投产
7	豫光集团	20万t/aZn 35万t/aPb	投产
8	葫芦岛锌业	15万t/aZn (新增)	投产
9	蒙自矿冶	6万t/aZn 6万t/aPb	投产
10	成州锌业	10万t/aZn	投产
11	罗平锌电	10万t/aZn	投产
12	安徽铜冠	10万t/aZn	投产
13	伊朗YZD	3万t/aZn	投产
14	文山锌铟	3万t/aZn 10万t/aZn	投产
15	南方冶炼	10万t/aZn	投产
16	新疆乌恰	10万t/aZn	投产
17	金利集团	15万t/a Zn	投产
18	陕西锌业	10万t/a Zn	投产
19	池州九华冶炼厂	10万t/a Zn	投产
20	盛屯贵州	10万t/a Zn	投产

Applications:

S/N	Description	Capacity	Remarks
1	Zhuzhou Smelter Group	300,000t/a 130,000t/a Zn direct leaching 320,000t/a purified electrolyte	In operation
2	Northwest Lead-Zinc Smelter of Baiyin Nonferrous Group	100,000t/a + 150,000t/a Zn	In operation
3	Yunnan Chihong Zinc & Germanium Company	140,000t/a + 150,000t/a + 100,000t/a Zn 100,000t/a + 60,000t/a Pb	In operation
4	Bayan Smelter of Zijin Nonferrous Metals Company	100,000t/a + 100,000t/a Zn	In operation
5	Chifeng NFC Zinc	220,000t/a Zn	In operation
6	Inner Mongolia Xing'an Copper Zinc Smelting Company	100,000t/a Zn 100,000t/a Zn	In operation Partly in operation
7	Yuguang Group	200,000t/a Zn 350,000t/a Pb	In operation
8	Huludao Zinc Industry Company	150,000t/a Zn (new)	In operation
9	Mengzi Mining and Metallurgy Co.,Ltd	60,000t/a Zn 60,000t/a Pb	In operation
10	Chengzhou Zinc Industry Company	100,000t/a Zn	In operation
11	Luoping Zinc and Electricity Company	100,000t/a Zn	In operation
12	Anhui Tongguan Non-ferrous Metal Company	100,000t/a Zn	In operation
13	Iran YZD	30,000t/a Zn	In operation
14	Wenshan Zinc-Indium	30,000t/a Zn 100,000t/a Zn	In operation
15	Nanfeng Non-Ferrous Metal Smelting Company	100,000t/a Zn	In operation
16	Wuqia smelter in Xijiang	100,000t/a Zn	In operation
17	Jinli Group	150,000t/a Zn	In operation
18	Shaanxi Zinc Industry	100,000t/a Zn	In operation
19	Chizhou Juhua Smelter	100,000t/a Zn	In operation
20	Chengtun Guizhou	100,000t/a Zn	In operation



**西北铅锌冶炼厂**  
该企业建成国内第一台109m<sup>2</sup>流态化焙烧炉，首次采用热酸浸出-黄钾铁矾工艺，单系列100kt/a电锌规模，1992年投产。二期采用152m<sup>2</sup>流态化焙烧炉，2017年投产。

**Northwest Lead-Zinc Smelter**  
The smelter owns the first 109m<sup>2</sup> fluidized-bed roaster in China. It's also the first to adopt hot acid leaching - jarosite process and to reach an output of single-series 100kt/a cathode, which was put into production in 1992. Phase II adopted a 152m<sup>2</sup> fluidized-bed roaster and was put into production in 2017.



**株洲冶炼集团**  
焙烧系统采用两台152m<sup>2</sup>流态化焙烧炉，浸出和净液工序单系列规模超过300kt/a，2019年投产。产品多样化，合金产量最高、品种齐全。

**Zhuzhou Smelter Group**  
The roasting system adopts two 152m<sup>2</sup> fluidized-bed roasters, and the single-series capacity of leaching and purification processes exceeds 300kt/a. The system was put into operation in 2019. The products are diversified, with a high alloy output and complete varieties.

