

能源环境篇
Energy & Environment

危险废物高效焚烧 熔融成套系统

Hazardous waste high-efficiency combustion-smelting
equipment package

应用业绩：

中国恩菲依托专利、专长以及集成技术，先后完成百余座危险废物（含医疗废物）处置中心项目咨询、设计及EPC总承包工程，技术水平在危险废物处置领域处于领先。

序号	使用地点	工程名称	建设规模 (处理量/t·d ⁻¹)	参与方式	备注
1	云南省	昆明医疗废物处置中心EPC项目	2×15	设计+供货	2条15 t/d逆流高效焚烧生产线
2	湖北省	孝感市固废处置中心项目	总规模30000t/a, 其中焚烧50t/d	设计+供货	1条50 t/d逆流高效焚烧+高温熔融生产线

Applications:

China ENFI has provided consulting, engineering and EPC services for nearly 100 hazardous waste treatment projects relying on its patents, expertise and complex technologies and is leading the field of hazardous waste treatment in China.

NO	Location	Description	Construction capacity /t·d ⁻¹	Way of participation	Remark
1	Yunnan Province	Kunming Medical Waste Treatment Center EPC Project	2×15	Engineering + equipment supply	Two 15t/d treatment lines of countercurrent high-efficiency incineration
2	Hubei Province	Solid Waste Treatment Center in Xiaogan City	Total capacity 30,000t/a, of which incineration capacity 50t/d	Engineering + equipment supply	One treatment line of countercurrent high-efficiency incineration + high-temperature melting



昆明医疗废物处置中心EPC项目
设计能力：2×15t/d，逆流回转窑：φ2.0m×9m，单台回转窑处理能力：10~19t/d

Kunming Medical Waste Treatment Center EPC Project
Engineering capacity of 2×15t/d, countercurrent rotary kiln of φ2.0m×9m and single rotary kiln capacity of 10-19t/d.



孝感市固废处置中心项目
焚烧系统设计能力50t/d，逆流回转窑：φ3.4m×9m；熔融系统设计能力18t/d，灰渣熔融电炉：1650kVA

Xiaogan Solid Wastes Treatment Center Project
Engineering capacity of incineration system 50t/d, counter-current rotary kiln: φ3.4m×9m; engineering capacity of melting system 18t/d, ash & clinker melting electric furnace: 1650kVA.



II 危险废物高效焚烧熔融成套装备

危险废物高效焚烧熔融成套装备（Combustion-Smelting Process，简称CS）是中国恩菲核心专长技术装备之一，实现有机危废“焚烧+熔融”终极处置，是现有焚烧技术的重大突破。

危险废物高效焚烧熔融成套装备解决了多种有机危废协同焚烧处置的难题，适用于具有一定热值的有机危险废物（如医疗垃圾、废有机溶剂、废矿物油、精馏残渣、染料、涂料废物等），彻底解决了危险废物二次产物灰渣填埋难题，无害化、资源化率达到100%，真正实现危险废物全组分无害化利用，达到国家“无废城市”的要求。

该成套装备包含两大部分：逆流式回转窑、高温熔融电炉。单系列成套装备处理危险废物的规模为100t/d，可分为30t/d、50t/d、70t/d、100t/d等系列。



Hazardous waste high-efficiency combustion-smelting equipment package

The hazardous waste high-efficiency combustion-smelting equipment package (Combustion-Smelting Process, CS for short), which is one of the core expertise equipments of ENFI, actualizes the ultimate treatment of organic bearing hazardous waste by "combustion + smelting", constituting a major breakthrough in existing incineration technology.

The equipment package solved the difficulties in the integrated incineration of multi-types of organic hazardous wastes and is applicable on organic hazardous wastes with certain calorific value (such as medical wastes, spent organic solvent, used mineral oil, dye and paint wastes). It has completely eliminated the necessity of landfilling secondary products/ashes resulted from the incineration of hazardous wastes for 100% harmless recycling and truly realized the safe reuse of all components of hazardous waste in full compliance with the state requirement of "zero-waste city".

The package includes two parts: countercurrent rotary kiln and high temperature melting EF. Treatment capacity of a single production line ranges 30t/d to 100t/d and the associated series are 30t/d, 50t/d, 70t/d, 100t/d, etc. respectively.

产品特点：

- » 逆流回转窑处理的废物入炉后即与高温烟气接触，快速干燥热解产生可燃气体，可燃气体进入二燃室进行燃烧，节约燃料消耗
- » 危险废物与高温烟气逆向流动，热效率高，减少危险废物水分对回转窑入口耐火材料的侵蚀，延长了窑炉寿命；回转窑长度较短，节省投资
- » 沿轴向形成明显的氧气浓度梯度，有利于干燥后的危险废物实现“热解-燃烧”的工况，从源头上控制二噁英的产生
- » 高温熔融炉内形成熔融玻璃化渣，实现危废减量化及资源化
- » 可进行有价金属回收，实现利益最大化

Features:

- » Feed into the counter-current rotary kiln is in immediate contact with high-temperature flue gas and is rapidly dried and pyrolyzed to produce combustible gas that is burned in the secondary combustion chamber to save fuel.
- » Hazardous waste and hot flue gas flow in reverse directions, which maintain high thermal efficiency. It also reduces the erosion of hazardous waste moisture on refractory materials at the entrance of the rotary kiln, prolonging the life of the kiln. The shorter length of rotary kiln saves investment.
- » An obvious gradient of oxygen concentration is formed along the axial direction, which is conducive to realize the working condition for "pyrolysis - combustion" of dried hazardous waste and eliminate the generation of dioxins at the source.
- » Melting glass slag is formed in high-temperature melting furnace to realize reducing slag quantity and resource utilization.
- » Valuable metal can be recovered, maximizing profit.

