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RESOURCE & TECHNOLOGY

INNOVATING FCR A GREENER FUTURE

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Hunan China 2025

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A Solution of Lead Contained Solid Waste Comprehensive Recycling And Safe Disposal

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1 Treatment Process Technologies and Challenges

Part 1- 1. Lead recycling process technologies

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1. Pyrometallurgy (high-temperature) process：reverberatory furnace, shaft furnace, blast furnace, fixed axis rotary furnace, short rotary furnace

2. Hydro + pyro metallurgy combined process: hydro desulfurization lead paste then pyrometallurgy smelting

3. Hydro-metallurgy (aqueous chemistry) process: after dissolution or replacement reaction then going through electrolysis or precipitation recovery.

4. Bioleaching process: uses microorganisms (such as bacteria or fungi) to extract lead. Then Lead is recovered from the leachate using chemical precipitation or electrowinning method.

Part 1- 2. Lead recycling process technologies comparison

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Lead recycling technology	Pyro metallurgy	Hydro + pyro metallurgy	Hydro metallurgy	Bioleaching	Remarks
Theory	High temperature reduction (>1000℃)	Chemistry replacement+ High temperature reduction smelting	aqueous chemistry+ electrolysis/ precipitation	Microorganisms metabolize and dissolve lead + electrolysis / precipitation	
Main raw material applicable:	High-grade lead concentrate ULABs, lead paste	lead paste	Low-grade lead concentrate, lead paste, lead contained wastewater	Tailings, Low-concentration lead slag	
Process period	Short	medium	Long	long	
Recovery rate	90%~98%	90%~98%	85%~95%	70%~90%, depends on the strain and conditions	
Energy consumption	High	Between pyro and hydo method	medium (hydro leaching) +high (electrolysis)	low +high (electrolysis)	
Pollutant emissions	SO2, NOx, lead, PM dioxin - need flue gas treatment	PM, dioxin, lead, SO2	waste water (needs neutralization)	almost no exhause gas, small amount of bio waste water	
Est. CAPX per tone Pb production	Low	Medium high	High	Medium high	
Unit line treatment capacity	High	High	Medium low	low	
Operation requirement	Mature	Mature	Complex, need automation	Hard, condtion needs to be strictly controlled	
Est. OPEX per tone Pb production	Low to Medium	Meidum high	High	Medium	
Typical application	Big smelters Lead recycling plant	Lead recycling plant	Small (< 10000t/a used battery) or micro-small (< 5000t/a used battery) lead recycling plant	Experimental stage, Small-scale tailings treatment	

Part 1- 3. Lead recycling challenges

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- Increase recovery rate of main metal.
- Recover other metal elements in used batteries as much as possible
- Recover other parts such as plastics, copper pole of the used batteries.
- Recover valuable metals from lead contained smelting waste as much as possible.
- Reduce energy consumption / CO_2 emission as much as possible
- Reuse energy as much as possible
- Reduce sanitary landfill as much as possible

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When plants in China face anticipated shortage of ULABs

1. In 2025 China ULABs recycling industry designed treatment capacity is 13 million t/a, lead production capacity 8.1 million t/a, however real ULABs is only about 8 million t/a

2. Some ongoing projects are going to complete, these new plants will start operation, which indensify the competition.

3.New type of batteries such as Li-on battery occupied some market share of lead acid battery.

4. The purchase price of ULABs increase, while lead market price remain stable, reduce the profit of the plants.

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The Solution We Experienced in China

- Bath smelting process

- Oxygen enriched side blown furnace

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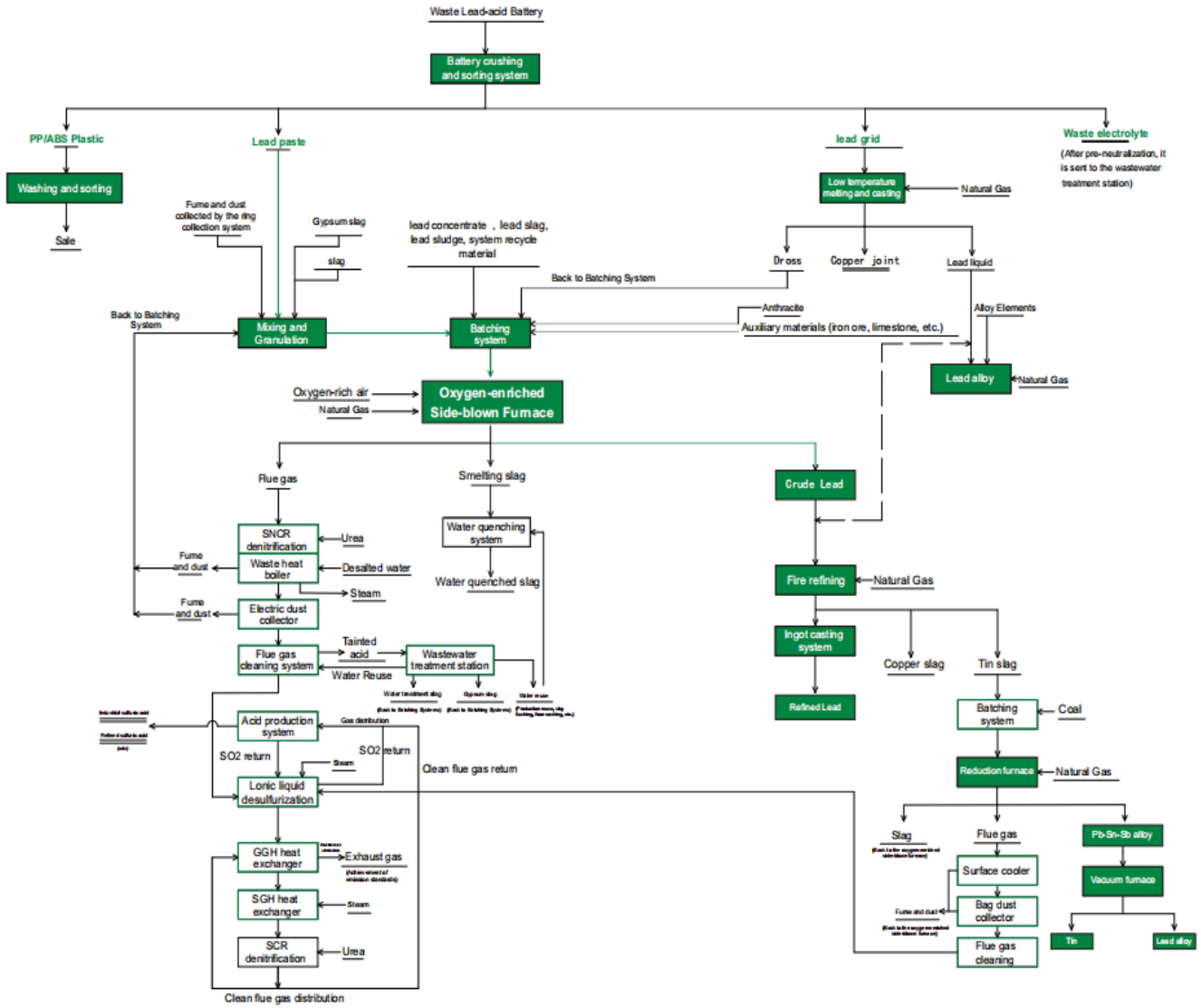
1. ULABs recycling