## || 大型流态化焙烧炉

中国恩菲于1992年设计建造了国内第一套109m<sup>2</sup>流态化焙烧炉系统在西北冶炼厂一次性投产成功。109m<sup>2</sup>流态化焙烧炉是单系列100kt/a及以上锌冶炼工艺关键设备，中国恩菲在此基础上不断改进和完善，相继将20多台套该规模焙烧炉（其中运行的109m<sup>2</sup>焙烧炉有20台，152m<sup>2</sup>焙烧炉4台）成功应用于株洲冶炼、巴彦淖尔紫金、豫光锌业、赤峰中色、驰宏锌锗、葫芦岛锌厂、南方有色等锌冶炼厂。中国恩菲成功研发设计了目前世界最大流态化焙烧炉和配套装置，并实现工业化生产。焙烧系统整体工艺及装备技术已经达到国际领先水平。

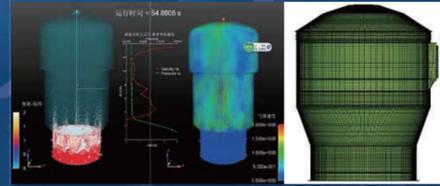
目前，国内90%以上的大型锌冶炼企业采用中国恩菲设计的大型流态化焙烧炉。

产品规格（炉床面积）：109m<sup>2</sup>、152m<sup>2</sup>、186m<sup>2</sup>

应用范围：主要应用于锌精矿焙烧；也可应用于铜精矿、金精矿、锡精矿、镍精矿、红土矿、硫铁矿等物料的焙烧。

### 产品特点：

- » 焙烧强度高，炉床处理锌精矿能力达7~8t锌精矿/m<sup>2</sup>·d
- » 焙烧产品残硫低，不溶硫≤0.4%
- » 热能回收率高，处理1吨硫化锌精矿约产1吨蒸汽
- » 自动化程度高，操作人员少，生产成本低



### Large fluidized-bed roaster

In 1992, China ENFI designed and built the first 109m<sup>2</sup> fluidized-bed roasting system of the country and successfully put it into production at one stretch at Northwest Smelter. The 109m<sup>2</sup> fluidized-bed roaster is the key equipment for the zinc smelting process with a single-series capacity of 100kt/a and above. With constant improvement, ENFI has successively applied over 20 sets of roasters of such scale to zinc smelters owned by companies such as Zhuzhu Smelter Group, Bayannur Zijin, Yuguang Zinc Industry, NFC Zinc, Chihong ZINC & Germanium, Huludao Zinc Industry Co., Ltd, and Nanfang Non-Ferrous Metal. Among these roasters in operation, 20 are of 109m<sup>2</sup> and 4 are of 152m<sup>2</sup>. Building on these experience, China ENFI successfully developed and designed the world's largest fluidized-bed roaster and its control system, and realized industrial production. ENFI's overall process, equipment and technologies for roasting system has come to the world's forefront.

So far, over 90% of large zinc smelting companies in China have adopted the large fluidized-bed roaster designed by ENFI.

Product specification (furnace bed area): 109m<sup>2</sup>, 152m<sup>2</sup>, 186m<sup>2</sup>

The fluidized-bed roaster is mainly applied to zinc concentrate roasting, as well as other roasting feed such as copper concentrate, gold concentrate, tin concentrate, nickel concentrate, laterite and pyrite.

### Features:

- » High roasting intensity of up to 7~8t/m<sup>2</sup>·d zinc concentrate.
- » Low sulfur residual rate in roasted products, with insoluble sulfur ≤0.4%.
- » High heat recovery, approx. 1t of steam produced from 1t of zinc sulfide concentrate.
- » High degree of automation, a small number of operators needed, and low production.