应用业绩：

咨询设计项目近百项，其中千吨级以上项目40余座，分布全国50多个城市。垃圾焚烧余热锅炉成功应用于赣州市垃圾焚烧发电厂、固安垃圾焚烧发电厂、襄阳市生活垃圾焚烧厂等。

序号	建设地点	工程名称	建设规模 (蒸发量/t · h ⁻¹)	参与方式	备注
1	江西省	赣州市生活垃圾焚烧发电厂	33.5	设计+供货	两台锅炉，焚烧炉处理量400t/d
		赣州市生活垃圾焚烧发电厂二期工程	36.5	设计+供货	一台锅炉，垃圾热值增大，处理能力增强
		南康恩菲生活垃圾焚烧发电项目	61	设计+供货	两台中温次高压锅炉，垃圾热值增大，单台焚烧炉处理量500t/d
2	河北省	固安垃圾焚烧发电厂	66	设计+供货	两台中温次高压锅炉，单台焚烧炉处理量600t/d
3	湖北省	襄阳市生活垃圾发电厂技改工程	43.9	设计+供货	一台锅炉，垃圾热值增大，处理能力增强

Applications:

ENFI has undertaken nearly 100 related consulting and engineering projects in WTE, in which about 40 projects with a capacity of more than 1,000t/d are distributed in over 50 cities. Successful applications include Ganzhou WTE plant, Gu'an WTE plant, Xiangyang WTE plant, etc.

NO	Location of construction	Description	Description Construction capacity (Boiler steam output /t·h ⁻¹)	Participation mode	Remarks
1	Jiangxi Province	Ganzhou WTE Plant	33.5	Engineering + equipment supply	Two boilers, incinerator capacity 400t/d
		Ganzhou WTE Plant Phase II	36.5	Engineering + equipment supply	One boiler, increased waste calorific value, increased treatment capacity
		Nankang (ENFI) Domestic Waste-to-Energy Project	61	Engineering + equipment supply	Two medium-temperature high-pressure boilers with higher calorific value of waste, processing capacity of single incinerator at 500t/d
2	Hebei Province	Gu'an WTE Plant	66	Engineering + equipment supply	Two boilers of medium temperature and intermediate pressure, single incinerator capacity 600t/d.
3	Hubei Province	Xiangyang WTE Plant	43.9	Engineering + equipment supply	One boiler, increased waste calorific value, increased treatment capacity



江西省赣州市生活垃圾焚烧发电厂
项目运营期30年（含建设期），达产后生活垃圾处理能力达1200t/d。项目2019年投产。

Ganzhou WTE Plant Jiangxi Province
Project operation life is 30 years (including construction period) and waste treatment capacity reaches 1,200t/d after ramp up. The project was up and run in 2019.



固安生活垃圾焚烧发电项目
项目运营期30年（含建设期），达产后生活垃圾处理能力达1800t/d。项目已投产。

Gu'an WTE Plant
Project operational life is 30 years (including construction period) and waste treatment capacity will reach 1,800t/d after ramp up. The project was put into operation successfully.



襄阳生活垃圾焚烧发电厂
项目运营期30年（含建设期），达产后生活垃圾处理能力达1600t/d。一期、二期项目2012年3月进入运营期，技改工程已投产运营。

Xiangyang Domestic WTE Plant
Project operational life is 30 years (including construction period) and waste treatment capacity will reach 1600t/d after ramp up. Phase I and Phase II were put into operation in March 2012 and currently technical modification is in progress.

II 垃圾焚烧余热锅炉

垃圾焚烧余热锅炉是垃圾发电系统余热高效回收利用的关键技术装备，是实现垃圾焚烧安全生产和节能环保的关键核心设备，可完成烟气降温、降尘，并回收余热，为后续烟气净化创造条件。

中国恩菲自主研发的垃圾焚烧余热锅炉具有处理能力大、热效率高、参数得到提升等优点。目前已实现4.0MPa、450℃参数锅炉的安全运行，6.4MPa、440℃/450℃参数锅炉已投入运行，锅炉处理能力提高20%以上，蒸汽发电效率提高2%~4%。垃圾焚烧发电厂采用高参数余热锅炉，可以提高吨垃圾发电量，显著提高全厂收益，是应对因垃圾焚烧发电补贴取消所造成收益损失的关键措施。

垃圾焚烧余热锅炉配合弹性振打清灰装置，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。

- » 适配的焚烧炉排炉型：适配各知名炉排厂家制造的R型炉排、L型炉排、逆推炉排、顺推炉排等；
- » 锅炉炉型：立式、卧式、π式布置。

产品特点：

- » 热效率高、经济效益好，相比中温中压余热锅炉，使用高参数余热锅炉的垃圾焚烧发电系统配合蒸汽再热技术，全厂热效率可由21%提高至30%。使用中温中压余热锅炉，垃圾吨发电量450kWh/t，高参数配合再热系统发电量可达到600kWh/t以上，增加售电收入
- » 配套炉型多、配置灵活、应用范围广，可以与国内外各类典型常用炉排配套组成焚烧发电系统，根据需求提供不同参数的蒸汽
- » 可靠的清灰方式支撑发电参数的提高，采用专利弹性振打清灰装置，在高粘、高腐蚀性冶金烟气中防腐蚀效果显著，提高锅炉蒸汽参数
- » 自动化程度、安全可靠性强

Waste Incineration WHB

Waste incineration WHB is the key piece of equipment for efficient waste heat recovery from the WTE system and the core equipment for operational safety, energy saving and environmental protection during waste incineration. It cools down and de-dusts flue gas, recovers waste heat and prepares flue gas for cleaning.