- Widely applied in Chinese lead recycling market.
- ULABs are automatically broken and separate into lead paste, lead grid, plastics and waste electrolyte.
- The plastics: color sorted, extruded for reusing
- The lead paste: directly goes smelting.
- Fire refined lead: sent to battery plant for reuse.
- The refining floating dross: reduced and vaccum distilled to recover Sn, Pb, Sb etc.
- The flue gas: desulfurization, acid making, de-NOx and then discharged meeting standard.
- Metallic lead (lead grid): low temperature smelting to get lead alloy.

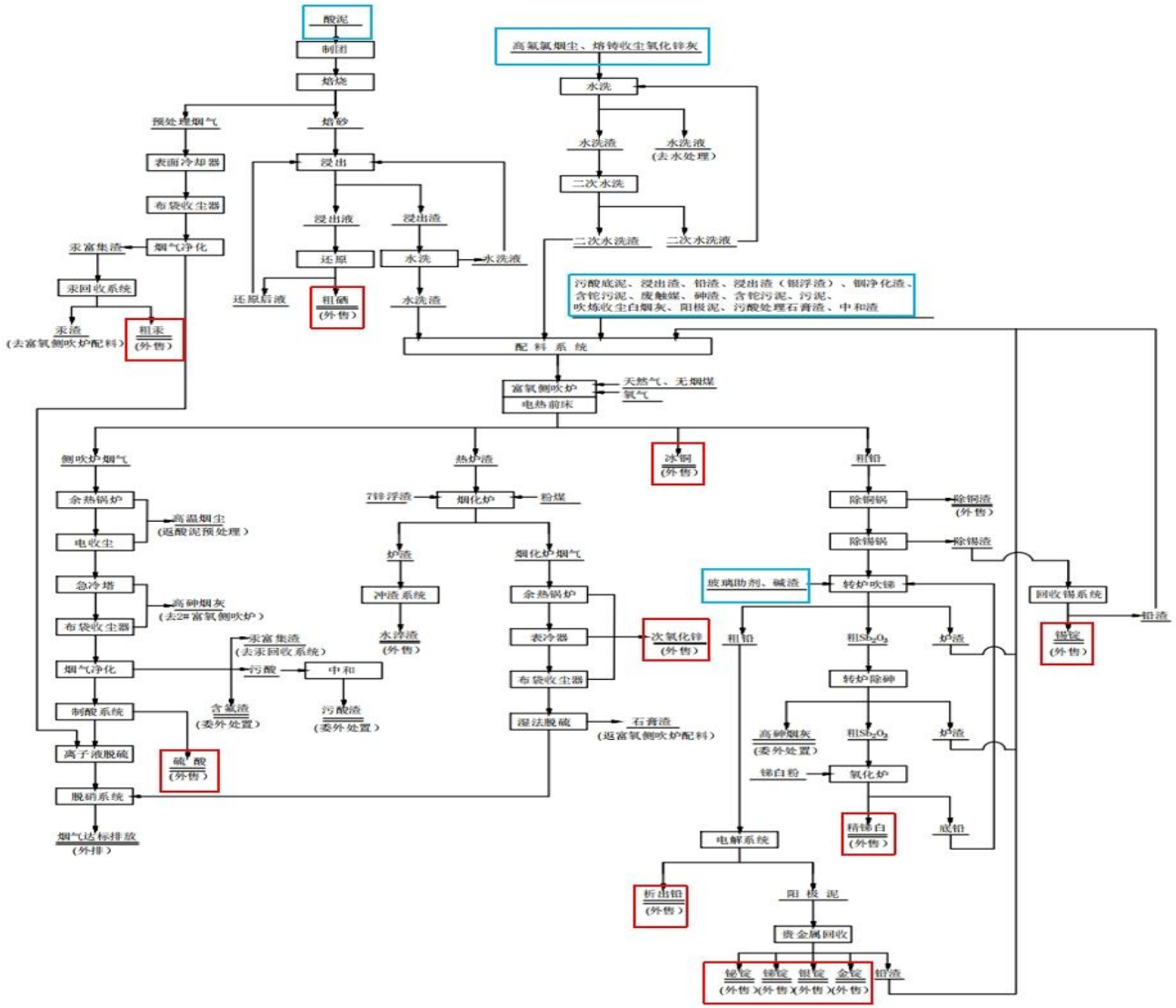


2. Lead contained smelting waste compehensive recycling

- All valuable metals are recovered from different kinds of lead contained smelting waste through a set of process technology including pyrometallurgy, hydrometallurgy, vacuum distillation etc.