## || 高效圆筒冷却机

中国恩菲自主研发的高效圆筒冷却机，可冷却焙烧砂及其他类似细粉、颗粒状高温物料，可承接上游550~850℃高温焙砂，冷却至120℃以下。

产品规格：φ800 mm、φ1200 mm、φ1250 mm、φ1500 mm、φ1920 mm、φ2200 mm、φ2360 mm、φ3150 mm  
处理能力：0.8~40 t/h



### 产品特点：

- » 冷却效率高，传热系数高达50~120 W/(m<sup>2</sup>·K)，是传统形式冷却筒的4~5倍
- » 换热面积大，冷却效果好，筒体的断面呈五个面积均等的扇形，换热面积是传统形式冷却筒的2~3倍
- » 体积小、设备轻，同等效果下，高效圆筒冷却机设备外形尺寸小，占地面积是传统形式冷却筒的1/5~1/6。重量是传统形式冷却筒的1/3左右

### High-efficiency cylinder cooler

ENFI's patented product high-efficiency cylinder cooler is used to cool zinc calcine and other similar undersized powder and high-temperature granular materials. It can cool high-temperature upstream calcine of 550~850℃ to below 120℃.

Product specification: φ800 mm, φ1200 mm, φ1250 mm, φ1500 mm, φ1920 mm, φ2200 mm, φ2360 mm, φ3150 mm  
Capacity: 0.8~40t/h

### Features:

- » **High cooling efficiency.** with the heat transfer coefficient as high as 50~120W/(m<sup>2</sup>·K), which is 4~5 times that of the traditional cooling cylinder.
- » **Large heat exchange area and great cooling effect.** The section of the cylinder is five sectors with equal area, and the heat exchange area is 2~3 times that of the traditional cooling cylinder.
- » **Small volume and light weight.** Under the same effect, the high-efficiency cylinder cooler has smaller external dimensions and occupies only 1/5~1/6 of the area of traditional cooling cylinder. The weight is about 1/3 of that of the traditional cooling cylinder.

## || 新型抛料机

中国恩菲专利技术产品抛料机机（ZL200810240922.4）将锌精矿粉及其他类似细粉、颗粒状物料，高速抛入焙烧炉或其他设备。抛料机安装在焙烧炉的进料口旁，承接精矿分配器排出的锌精矿粉。

### New-type slinger feeder

ENFI's patented product slinger feeder is for throwing zinc concentrate powder and other similar fine powder and granular materials into roaster or other equipment at a high speed. The slinger feeder is installed next to the feed inlet of the roaster to receive the zinc concentrate powder discharged from the concentrate distributor.



冶金装备篇  
Metallurgical equipment

冶炼余热锅炉及弹性  
振打清灰装置  
WHB and Vibrator for Smelting

应用业绩:

序号	业主名称	数量(套)	供货时间
1	赤峰金剑铜业有限责任公司	256	2020
2	云南驰宏锌锗股份有限公司会泽冶炼分公司	60	2019
3	中国有色金属建设股份有限公司	256	2017
4	铜陵有色金属集团控股有限公司	283	2016
5	灵宝市金城冶金有限责任公司	180	2016
6	四川东方锅炉工业锅炉集团有限公司	15	2016
7	五矿铜业(湖南)有限公司	186	2014
8	内蒙古兴安铜锌冶炼有限公司	228	2014
9	大冶有色金属有限公司	8	2014
10	河南中原黄金冶炼厂有限责任公司	250	2013
11	北方铜业股份有限公司	110	2011
12	大冶有色金属有限公司	126	2009
13	金川集团有限公司	124	2006

Applications:

S/N	Name of Client	Qty (set)	Supply time
1	Chifeng Jinjian Copper Co., Ltd.	256	2020
2	Yunnan Chihong Zn & Ge Co., Ltd, Huize Branch	60	2019
3	China Nonferrous Metals Construction Co., Ltd	256	2017
4	Tongling Non-ferrous Metals Group Holdings Co.,Ltd	283	2016
5	Henan Lingbao City Jincheng Metallurgy Co., Ltd	180	2016
6	Dongfang Boiler Industrial Boiler Group Co., Ltd	15	2016
7	Minmetals Copper (Hunan) Co., Ltd.	186	2014
8	Inner Mongolia Xing'an Copper & Lead Smelting Co.,Ltd	228	2014
9	Daye Nonferrous Metals Co., Ltd.	8	2014
10	Henan Zhongyuan Gold Smelter LLC	250	2013
11	Northern Copper Industry Co. Ltd.	110	2011
12	Daye Nonferrous Metals Co., Ltd.	126	2009
13	Jinchuan Group Ltd.	124	2006