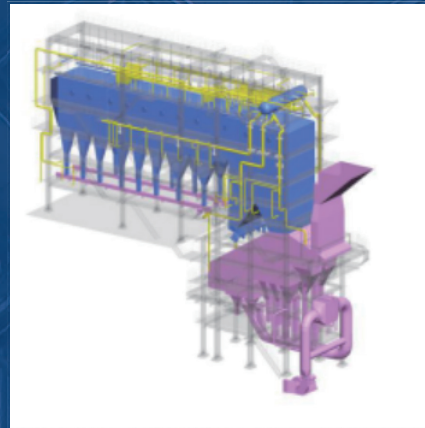
The waste incineration waste heat boiler independently developed by China ENFI has the advantages of large treatment capacity, high thermal efficiency and improved parameters. Safe operation of boiler at 4.0MPa, 450℃ has been achieved so far, and boiler rated at 6.4MPa, 440℃ has been put into operation with the boiler capacity increased by more than 20%, and the power generation efficiency increased by 2%~4%. The Waste-to-Energy plant utilizes waste heat boilers with big parameters, which can improve the energy output per ton waste, creating higher revenue for the plant, and is the critical measure to deal with revenue loss due to revocation of subsidies for Waste-to-Energy plants.

The waste incineration WHB with elastic vibrating ash cleaning device can realize the removal of all kinds of boiler ash under complex working conditions and harsh environment, enabling long-term and clean operation of the boiler.

- » Associated incineration grate furnace types, including R-shaped grate, L-shaped grate, reverse pushing grate, pusher grate, etc. that are manufactured by various well-known grate manufacturers.
- » Furnace profile: Vertical type, horizontal type and π type

Features:

- » **High heat efficiency and economic efficiency.** Compared with medium temperature and pressure WHB, the WTE system using high-parameter WHB with steam reheat technology can increase plant-wide thermal efficiency from 21% to 30%. By using WHB of medium temperature and pressure, 450kWh/t of power can be generated per ton of waste incinerated, while the WHB of high parameters with reheat system can generate more than 600kWh/t, increasing power sales income.
- » **Flexible with supporting furnace types and wide application.** It can match all kinds of typical grates at home and abroad to form a complete set of WTE system and produces steam at various required parameters according to demand.
- » **Reliable ash removal method for the improvement of power generation parameters.** Patent mechanical rapping ash removal device is provided for the boiler, which protects the boiler from corrosion by high viscosity and highly corrosive metallurgical off-gas, improving steam parameters.
- » **Highly automated, safe and reliable.**



垃圾焚烧余热锅炉整体效果图
Effect drawing of waste incineration WHB package

II 弹性振打清灰装置

弹性振打清灰装置，俗称振打锤，是一种高效锅炉清灰专利产品。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，产品能在工况复杂、环境恶劣的条件下工作。

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

Mechanical rapping ash removal device

The mechanical rapping ash removal device, known as vibrating hammer, is a patent product for efficient boiler ash cleaning. The product can realize the removal of 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 serve stably for 10 years while requiring minimum spare parts.

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

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

Features:

- » Strong vibration, 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 (0.37kW/pc), long service life with easy maintenance;
- » Global renowned brand SEW and Bonfiglioli driving devices selected as the key parts.



能源环境篇
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垃圾焚烧ICC智能控制系统

Intelligent Combustion Control System (ICC)



垃圾焚烧ICC智能控制系统

ICC^{ENFI} (Intelligent Combustion Control)，是中国恩菲基于大数据和人工智能技术，并结合二十余年的垃圾焚烧工程经验，自主开发的新一代垃圾焚烧炉燃烧控制系统。它将垃圾焚烧复杂的工艺原理、现场运行的海量工况数据和操作人员的人工智慧结合，运用大数据深度学习和人工智能，建立了垃圾焚烧炉核心控制算法库，开发了独立运行的软件系统。该系统克服了传统ACC系统逻辑控制复杂、投用难度大等缺点，是适合我国垃圾焚烧特性、具有国际先进水平的控制系统。

产品特点：

- » 智能化控制，控制系统附加运行人员经验与智慧，多参数同步参与控制决策
- » 系统投用便捷，ICC软件系统经过短时间大数据学习即可投入焚烧炉控制
- » 无缝对接现有系统，ICC系统可100%替代ACC控制系统，可实时在手动模式、ACC模式、ICC模式之间切换
- » 主要控制指标波动小，与人工控制相比，主要控制指标运行数据标准差可减小20%以上
- » 系统投用率高，24h投用率可达95%~100%



对比曲线：

Curve comparison:

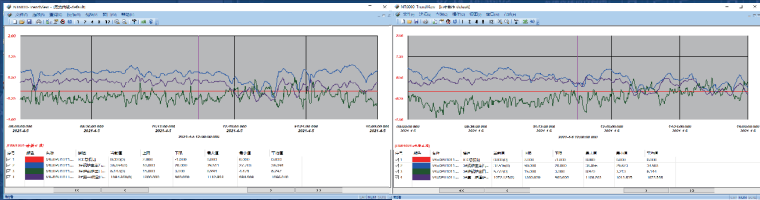


图 ICC 投入前
Before application of ICC system

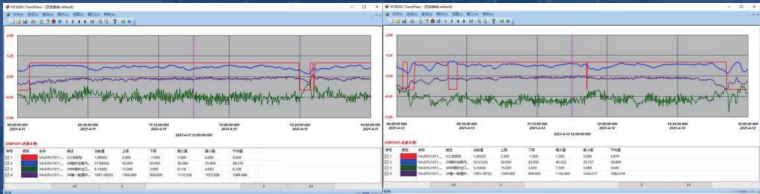


图 ICC 投入后
Before application of ICC system

Intelligent Combustion Control System (ICC)

ICC^{ENFI} (Intelligent Combustion Control) is a new generation of waste incinerator combustion control system developed independently by China ENFI based on big data and artificial intelligence technology while combining ENFI's more than 20 years' engineering experience in waste incineration. It integrates the complex process principle of waste incineration, massive data on site working conditions and the artificial intelligence of operators. By virtue of big data deep learning and AI technology, a core control algorithm library for waste incinerators has been established and an independently operated software system has been developed. The system overcomes the disadvantages of the traditional ACC system, such as complex logic control and difficult application, etc., and is an international advanced control system that accommodates China's waste incineration characteristics.