- these metals including: crude mecury, copper matte, crude tin, precipitate lead, zinc hypoxide, gold ingot, silver ingot, bismuth ingot, antimony ingot (or antimony trioxide), H_2SO_4 etc.

- If metals such as platinum, palladium, rhodium and selenium are present in the raw materials, they can also be extracted through process design



Part 2-2. Lead recycling technology equpment support

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No matter whether it is the recycling of used lead-acid batteries or the comprehensive recycling of hazardous waste from lead-containing smelting or mixed material, the core smelting equipment that support this process mostly adopts oxygen-enriched side-blown furnace.

Part 2-2. Lead recycling technology equipment support

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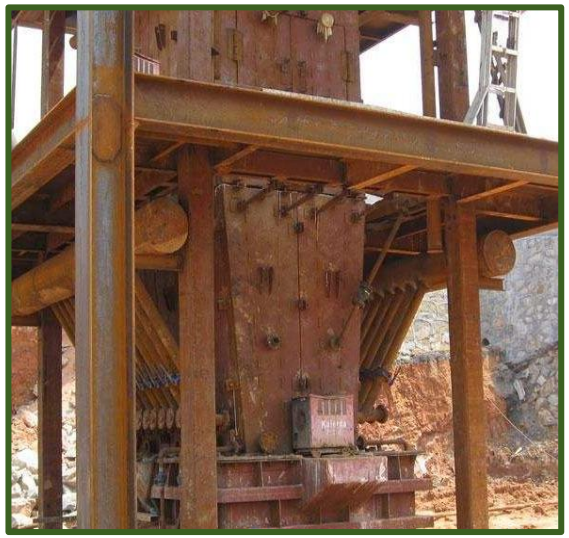

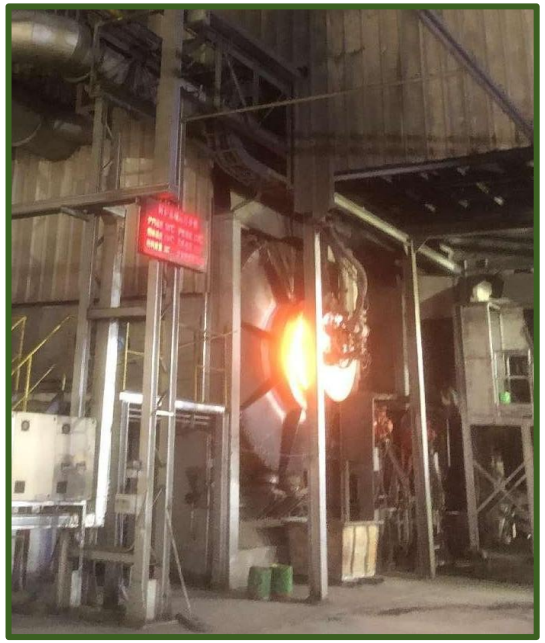

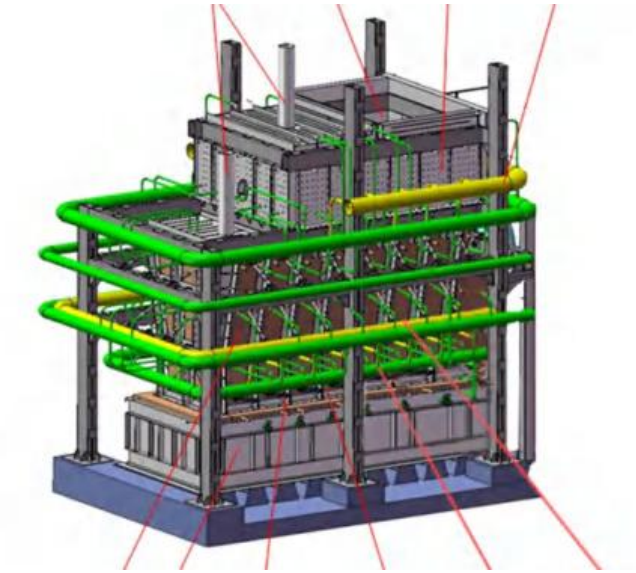

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Features of the furnace

1. Copper jackets are used on OSBF；
2. Pirmary layer tuyeres are water-cooled protected.
3. It is a typical bath smelting furnace. Fast reaction, low energy consumption and high energy efficiency.
4. Long service life. .
5. The oxygen enriced air concentration reach more than 60%.
6. The volume of flue gas is much less.
7. Fuel and reducing agent can be flexibly adjusted
8. The wide adaptability of fed in raw material.
9. Suits wide range of treatment capacity.