## || 冶炼余热锅炉

中国恩菲拥有全球领先的余热锅炉技术，设计并运行的余热锅炉达2000余台，经过50余年的不断优化与技术提升，形成了中国恩菲核心专长技术，在结构设计、强制循环、热力计算、控制系统、清灰设备等关键技术方面拥有自主知识产权专利20余项（ZL201721724955.7, ZL201820027355.3, ZL200710304088.6），可有效提高有色冶炼能源利用率，在节能减排、减碳环保等方面效果显著。

适用于铅、锌、铜、镍、锡等冶炼工艺，可适配底吹炉、还原炉、侧吹炉、回转窑、沸腾焙烧炉、鼓风机、反射炉、电炉、闪速炉、烟化炉、焦结炉、旋转炉、奥斯麦特炉等多种炉窑。

### 技术指标：

- » 单台最大产汽量150t/h，最高蒸汽参数6MPa、400℃
- » 最大可配套100万t/a顶吹镍熔炼炉、40万t/a铜闪速炉

### 产品特点：

- » 通过蒸汽全时恒压调节技术，混合水循环技术等，有效克服烟气腐蚀、烟尘积灰结渣，腐蚀和磨损等难题，适应冶炼工艺负荷频繁波动的特点
- » 具有应用范围广、配套炉型多、可靠性高、经济效益好等优点

### 应用业绩：

中国恩菲完成有色冶金余热锅炉设计100余项，承担余热锅炉总承包40余项，其中包括世界上首台蒸发量最大的富氧顶吹镍熔炼炉余热锅炉（规模为100万t/a，蒸发量160t/h）、首台蒸发量最大的铜闪速炉（规模为40万t/a，蒸发量116t/h）余热锅炉等。先后为金川集团、白银集团、大冶集团、江西铜业、云南铜业、云南锡业、吉恩镍业、中色镍业等公司提供优质服务，并将余热锅炉输出到印度、巴基斯坦、赞比亚、刚果（金）、缅甸、越南、等10余国家。



## WHB for smelting

Having the experience of designing and operating over 2000 WHBs, ENFI has the leading WHB technologies in the world. After technological development and improvement for more than 50 years, the core expertise owned by ENFI has been formed with over 20 proprietary and patented technologies of ENFI own in structural design, forced circulation, thermal calculation, control system, dust removal equipment and other key technologies capable of effectively improving energy efficiency and providing significant upgrades in energy saving, emission reduction and environmental protection.

The WHB can be adopted in smelting process of lead, zinc, copper, nickel and tin, compatible with bottom blowing furnace, reduction furnace, side blowing furnace, rotary kiln, boiling roasting furnace, blast furnace, reflection furnace, electric furnace, flash furnace, fuming furnace, coking furnace, rotary furnace, AUSMELT furnace and other furnaces.

### Technical indicators:

Maximum steam output of single unit: 150t/h; maximum steam parameters: 6MPa, 400℃.  
Applicable for 1 million t/a top blown nickel smelting furnace and 400kt/a copper flash furnace to its largest capacity.

### Features:

Full-time constant pressure regulating technology and mixed water recycling technology are applied to effectively eliminate corrosion caused by flue gas, smoke dust depositing and slagging, corrosion and wear. It also adapts to the frequent fluctuation of smelting process load.

The WHB has the advantages of wide application range, supporting multiple furnace types, high reliability and good economic benefits.

### Applications:

ENFI has completed more than 100 projects of WHB design for nonferrous metallurgy, and has undertaken more than 40 projects as the main contractor for WHB, including the world's first WHB for oxygen-enriched air top-blowing nickel smelting furnace with the largest evaporation (capacity 1million t/a, evaporation160t/h) and the first WHB for copper flash furnace with the largest evaporation (capacity 400k t/a, evaporation116t/h). ENFI has provided excellent service for clients such as Jianchuan Group Co.,Ltd, Baiyin Nonferrous Group Co.,Ltd, Daye Nonferrous Metals Group Holdings Co., Ltd, Jiangxi Copper Corporation Limited, China Yun Copper (Group) Co., Ltd, Yunnan Tin Group (Holding) Company Limited, JIEN NICKEL, China Nonferrous Metal Mining(Group) Co., Ltd among others, and has introduced WHBs to more than 10 countries including India, Pakistan, Zambia, Congo, Myanmar, Vietnam, Papua New Guinea and so on.