Features:

- » **Intelligent control.** The system has integrated the experience and intelligence of operators, enabling to make control decision based on multiple parameters.
- » **Convenient in application.** The ICC system can be applied to incinerator control after a short period of big data learning.
- » **Seamlessly interfacing with existing systems.** The ICC system can completely replace ACC system and allow for real-time switch among manual mode, ACC mode and ICC mode.
- » **Small fluctuation of main control indicators.** Compared with manual control, the standard deviation of the operating data of main control indicators can be reduced by more than 20%.
- » **High availability.** The availability within 24h can reach 95% - 100%.

ICC^{ENFI}智能控制系统主要功能：

- » 給料炉排控制
- » 干燥炉排控制
- » 燃烧炉排控制
- » 燃烬炉排控制
- » 一次风机控制
- » 二次风机控制
- » 燃烧空气温度控制
- » 炉膛主控温度控制
- » 余热锅炉出口O₂控制
- » 炉渣燃烬率控制
- » 主蒸汽流量控制

Main functions of ICCENFI:

- » Control of feeding grate
- » Control of drying grate
- » Control of combustion grate
- » Control of burnout grate
- » Control of primary air
- » Control of secondary air
- » Control of combustion air temperature
- » Control of key control temperature in hearth
- » Control of WHB outlet O₂
- » Control of ash burnout ratio
- » Control of main steam flow

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生活垃圾渗沥液处理成套装备

Whole-set Equipment for Domestic Waste Leachate Treatment



危废处置中心污水处理站业绩

序号	工程名称	建设规模	参与方式	备注
1	孝感市固废处置中心项目 污水处理工程	200m³/d	EPC	物化预处理+水解酸化 +A²/O-MBR (其中碱洗塔排水采用多效 蒸发处置后回用)
2	内蒙古正镶白旗固体废物 综合利用与处置中心一期 工程污水处理工程	综合废水150m³/d, 三效蒸发8m³/h	设计	物化预处理+水解酸化+A/O- MBR+膜深度处理+三效蒸发
3	崇州市包装容器循环再生 及废乳化液、染料涂料废 物、废酸综合利用项目污 水处理工程	综合废水100m³/d, 三效蒸发3m³/h, 应 急处理系统1m³/h	设计	物化预处理+水解酸化+A/O- MBR+膜深度处理+三效蒸发
4	山东海阳绿色工业服务中 心项目污水处理工程	综合废水400m³/d, 三效蒸发8m³/h	设计	水解酸化+A/O-MBR+膜深 度处理+三效蒸发
5	辽宁(锦州)再生资源 产业园危废项目污水处 理工程	综合废水200m³/d, 三效蒸发8m³/h	设计	物化预处理+水解酸化+A/O- MBR+膜深度处理+三效蒸发

Track records on effluent treatment of hazardous waste treatment center

NO	Description	Construction capacity	Participation mode	Remarks
1	Effluent treatment of Xiaogan Solid Waste Treatment Center Project	200m³/d	EPC	Physicochemical pretreatment + hydrolytic acidification + A2/O-MBR (drainage from alkali scrubber is recycled after being subject to multiple-effect evaporation)
2	Effluent treatment of Solid Waste Comprehensive Utilization and Disposal Center Project (Phase I) in Zhengxiangbai Banner	Effluent treatment 150m³/d, triple effect evaporation 8m³/h	Engineering	Physicochemical pretreatment + hydrolytic acidification + A/O-MBR + membrane advanced treatment + triple effect evaporation
3	Effluent treatment of Packing Container Recycling and Waste Emulsion, Waste Dye & Paint, Waste Acid Comprehensive Utilization Project in Chongzhou	Effluent treatment 100m³/d, triple effect evaporation 3m³/h, emergency treatment system 1m³/h	Engineering	Physicochemical pretreatment + hydrolytic acidification + A/O-MBR + membrane advanced treatment + triple effect evaporation
4	Effluent treatment of Haiyang Green Industrial Service Center Project in Shandong	Effluent treatment 400m³/d, triple effect evaporation 8m³/h	Engineering	Hydrolytic acidification + A/O-MBR + membrane advanced treatment + triple effect evaporation
5	Effluent treatment of Hazardous Waste Project in Liaoning (Jinzhou) Renewable Resources Industrial Park	Effluent treatment 200m³/d, triple effect evaporation 8m³/h	Engineering	Physicochemical pretreatment + hydrolytic acidification + A/O-MBR + membrane advanced treatment + triple effect evaporation



孝感市固废处置中心危废污水处理站
Effluent treatment station of Xiaogan
Solid Waste Treatment Center



山东海阳绿色工业服务中心污水处
理站
Sewage Treatment Plant of Haiyang
Green Industrial Service Center in
Shandong



辽宁(锦州)再生资源产业园危废处
置中心污水处理站
Wastewater Treatment Station of the
Hazardous Waste Treatment Center
in Liaoning (Jinzhou) Renewable
Resources Industrial Park