Part 2-3. Comparison of different furnaces

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Furnace	Merits		Demerits
Reverb. Furnace	1) Low investment 2) Easy to operate 3) Strong adaptability		1) Low hearth area efficiency, low unit process capacity 2) Poor furnace airtightness, poor worksafe environment 3) Low automation and machanization, high labor intensity 4) Pb contained in slag is high, low lead recovery rate, serious enviroment pollution problems
Blast Furnace	1) Strong raw material adaptability 2) Small cover area, low investment and short payback time		1) Raw material needs to be sintered or moulded 2) Large amount of retured slag, 3) Low effective processing capacity 4) Air cumbustion, large flue gas volume, 5) Worse furnace airtightness, poor worksafe environment 6) High cost of envrionmental treatment
Rotary Furnace	1) Pre desulfurization is applied, reduces the emission of lead and dust to certain extent, thus reduce the environmental pollution 2) Short process, less investment, short construction cycle 3) Improves the heat utilization rate and production efficiency 4) Improves the lead recovery rate		1) The refractory material life is short (around 10 months) 2) Sulfur conversion rate is less than 90%, and the sulfur cannot be fully utilized 3) The desulgurizaiton needs to use Na_2CO_3, which is expensive. 4) The MVR will cost lots of energy, operation cost is high
OSBF	1) High lead recovery rate(＞98.5%), low Pb in smelting slag (＜1-1.5%） 2) High hearth efficiency that can reach ＞70 t/m^2 ·d; 3) Simple structure of furnace with copper water jacket proctection, long service life, simple structure of tuyere, convenient to operate 4) The optional choice of fuel and reducing agent according to local supply condition 5) Friendly working environment 6) High degree of mechanization and automation 7) Water quenched slag can be used as raw material of cement 8) High adaptability to raw material and suitswide range of treatment capacity		1) Granular anthracite needs to be added from the furnace top into the molten pool to maintain the heat balance. 2) Soot rate is a bit high, reaching 12% ～ 18% 。 3) Frequent shutdown of the furnace will lead to a substantial increase in operation cost

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Improvment in fuel use - less consumption - less CO2 emission

Coal + Natural gas

Coal acts as a reducing agent in the lead smelting process to extract lead.

Natural gas is used as fuel to provide heat for the lead smelting reaction.

As the main component of natural gas is methane, it has high calorific value per unit, low exhaust pollution, reliable supply and relatively low price.

The proportion of coal and natural gas can be flexibly adjusted according to the different components of raw materials to minimize fuel costs and increase heat efficiency.

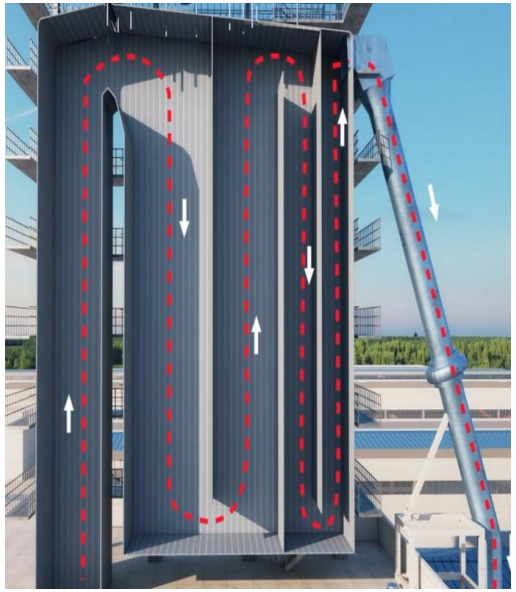
“Waste treatment with waste”

Some hazardous wastes mainly consist of carbon. Such wastes can be used as reducing agents to replace coal, achieving the effect of "waste treatment with waste", and at the same time reducing operation costs.

Improvment in energy management - energy reuse

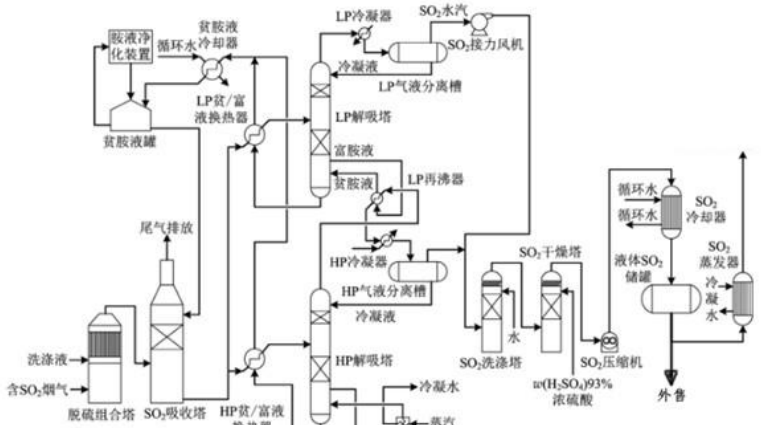
where the waste heat generated

waste heat boiler

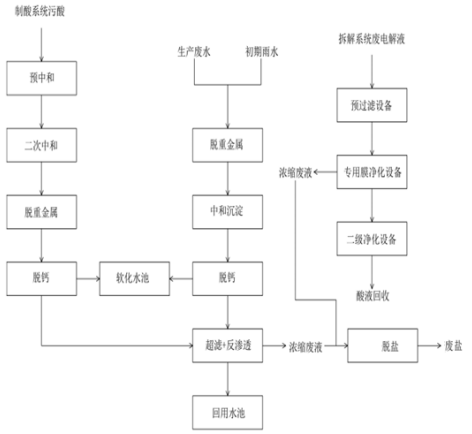


The heat usage within the main process system

where the waste heat can be used



1) desulfurization and acid making need



2) waste water treatment needs

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Improvment in energy management