## || 弹性振打清灰装置

弹性振打清灰装置，俗称振打锤，是由中国恩菲结合有色冶炼余热锅炉设备设计、使用及运行维护的实践经验，自主开发的技术产品（ZL201620323115.9），目前已升级为第二代产品，是一种高效锅炉清灰装置。产品能在工况复杂、环境恶劣的条件下有效清除各种锅炉积灰，实现锅炉的长效、清洁运行。正常维护可稳定使用10年，备件量低。

振打力范围40~400kN，六档可调。

适用条件：可用于各种锅炉受热面清灰，产品可在工况复杂、环境恶劣的条件工作。

### 产品特点：

- » 振打力大，六档可调，振打力范围40~400kN
- » 低频震荡，清灰效果好，不损受热面
- » 振打频率3次/min，振打周期可程序调控
- » 能耗低（0.37kW/台），寿命长，使用维护方便
- » 核心部件选用SEW、邦飞利等国际知名品牌的驱动设备

### 应用业绩：

已在有色冶金行业近60个项目、130多台锅炉中使用，销量超过4500台。此外在垃圾焚烧项目上也有应用。

## Vibration ash removal device

The mechanical rapping ash removal device, commonly known as the vibration hammer, is a high-efficiency boiler ash removal device developed by ENFI (ZL201620323115.9) based on the design, use, and operation and maintenance experience of waste heat boilers in nonferrous metal smelting. It is currently upgraded to its second generation. The product can effectively remove all kinds of boiler ash under complex working conditions and harsh environment, realizing long-term and clean operation of the boiler. With normal maintenance, the device can be used for 10 years with stable service while requiring minimum spare parts.

The vibration force range is 40-400KN, six levels adjustable.

Applicable conditions: suitable for ash removing in all kinds of boiler heating surface, under complex working conditions and harsh environment.

### Features:

Strong vibration force, with six levels adjustable, vibration force ranges 40~400KN.  
Low frequency vibration, effective dust removal, no damage to the heating surface.  
Vibrating frequency: 3 times/min, vibrating cycle controlled by program.  
Low energy consumption, long service life with easy maintenance.  
Global renowned brand SEW and Bonfiglioli driving devices selected as the key parts.

### Applications:

Applications: up to now, it has been used in nearly 60 projects and more than 130 boilers in the nonferrous metallurgy industry, a total number of more than 4500 sets. In addition, it has also been applied in waste incineration power generation projects.



冶金装备篇  
Metallurgical equipment

# 大型高效自调节圆盘制粒机

Large High-efficiency Self-regulating Disc Pelletizer





中国五矿



MCC 中国恩菲

## 大型高效自调节圆盘制粒机

中大型高效自调节圆盘制粒机是中国恩菲自主开发产品，能将细粒度粉状物制成粒度符合冶炼工序要求的球粒状物料，提高冶炼效率，减少粉尘逸散。该设备结构先进、性能可靠、制粒效果好、低能耗、耐磨损、运行平稳、易于维护。

适用于铜精矿、铅精矿、烟灰、球团、煤粉和石灰石等物料。

### 产品特点：

- » **结构先进、性能可靠：**原创设计的三角式机架，既方便圆盘倾角的调整，又降低了设备重心，减轻了设备总重，提升了设备运行平稳性；采用了大型交叉辊子轴承支撑圆盘，电动旋转刮刀清理黏料，轻巧方便的圆盘倾角调整装置，圆盘内表面用钢板网衬里，使设备运行稳定可靠
- » **制粒效果好：**采用多喷头喷雾状加水，水量、角度和喷水点可调节，有利于物料成球。设备运行参数实时可调，能满足多种类物料的制粒需求
- » **低能耗：**传动装置技术先进，传动链短，较低功率运行，确保设备电能消耗少，节能环保
- » **维护工作量小：**设备可靠性高，润滑技术先进（可配置集中润滑技术方案），易损件使用寿命长且易于更换，大大减少了维护工作量
- » **经久耐用，寿命长：**圆盘内表面采用高分子材料作衬板，大大减轻了盘面的磨损和物料黏结，并减少制粒过程中的电能消耗