II 生活垃圾渗沥液处理成套装备

生活垃圾渗沥液源于垃圾贮存仓生活垃圾渗出的水分液体、垃圾卸料区冲洗水和车辆冲洗水等，属于高浓度有机污水，色度高，有臭味。垃圾渗沥液中主要含低分子量的脂肪酸类物质、高分子量的腐殖质类物质、中等分子量的黄霉酸类物质。渗沥液中含高浓度的BOD₅、COD_{Cr}、SS、氨氮和重金属离子，而且还含有病原体等污染物。

生活垃圾渗沥液处理成套装备的工艺是由“预处理+调节池+厌氧+膜生物反应器MBR+纳滤NF+反渗透RO+浓缩液减量装置”组成的。适用于生活垃圾焚烧发电厂渗沥液处理站。

生活垃圾渗沥液处理成套核心装备：

（1）新型高效厌氧反应器，在厌氧反应器内完成渗沥液80%~85%的COD_{Cr}去除及难降解COD_{Cr}的水解酸化降解，为后续好氧生化反应创造条件。

（2）由“纳滤（NF）+反渗透（RO）+纳滤浓液减量装置+反渗透浓液减量装置”构成的膜深度处理及浓缩液减量系统，实现二价离子、腐殖酸、TDS、Cl⁻和其他有价阳离子及氨氮、总氮等的去除，系统产水满足敞开式循环冷却水系统补充水标准，达标回用。

根据焚烧厂设计规模，对应的渗沥液处理系统可以处理150m³/d、200m³/d、250m³/d、300m³/d及不同组合规模的生活垃圾渗沥液。



膜处理系统
Picture 1 Membrane treatment system



厌氧反应器
Picture 2 Anaerobic reactor

厌氧反应器标准化设备规格

序号	渗沥液处理系统规模 /m ³ ·d ⁻¹	厌氧反应器尺寸/m	对应生活垃圾焚烧厂设计规模 /m ³ ·d ⁻¹
1	150	D×H=9.0×18.0	入炉垃圾500
2	200	D×H=10.0×20.0	入炉垃圾600
3	250	D×H=11.0×22.0	入炉垃圾800
4	300	D×H=12.0m×24.0	入炉垃圾1000

注：其余规模可根据上述设备进行组合和优化

Specifications of standard anaerobic reactor

NO	Capacity/m ³ ·d ⁻¹	Size/m	Engineering capacity of corresponding WtE plant/m ³ ·d ⁻¹
1	150	D×H=9.0×18.0	500 feeding waste
2	200	D×H=10.0×20.0	600 feeding waste
3	250	D×H=11.0×22.0	800 feeding waste
4	300	D×H=12.0×24.0	1000 feeding waste

Note: other capacities can be combination and optimization of the above figures.

Whole-set Equipment for Domestic Waste Leachate Treatment

Domestic waste leachate is sourced from the liquid seeped from waste storage bins, flushing water from waste dumping area and vehicles, etc. It's a kind of highly concentrated organic wastewater with high chroma and foul smell. The leachate is mainly composed of fatty acids of low molecular weight, humic substances of high molecular weight and fulvic acids of medium molecular weight. It contains highly concentrated BOD₅, COD_{Cr}, SS, ammonia nitrogen and heavy metal ions, as well as pathogen and other pollutants.

A complete set of equipment is used to treat domestic waste leachate, comprising the devices for pre-treatment + regulating tank + anaerobic treatment + MBR + NF + RO + concentrate reduction. The whole-set equipment are applicable to the leachate treatment station of WtE plants.

Core equipment for domestic waste leachate treatment:

(1) New high-efficiency anaerobic reactor, in which 80%~85% of COD_{Cr} contained in the leachate will be removed and refractory COD_{Cr} will be hydrolyzed and acidified, creating conditions for the subsequent aerobic biochemical reaction;

(2) The membrane advanced treatment and concentrate reduction system made up by "NF + RO + NF concentrate reduction device + RO concentrate reduction device" can realize the removal of divalent ions, humic acids, TDS, Cl⁻ and other valence cations, ammonia nitrogen and total nitrogen, etc. in the leachate. The water from treatment can be recycled because it is up to the standards of makeup water for open recirculating cooling water system.

According to the engineering capacity of WtE plants, the corresponding leachate treatment system can handle leachate of 150m³/d, 200m³/d, 250m³/d, 300m³/d or any combination of above figures.

应用业绩：

中国恩菲先后完成近百座渗沥液处理站及危废处置中心污水处理站项目咨询、设计及EPC总承包工程，技术水平在国内城市固废污水处理处置领域遥遥领先。

渗沥液处理工程业绩（EPC工程）

序号	工程名称	建设规模/m ³ ·d ⁻¹	参与方式	备注
1	襄阳生活垃圾焚烧厂渗沥液改扩建工程（一、二期及技改）	700	EPC	厌氧+A/O-MBR+膜深度处理
2	赣州市生活垃圾焚烧发电厂渗沥液处理工程（一、二期）	600	EPC	厌氧+A/O-MBR+膜深度处理
3	固安县生活垃圾焚烧发电厂渗沥液处理站工程——雄安新区国家水环境技术转化体系构建与综合示范课题（2018ZX07110-007）依托工程	500	EPC	厌氧+A/O-MBR+NF
4	赣州市南康生活垃圾焚烧发电厂渗沥液处理工程	350	EPC	厌氧+A/O-MBR+膜深度处理

Applications:

China ENFI has provided consulting, engineering and EPC services for nearly 100 leachate treatment stations and hazardous waste treatment center effluent treatment stations, taking a leading position in the field of municipal solid waste and sewage treatment in China.