where the waste heat can be used

Heat usage outside the main process system

(1) Cogeneration

2. Drive the motor

3. Evaporation of waste salt

4. Sale to external use

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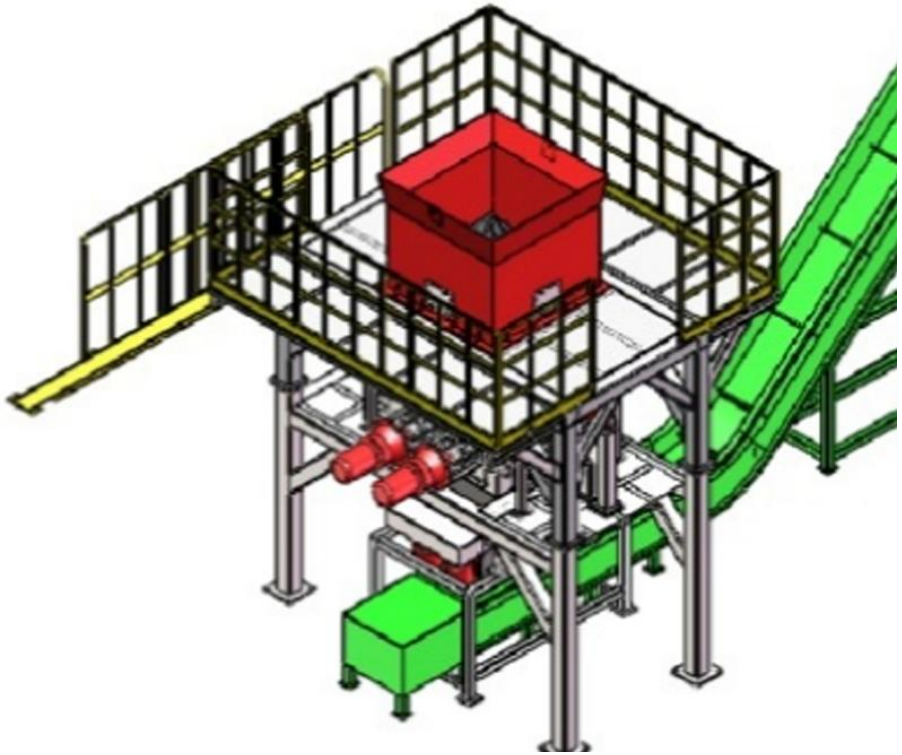
Improvment in automation

Automatic electrolyte discharging maching for used lead acid batteries



Automatically unpack machine for ton bags

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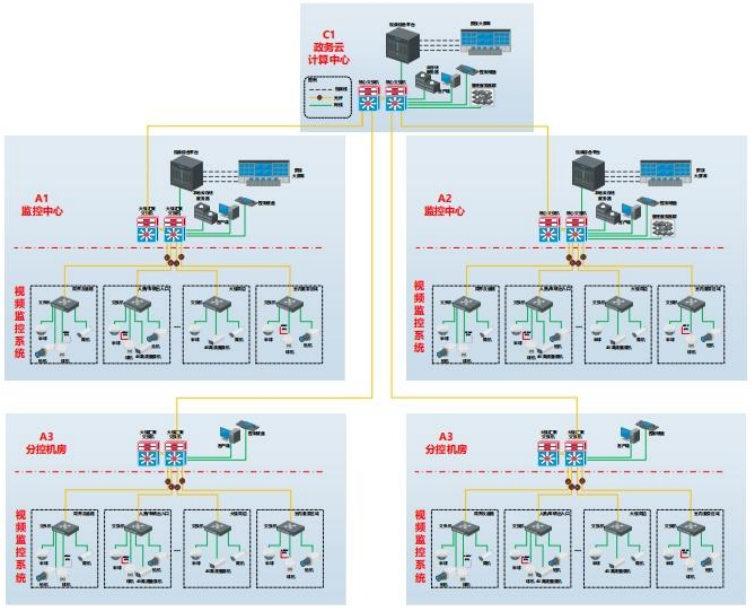
Improvment in automation