**产品规格系列：**圆盘直径3.8m，5.5m，6m，处理能力：6~65t/h。

#### Φ3800mm圆盘制粒机：

圆盘直径：Φ3800mm；圆盘倾角：45°~55°；  
处理能力：6t/h；主电机功率：37kW；  
刮刀功率：3\*2.2kW

#### Φ5500mm圆盘制粒机：

圆盘直径：Φ5500mm；圆盘倾角：45°~55°；  
处理能力：30t/h；主电机功率：75kW；  
刮刀功率：3\*3kW

#### Φ6000mm圆盘制粒机：

圆盘直径：Φ6000mm；圆盘倾角：45°~55°；  
处理能力：60t/h；主电机功率：90kW；  
刮刀功率：3\*3kW

### 应用业绩：

成功应用于金川集团、铜陵有色、印度德里巴、山东恒邦、湖南贵阳银星、云南蒙自、西乌旗、赤峰山金等项目。

## Large High-efficiency Self-regulating Disc Pelletizer

As a product independently developed by ENFI, large high-efficiency self-regulating disc pelletizer can make fine-grained powder into pellets with a particle size up to the requirements of smelting process, so as to improve smelting efficiency. The equipment is characterized by advanced structure, reliable performance, good pelletizing effect, low energy consumption, wear resistance, stable operation and easy maintenance.

It is applicable to materials such as Cu concentrate, Pb concentrate, dust, briquettes, pulverized coal and limestone.

### Features:

- » **Advanced structure and reliable performance.** The originally designed triangular rack facilitates the adjustment of disc's dip angle and lowers the equipment's center of gravity, reducing the total weight of equipment and improving operation stability of equipment. The large-size disc with crossed roller bearing is adopted, electric rotary scraper is used to clean up sticky materials, light and convenient device for disc dip angle adjustment is employed, and the inner surface of disc is lined with expanded metal mesh to make its operation stable and reliable.
- » **Good pelletizing effect.** Multiple sprayers are used to add water in the form of mist, and the water volume, spraying angle and point can be adjusted to facilitate pelletizing. The operation parameters of equipment can be adjusted in real time so as to meet the demands of pelletizing a wide variety of materials.
- » **Low energy consumption.** The transmission device has advanced technology and short transmission chains, and it can operate under a relatively low power, ensuring low electricity consumption, energy conservation and environmental protection.
- » **Small maintenance workload.** The equipment is highly reliable with advanced lubrication technology (or equipped with centralized lubrication technology), and wear parts have a long service life and are easy to replace, greatly reducing the maintenance workload.
- » **Durability and a long service life.** High polymer materials are adopted as the liner of the inner surface of disc, greatly alleviating abrasion to the disc surface and reducing bond between materials and electricity consumption during pelletizing.

**Series of product specification:** disc diameters are 3.8m, 5.5m and 6m respectively, and relevant throughput varies from 6t/h to 65t/h.

#### Φ3,800mm disc pelletizer:

Disc diameter: Φ3,800mm; Disc dip angle: 45°-55°;  
Throughput: 6t/h; Main motor power: 37kW;  
Scraper power: 3\*2.2kW

#### Φ5,500mm disc pelletizer:

Disc diameter: Φ5,500mm; Disc dip angle: 45°-55°;  
Throughput: 30t/h; Main motor power: 75kW;  
Scraper power: 3\*3kW

#### Φ6,000mm disc pelletizer:

Disc diameter: Φ6,000mm; Disc dip angle: 45°-55°;  
Throughput: 60t/h; Main motor power: 90kW;  
Scraper power: 3\*3kW

### Applications:

This equipment has been successfully applied to projects of Jinchuan Group, Tongling Nonferrous Metals Group, Shandong Humon, Hunan Guiyang Yinxing Nonferrous Metals Smelting and Chifengshan Gold-Silver-Lead Company, as well as projects in Dariba of India, Mengzi of Yunnan, and West Ujimqin Banner of Inner Mongolia.