Track records on leachate treatment (EPC projects)

NO	Description	Construction capacity/m ³ ·d ⁻¹	Participation mode	Remarks
1	Leachate treatment renovation and expansion project (Phase I & II and technical upgrade) of Xiangyang Domestic Waste to Energy Plant	700	EPC	Anaerobic + A/O-MBR + membrane advanced treatment
2	Leachate treatment project (Phase I & II) of Ganzhou WtE Plant	600	EPC	Anaerobic + A/O-MBR + membrane advanced treatment
3	Leachate treatment station of Gu'an WtE Plant - supporting the establishment and comprehensive demonstration subject (2018ZX07110-007) of national water environment technology transformation system in Xiong'an New Area	500	EPC	Anaerobic + A/O-MBR + NF
4	Leachate treatment project of Ganzhou Nankang WtE Plant	350	EPC	Anaerobic + A/O-MBR + membrane advanced treatment



襄阳生活垃圾焚烧厂渗沥液处理站
Leachate treatment station of Xiangyang WtE Plant



赣州生活垃圾焚烧厂渗沥液处理站
Leachate treatment station of Ganzhou WtE Plant



固安生活垃圾焚烧厂渗沥液处理站
Leachate treatment station of Gu'an WtE Plant

能源环境篇
Energy & Environment

氧化锌烟气脱硫成套装备

Complete zinc oxide off-gas desulfurization equipment



|| 氧化锌烟气脱硫成套装备

氧化锌烟气脱硫成套装备应用于脱除铅锌冶炼厂烟气中的二氧化硫，即使用氧化锌作为脱硫剂，与烟气中 SO_2 进行反应，生成 ZnSO_3 ，从而对烟气进行脱硫处理，经空气氧化或热分解或酸分解，一般尾产品为 ZnSO_4 溶液，可直接送往电解车间。可在满足 SO_2 环保排放限值的情况下，实现铅锌厂内物料自循环，降低脱硫的运行成本。

氧化锌脱硫工艺的副产品能够完全融于冶炼工艺，并且亚硫酸锌可用做除铁剂，它是比锌精矿活性更好、反应更快的还原剂。它的环境效益、社会效益显著，应用前景广阔，是氧化锌法脱硫在铅锌企业中最重要优势体现。

产品特点：

- » 脱硫效率高，在入口烟气的 SO_2 浓度约6000mg/Nm³的情况下采用两级吸收，平均脱硫效率达到99%以上
- » 采用空塔喷淋吸收设备，该设备在反应时间方面优于动力波，在防堵塞方面优于湍球塔
- » 装置同时具有污酸综合利用功能
- » 无二次污染，副产品完全返回冶炼过程，实现脱硫过程与冶炼工艺的无缝对接
- » 操作运行安全，全流程溶液无强酸强碱；除原烟气外，其他固体、液体、气体的温度不高于60℃，无烫伤危险，无高压气体

应用业绩：

成功应用于蒙自铅冶炼厂、蒙自钢锌冶炼厂渣处理、成州锌冶炼厂硫酸尾气治理、成州锌冶炼厂渣处理、印度德里巴铅厂、印度HZL公司渣处理等项目。

Complete zinc oxide off-gas desulfurization equipment

The complete zinc oxide off-gas desulfurization equipment is applied to remove sulfur dioxide in the off-gas generated from lead-zinc smelters. That is, zinc oxide is used as desulfurization agent to react with SO_2 in the off-gas to generate ZnSO_3 , in such way the off-gas is desulfurized. Then through air oxidation or thermal decomposition or acid decomposition, the tail product of ZnSO_4 solution is acquired and directly sent to the cell house. In this way, under the premise of satisfying the requirements on SO_2 emission limit, the materials in lead-zinc plant can be self-circulated, thereby reducing the operation cost of desulfurization.

The desulfurization by-products of zinc oxide desulfurization process can be completely integrated into the smelting process, and zinc sulfite can be used as a solid reducing agent to remove iron, which has better activity and faster reaction than zinc concentrate. It has remarkable environmental and social benefits and broad application prospects, which is the most important advantage of zinc oxide desulfurization in lead-zinc enterprises.

Features:

- » **High desulfurization efficiency.** When the SO_2 concentration of inlet off-gas is about 6000mg/Nm³, second-stage absorption is adopted with the average desulfurization efficiency of more than 99%.
- » **Adopting empty tower spray absorption equipment.** The equipment is superior to dynamic wave from the aspect of reaction time and better than turbulent ball tower in terms of anti-blocking.
- » **The equipment also has the function of comprehensive utilization of waste acid.**
- » **No secondary pollution.** The by-products completely return to the smelting process to realize a seamless connection with the desulfurization process.
- » **Safe operation.** Solution is free of strong acid and alkali in the whole process; Except for the original off-gas, the temperature of other solids, liquids and gases shall not be higher than 60℃, without scald risk and high-pressure gas.

Applications:

It has been successfully applied to Mengzi lead smelter, Mengzi indium zinc smelter slag treatment, Chengzhou zinc smelter sulfuric acid tail gas treatment, Chengzhou zinc smelter slag treatment, India Deriba lead plant, India HZL company slag treatment and other projects.