DCS system
& monitoring
system



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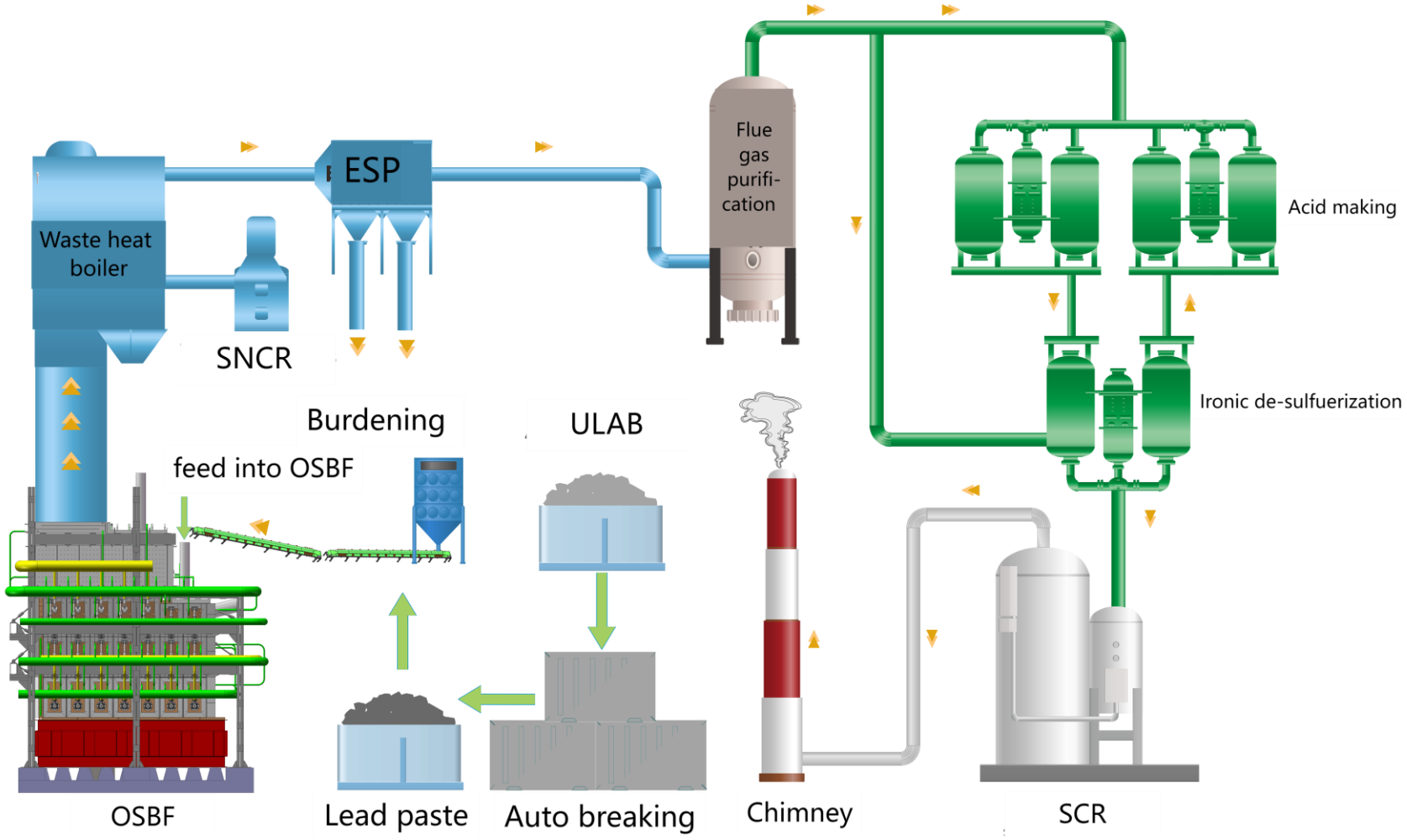
Reduce environmental risk - waste flue gas treatment



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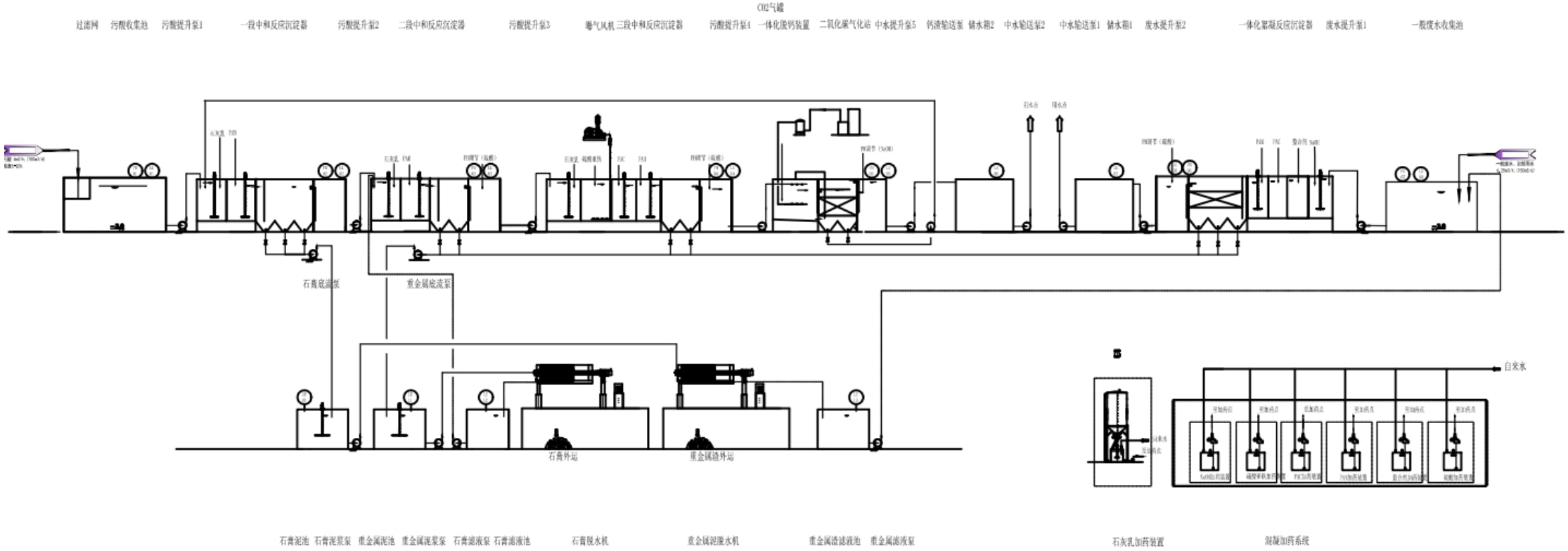
Reduce environmental risk - waste water treatment



Reduce environmental risk - waste slag treatment

PONY
Pony Testing International Group

检 测 结 果
(Test Results)

报告编号(Report ID): I090131207~121002D　　第2页,共5页 (page 2 of 5)