能源环境篇
Energy & Environment

工业废水浓缩装置

Industrial wastewater thickening equipment



工业废水浓缩装置

中国恩菲自主研发的、拥有发明专利的工业废水低温浓缩装置，最高蒸发温度不超过85℃，设计多级换热装置，利用低压蒸汽或乏汽等低品位热源，实现盐、渣和水分离，入选国家鼓励发展的重大环保技术装备目录（2020年版）。该成套装置广泛适用于有色冶炼厂、垃圾焚烧发电厂、火电厂、钢铁厂、化工厂等具有低价热源和化水制备需求、复杂难处理废水（含高盐，高钙，涉重，高氨氮等废水）处理需求的生产企业，可在低成本运营下大幅提高工业废水浓缩倍率，助力企业实现趋零排放和节能减排降碳。

高盐废水浓缩终点含盐量可达350g/L，该方法适用于高浓度钠盐、钙盐、氨盐体系的废水处理。

产品特点：

- » 流程短，能耗低，吨水处理耗蒸汽量0.15~0.4t，可显著降低废水处理成本，使用年限可达20年
- » 使用废弃乏汽作为热源，解决乏汽热能没有得到有效利用和冶炼厂废水的深度浓缩用热问题，减少碳排放
- » 可模块化处理200m³/d、500m³/d、1000m³/d、2000m³/d的高盐高钙、高氨氮等工业废水
- » 处理高盐废水产水率高（80%~95%）、产水水质好（电导率≤50 μs/cm）；处理高氨氮废水去除率高（99%及以上）
- » 操作温度低于85℃、设备不结垢、强耐腐蚀性
- » 信息化程度高，可实现“无人值守、无人操作”的自动化水平
- » 无钠盐引入，根本上杜绝了浓水新增钠盐

应用业绩：

- » 已在云南建成一个处理量为200m³/d的高盐、高氨氮废水工业化应用示范基地，该项目荣获2020年度有色金属建设行业（部级）优秀工程设计二等奖
- » 四川某锌铟公司ENFI-LTE法300m³/d污水深度处理项目，典型的高盐高钙废水，产水率≥90%，产水回用，实现全厂节水减排，降低废水处理成本
- » 西部地区多个超高盐（含盐量大于10%）废水处理及盐资源化回收利用项目，产水为高品质淡水，浓缩液含盐量超过400g/L，实现盐的资源化回收利用



Industrial wastewater thickening equipment

The industrial wastewater low-temperature thickening equipment with patent for invention is independently researched and developed by China ENFI, with the highest evaporation temperature of no more than 85℃ and multistage heat exchangers. It is a kind of hot thickening equipment that realizes separation of salt, slag and water by using low pressure steam or dead steam and other low grade heat sources, and is selected into the Catalog of Major Environmental Protection Technology and Equipment Encouraged by the State (2020 edition). The complete set of device is widely applicable to non-ferrous smelters, waste incineration power plants, thermal power plants, iron and steel plants, chemical plants and other production enterprises with low-cost heat sources, chemical water preparation needs and complex and difficult treatment of wastewater (including wastewater with high salt, high calcium, heavy weight and high ammonia nitrogen). It can significantly improve the concentration ratio of industrial wastewater under low-cost operation, and help enterprises achieve zero emission, energy conservation, as well as emission and carbon reduction.

The salt content of the concentrated water at the endpoint of high salt wastewater thickening can be as high as 350g/L, applicable to the treatment of wastewater with high concentration of sodium salt, calcium salt and ammonia salt.

Features:

- » The process is short, the energy consumption is low, and the steam consumption per ton of wastewater treatment is 0.15-0.4 tons, which can significantly reduce the cost, and the service life can reach 20 years.
- » Waste exhaust steam is used as heat source to solve the problems of ineffective utilization of exhaust steam heat energy and deep concentration of smelter wastewater, so as to make effective utilization of waste heat and reduce carbon emission.
- » The high salt, high calcium and high ammonia-nitrogen, etc. industrial wastewater of 200m³/d, 500m³/d, 1000m³/d, 2000m³/d can be treated in a modular way.
- » When being used to treat high salt wastewater, it can produce water of high yield (80%-95%) and high quality (conductivity≤50μs/cm); for high ammonia-nitrogen wastewater, it has a high removal rate (99% and above).
- » The operating temperature is lower than 85℃, and the equipment has strong corrosion resistance without scaling.
- » It has high extent of informatization and achieve the automation level of “no human on duty and no human operating”.
- » No sodium salt is introduced, which basically eliminates the new addition of sodium salt to the concentrated water.

Successful application case

- » An industrial application demonstration base has been built in Yunnan, where a set of high salt and high ammonia-nitrogen wastewater treatment equipment with a capacity of 200m³/d has been installed. This project won the second prize of Excellent Engineering Design in Nonferrous Metal Construction Industry (Ministerial Level) in 2020.
- » The ENFI-LTE 300m³/d sewage advanced treatment project of a zinc germanium company in Sichuan Province treated high salt and high calcium wastewater, with a water yield of no less than 90%, and the produced water is reused to save water, reduce emission in the whole plant and cut down the cost of wastewater treatment.
- » For several ultra-high salt (salt content greater than 10%) wastewater treatment and salt recycling projects in the western region, the water produced by the unit is high-quality fresh water, and the salt content of the concentrated solution exceeds 400g/L, so as to realize the resource recycling of salt.

能源环境篇

Energy & Environment

危险废物稳定剂

Hazardous waste stabilizer

危险废物稳定剂

ENFI-Z4

应用领域：

垃圾发电厂重金属危废处理、河道淤泥、
城市污泥、含重金属的工业污泥、矿渣
的稳定化处理等。

净含量：25kg ± 0.25kg



危险废物稳定剂

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垃圾发电厂重金属危废处理、河道淤泥、
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的稳定化处理等。

净含量：25kg ± 0.25kg



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|| 危险废物稳定剂ENFI-Z系列

中国恩菲危险废物稳定剂ENFI-Z系列是一种处理含重金属废渣的稳定剂。稳定剂集吸附、包附、螯合、晶化、矿化、配位功能于一体，在有色金属冶炼废渣处理及含重金属废渣的稳定化填埋领域应用效果显著，可以实现废渣重金属含量达到《危险废物填埋污染控制标准》（GB 18598-2019）要求的入场填埋标准。