样品名称和编号 (Sample Description and Number)	检测项目 (Test Items)		限值 (Limit)	检测结果 (Test Result)
I09013120702D Sslag from smelting furnace	Cu（以总铜计），mg/L		100	0.929
	Zn（以总锌计），mg/L		100	N.D. (<0.006)
	Cd（以总镉计），mg/L		1	N.D. (<0.003)
	Pb（以总铅计），mg/L		5	N.D. (<0.05)
	Cr，mg/L		15	N.D. (<0.01)
	Cr（VI），mg/L		5	N.D. (<0.004)
	Alkyl mercury ng/L	Methyl mercury	N.D.	N.D. (<10)
		Ethyl mercury	N.D.	N.D. (<20)
	Hg（以总汞计），mg/L		0.1	N.D. (<0.0002)
	Be（以总铍计），mg/L		0.02	N.D. (<0.0003)
	Ba（以总钡计），mg/L		100	1.18
	Ni（以总镍计），mg/L		5	N.D. (<0.01)
	Ag，mg/L		5	N.D. (<0.01)
	As（以总砷计），mg/L		5	N.D. (<0.0001)
	Se（以总硒计），mg/L		1	N.D. (<0.0002)
	Inorganic fluoride (exclude CaF2)，mg/L		100	0.88
	(CN)2（以CN计），mg/L		5	N.D. (<0.001)

Smleting waste contained metals such as lead and copper is comprehensively recovered and safely disposed of through a process system centered on OSBF. The final tailings produced are water-quenched slag, which has been repeatedly analysed and identified as general solid waste under Chinese standard. However, whether it can meet that of project country's needs to be confirmed.

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Reduce environmental risk - rigid landfill

The small amount of hazardous waste produced in the end is not exported to the outside but is dumped in a self-built rigid landfill, completely eliminating the risk of secondary hazardous waste overflow and solving the environmental protection risks associated with secondary hazardous waste overflow.

Part 3-5.Typical cases in China

Leoch-Dahua energy resource Co. Ltd. (ULABs recycling plant)

Part 3-5.Typical cases in China

Guangxi RE Environmental Technology Co., Ltd.

250,000t/a lead & zinc contained material comprehensive smelting project

(lead contained smelting waste recycling)

Part 3-5.Typical cases in China

Guangxi RE Environmental Technology Co., Ltd.
250,000t/a lead & zinc contained material comprehensive smelting project

Part 3-5.Typical situation in China

Chenzhou Tengchi 200,000t/a lead and zinc contained material treatment project EPC (mixed smelting)

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3

Who Are We?

- Hunan RE Technology Co. Ltd.

Part 4-1.Who is RE TECH — Member of IUR technology innovation alliance

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Hunan RE Technology Co., Ltd. was founded in 2017, Changsha city, Hunan Province, P. R. China

- It is an “industry-university-research” company cooperate with Central South University (China) of which metallurge major is ranked top of the world.
- It dedicates to provide turn key solutions for the low carbon resource of non-ferrous mental industry.

China Industry Technology Innovation Alliance of Nonferrous Metals is a technological innovation cooperation organization jointly initiated by more than 70 colleges and universities, scientific research institutes, enterprises and institutions, including Central South University, Kunming University of Science and Technology, and Institute of Process Engineering, Chinese Academy of Sciences.

•solve the key technical problems in the development of the non-ferrous metalurgyl industry

•industrialization of scientific research achievements

•realize the sustainable development.

NMIU

China Industry Technology Innovation Alliance of Nonferrous Metals

Part 4-2.The role of RE TECH —— Make a greener future

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Integrated development of advanced industrial equipments

R&D in Metallurgy

Environmental cleanup system integration

Low carbon toolkit

OSBS Technology:

Secondary lead | Copper contained material treatment | Recycle of heavy mental contained hazadous waste | Extract high nickel matte from Laterite nickel ore

Low Temperature Pyrolysis Technology:

Lithium battery break | PCB break | Steel scrap disposal | Recycle waste tires

Pure Oxygen Converter Technology:

Secondary tin | Secondary silver | Copper Nickel | Antimony | Bismuth recycling | Aluminum ash recycling

Vacuum Distillation Technology:

Sn-Pb, Sb seperation | Bi-Ag seperation | ……

Fuming Furnace Technology: extract Zn from slag, extract Sn from slag ……

Electical Furnace

Consulting → Engineering → Core equipment fabricating/toolkit intelligent upgrading → EPC Contracting → Operation

Part 4-3.Main field of RE industrial application

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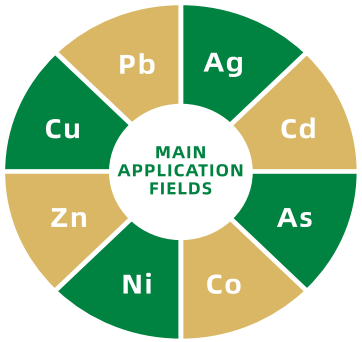
Recycling of resources

- Valuable metal recycling
- Lithium battery Recycling
- Waste electronic product recycling
- Copper contained material recycling

Harmless treatment of hazardous waste

- Smelting waste
- Other hazardous waste



Metal extracting

- Lead (Pb), Copper (Cu), Zinc (Zn),
- Laterite nickel & nicke matte (Ni)
- Tin (Sn) , Antimony (Sb)
- Silver (Ag), Gold (Au), etc.
- Preciouse metals, such as In, Bi, Pt,

Part 4-2. Equipment to support our technologies

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Part 4-5. Cases that we have done

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Jiangsu Tianneng Resource Recycling Technology Co., Ltd.

Part 4-5. Cases that we have done

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Tianneng Group (Jiangsu)

Part 4-5. Cases that we have done

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Guangxi Zhenyu Environmental Protection Technology Co., Ltd.

Part 4-5. Cases that we have done

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Guangxi Zhenyu Environmental Protection Technology Co., Ltd.

Part 4-5. Cases that we have done

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No	Item	No	Item
1	Hunan Tengchi Environmental Protection Technology Co., Ltd. 300,000 t/a non-ferrous metal waste rare metal comprehensive recycling project	21	Guangxi Ruiyi Environmental Technology Co., Ltd. 250,000 t/a comprehensive recovery and safe disposal of rare and precious metal materials project general contracting
2	Dongguan Xindongxin Environmental Protection Investment Co., Ltd. 200,000 t/a copper-containing sludge disposal project	22	Yunnan Ruiyi Environmental Technology Co., Ltd. 50,000 t/a smelting hazardous waste disposal project
3	Zhejiang Runhong Environmental Technology Co., Ltd. 150,000 t/a copper-containing sludge disposal project	23	Hunan Kangze Environmental Technology Co., Ltd. 300,000 t/a used battery disposal project
4	Leoch International Taihe Dahua 300,000 t/a used battery disposal project	24	Guangxi Zhenyu Environmental Technology Co., Ltd. 250,000 t/a used battery disposal project
5	Anhui Tianchang Metal Materials Co., Ltd. 300,000 t/a waste battery disposal project	25	Shandong Laiyang 150,000 t/a copper-containing sludge disposal project
6	Leoch International Guizhou Dahua 300,000 t/a used battery disposal project	26	Anyang Minshan Huanneng Hi-Tech Co., Ltd. 130,000 t/a lead-containing secondary resource recycling project
7	Zhejiang Tianneng Power Supply Co., Ltd. 130,000 tons of annual recycled electrolytic lead and 60,000 tons of annual desulfurization product extension clean technology transformation project	27	Wuzhou Sensheng Nonferrous Metals 5,000 t/a metal tin recycling project
8	Hunan Tengchi Environmental Protection Technology Co., Ltd. lithium battery recycling project	28	Hanyuan Huafeng Environmental Technology Co., Ltd. 250,000 t/a solid waste harmless resource Comprehensive utilization of lead resources
9	Guangxi Jixin Recycling Resources Utilization Co., Ltd. 200,000 t/a used lead battery recycling and regeneration project	29	Anyang Minshan Nonferrous Metals Co., Ltd. Comprehensive technical transformation project
10	Shandong Heze Caoxian Huixin Metal Co., Ltd. 600,000 t/a lead-acid battery recycling and regeneration lead	30	Feasibility study of Jiangxi Xinya Alloy Materials Co., Ltd. 100,000 t/a recycled lead expansion project
11	Zhejiang Taitong Recycling Resources Utilization Co., Ltd. annual processing of 100,000 tons of surface treatment waste resources comprehensive utilization project	31	Hanzhong Zinc Industry Co., Ltd. Comprehensive recycling production line technology upgrade and transformation project
12	Yunnan Tianzha Technology Co., Ltd. recycling 150,000 tons of used lead-acid batteries and lead recycling project	32	Guizhou Gravity Technology Environmental Protection Co., Ltd. Annual treatment of 100,000 tons of lead-containing hazardous waste comprehensive disposal smelting system general contracting
13	Henan Ruiyi Environmental Technology Co., Ltd. arsenic smelting hazardous waste disposal project	33	Shandong Haowei 200,000 t/a used lead-acid batteries, lithium batteries resource recycling comprehensive utilization project
14	Yunnan Gejiu Tianli Smelter low-grade lead and silver waste comprehensive utilization project	34	Guizhou Qizhen Environmental Protection Technology Co., Ltd. annual production of 200,000 tons of recycled lead project
15	Jiyuan Xinxin Industrial Co., Ltd. nickel resource comprehensive utilization side-blowing furnace to replace blast furnace energy-saving and environmental protection upgrade project	35	Anhui Pengran Recycling Resources Co., Ltd. 130kt/a multi-metal smelting intermediate material processing and comprehensive utilization project
16	Inner Mongolia Guona Recycling Resources Technology Co., Ltd. National used battery recycling resource utilization industry-university-research phase I project	36	Anhui Chaowei Environmental Protection Technology Co., Ltd. Lead alkali slag converter system
17	Zhongde Environmental Protection Self-produced Hazardous Waste Comprehensive Utilization and Technical Equipment Upgrading Project Smelting System General Contracting	37	Anhui Tianshuo Metal Materials Co., Ltd. annual production of 100,000 tons of recycled lead project burdening and smelting system general contracting
18	Wuzhou Huaxi Environmental Protection Technology Co., Ltd. Lead Enhanced Smelting Energy Saving and Emission Reduction Technical Transformation Project Equipment General Contracting	38	Guizhou Lukong Environmental Protection Technology Co., Ltd. Taijiang County lead-acid battery resource recycling integrated project
19	Xiangcheng Haoxin Metal Recycling Co., Ltd. used Battery Comprehensive Utilization Project	39	Jiangxi Jiangtong Environmental Resources Technology Co., Ltd. Environmental protection equipment manufacturing and resource comprehensive utilization project
20	Nigeria 100,000 tons of used batteries	40	Liaoning Teli Environmental Protection Technology Co., Ltd. annual treatment of 250,000 tons of used lead-acid batteries side-blown furnace project

Thanks for listening !

Welcome to visit us !

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