ENFI-Z系列稳定剂具有操作简便、螯合重金属效果好、费用低、便于运输、储存安全方便等特点。稳定剂添加量为10~80wt.%。

化学性质：

由无机碱性调节剂、无机吸附天然岩石粉、磷酸盐、N，N-双（二硫代羟基）二胺、稳定剂、抗氧化剂等复配而成

应用领域：

适用于已建或申请建设危废填埋厂的企业，应用领域主要涵盖：垃圾发电厂飞灰处理、固废处理（特别是含重金属的危废、河道淤泥、城市污泥、含重金属的工业污泥、矿渣）、特别适用于重金属浓度高、成分复杂的固体废弃物的无害化处理。

应用业绩：

甘肃某危废填埋厂，含铜、镍、砷、镉废渣的稳定化处理项目

Hazardous waste stabilizer

China ENFI hazardous waste stabilizer is used for the treatment of waste residue containing heavy metals. The stabilizer integrates adsorption, inclusion, chelation, crystallization, mineralization and coordination, and has been successfully applied in the field of non-ferrous metals smelting waste residue treatment and waste residue containing heavy metal stabilization landfill, which can meet the landfill admission requirement of Standard for Pollution Control on the Security Landfill Site for Hazardous Wastes (GB18598-2019).

ENFI-Z series stabilizers have the characteristics of simple operation, good chelating effect of heavy metals, low cost, convenient transportation, safe and convenient storage, etc. The addition of the stabilizer is 10-80wt.%.

Chemical properties:

It is composed of inorganic alkaline regulator, inorganic adsorbed natural rock powder, phosphate, N, N-bis (dithio hydroxyl) diamine, stabilizer, antioxidant, etc.

Fields:

It is applicable to enterprises that have built or apply for the construction of hazardous waste landfill plants. The application fields mainly include: fly ash treatment of waste power plants, solid waste treatment (especially hazardous waste containing heavy metals, river sludge, urban sludge, industrial sludge containing heavy metals and slag), and especially suitable for harmless treatment of solid waste with high concentration of heavy metals and complex components.

Applications:

Stabilization treatment project of waste residue containing copper, nickel, arsenic and cadmium in a hazardous waste landfill plant in Gansu Province.



能源环境篇

Energy & Environment

土壤修复剂

Soil remediation reagent

土壤钝化剂

ENFI SoilRem F-006

主要用途：农田土壤改良

有效成分：矿物质、生物质、硅酸盐
pH调节剂、营养物质等

净含量：40 kg



土壤修复剂

ENFI SoilRem RE-006

主要成分：重金属稳定剂、土壤改良剂、肥料

营养成分：有机质含量 ≥ 180 g/kg
 $P_2O_5 \geq 25$ g/kg
氮钾总量 ≥ 20 g/kg

净含量：40 kg



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土壤修复剂

中国恩菲自主研发的一系列土壤修复药剂和土壤改良药剂具有适用性强、效果显著等优点，尤其适合复杂污染土壤的修复。

ENFI SoilRem F-006

ENFI SoilRem F系列为农田污染土壤的改良药剂。该药剂具有重金属钝化功能和土壤结构改良两种特性，有效成分包括磷酸盐、铁基化合物、钙盐、硫酸盐、矿物土、肥料、保水剂、微生物菌剂、土壤结构调理剂等。ENFI SoilRem F-006成功应用于张家口某农田污染项目。

ENFI SoilRem RE-006

ENFI SoilRem RE-006是一种离子型稀土矿区污染土壤修复药剂。南方离子型废弃稀土矿区内尾矿、尾砂具有pH低、板结、生产功能丧失、易发地质灾害等特点，常年寸草不生，对周边环境造成不利影响。为解决上述问题，中国恩菲专门开发了ENFI SoilRem RE-006。该药剂具有调节土壤pH、钝化重金属、调整营养结构、保水增墒等作用。成功应用于江西某废弃稀土矿区重金属综合治理工程，实现供货约3000t，帮助解决了废弃矿区内的重金属污染问题并实现稀土尾矿的生态修复，取得了良好的环境效益。



修复前
Before remediation



修复后
After remediation



Soil remediation reagent

Through long-term independent research and development, China ENFI has developed a series of soil remediation agents and soil improvement agents which have the advantages of strong applicability and remarkable effect, especially suitable for the remediation of complex contaminated soil.

ENFI SoilRem F-006

ENFI SoilRem F Series is an improvement agent for contaminated soil in the farmland. It has two characteristics of heavy metal passivation and soil structure improvement, with effective compositions of phosphate, iron based compound, calcium salt, sulfate, mineral soil, fertilizer, water-retaining agent, microbial agent, soil structure adjustment agent, etc. ENFI SoilRem F-006 has successfully applied to a farmland pollution project in Zhangjiakou.

ENFI SoilRem RE-006

ENFI SoilRem RE-006 is a remediation agent for contaminated soil in the ion-type rare earth mining area. Tailings in abandoned ion-type rare earth mining areas in southern China are characterized by low pH, hardening, loss of production function, and prone to geological disasters. These areas are barren and cause negative impacts on the surrounding environment. To solve the above problems, ENFI has specially developed ENFI SoilRem RE-006, which has the ability of adjusting soil pH, passivating heavy metals, adjusting nutrition structure, keeping water and increasing soil moisture, and so on. It has successfully applied to a heavy metal comprehensive treatment project of the abandoned rare earth mining area in Jiangxi province, realizing the supply of about 3,000t, which helped solve the problem of heavy metal pollution in the abandoned mining area and realized the ecological remediation of rare earth tailings, and achieved good environmental benefits.