

应用业绩：

中国恩菲目前承揽的矿山充填工程涉及有色金属、钢铁、煤炭、化工、核工业等行业，受到业主的广泛赞誉和好评。具有代表性的充填项目有驰宏会泽铅锌矿、冬瓜山铜矿、红透山铜矿、安庆铜矿、赞比亚谦比希铜矿、铜山口铜矿、三山岛金矿、金川镍矿、南京栖霞铅锌矿、大冶铁矿、香炉山钨矿、白音查干铅锌矿和泰国乌东他尼盐矿等。

Applications:

The mine filling projects currently undertaken by China ENFI involve non-ferrous metals, iron and steel, coal, chemical engineering and nuclear industry, etc., which have been widely acclaimed by the Owner. The representative filling projects comprise Pb-Zn mine of Yunnan Chihong Zinc & Germanium Co., Ltd, Dongguashan copper mine, Hongtoushan copper mine, Anqing copper mine, Chambish copper mine in Zambia, Tongshankou copper mine, Sanshandao gold mine, Jinchuan nickel mine, Qixia lead and zinc mine in Nanjing, Daye iron ore mine, Xianglushan tungsten mine, Baiyin Chagan lead and zinc mine and Udon Thani potash mine in Thailand, etc.



冬瓜山铜矿项目

项目位于安徽铜陵，是我国较早建设的千米深井大规模开采矿山，规模400万t/a，开采深度1100m。项目共设置6套充填系统，采用新型全尾砂浓缩贮存装置，充填系统能力100m³/h。

Dongguashan copper mine

The project is located in Tongling, Anhui Province, which is one of China's first 1,000m+ large-scale deep shaft mining mines, with a capacity of 4 mt/a and a mining depth of 1,100m. The project is designed to have 6 filling systems, for which novel total-tailings thickening and storage facilities are used, having a filling material preparation capacity of 100m³/h.



大冶铁矿西区项目

项目位于湖北省黄石市，2020年建成投产。充填站共设2套充填系统，单套充填系统能力为100m³/h。尾砂浓缩贮存装置底流浓度高，放砂连续性好，流量稳定。胶结充填料浆达到膏体状态，泌水率低，流动性好，充填体强度高。

Daye iron ore mine project in the west area

The project is located in Huangshi, Hubei province, which was completed and put into production in 2020. The filling station is provided with 2 sets of filling systems, and each system has a filling capacity of 100m³/h. The tailings thickening and storage device features a high-density underflow, sound continuity of tailings discharge and stable flowrate. The cemented filling slurry reaches a paste state with a low bleeding rate, good fluidity and high strength of fill mass.



刚果（金）金森达铜矿项目

中国恩菲EPC承包项目，2017年完成验收并移交。项目设置1套充填系统，充填系统能力100m³/h。

Kinsenda copper mine in DRC

It is an EPC project undertaken by China ENFI, with the acceptance and hand-over completed in 2017. The project is provided with one set of filling system with a capacity of 100m³/h.

矿山装备篇

Mine equipment

智能尾砂充填成套装置

Intelligent Tailings Filling Package Equipment



产品特点：

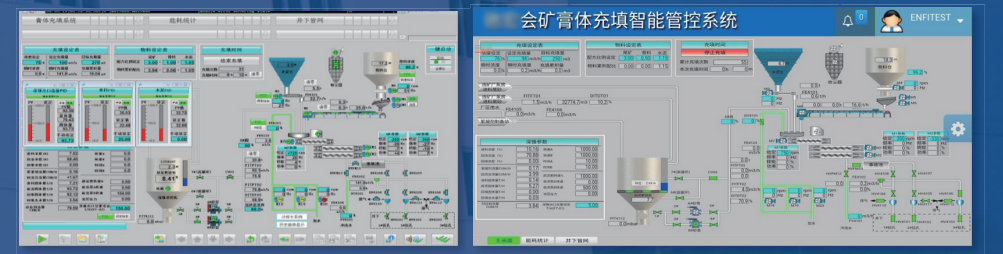
- » 适应范围广、缓冲能力强，适用于全尾砂、分级尾砂，适应粗尾砂和细尾砂的浓缩和贮存，同时具有较大的尾砂贮存缓冲能力，能解决选矿生产与采矿充填作业的匹配问题
- » 浓缩效果好，溢流水闭路循环，与传统立式砂仓制备效果相比，砂仓放砂浓度提高3%~18%、放砂连续性好，流量稳定；胶结充填料浆达到膏体状态，泌水率低，充填体强度高。装置仓顶溢流脱水与仓底造浆同步进行，提高了充填能力，达到了选矿水闭路循环目的
- » 无耙架装置，节能环保
- » 成套装置机械部分可全部由钢结构件制作，施工快速、安装便捷

采用智能充填自动化控制技术，在短流程工艺基础上做出智能算法，实时优化调节各种液位、流量和计量等关键参数，通过自适应的工艺智能分析和APP移动终端，实现人工控制与自动控制的无扰动切换，从而完成“一键式充填”，保证了充填生产过程的高效、稳定运行，效益显著。充填自动化控制系统将充填过程中各种参数进行全面分析，生成生产报表和生产数据统计分析图表，简化工艺流程、提高充填质量、降低充填成本和投资、减少劳动定员、便于管理维护。

Features:

- » Wide adaptability and strong surge capacity. It is applicable to both unclassified and classified tailings as well as thickening and storage of crude and fine tailings. It also features a large surge capacity in tailings storage, which can solve the matching problem of beneficiation production and filling operation in mining.
- » Good thickening effect and closed-circuit recycling of overflow water Compared with the preparation effect of traditional vertical tailings bin, the discharge density of tailings bin increases by 3%-18%, characterized by a sound continuity of tailings discharge and stable flowrate. Cemented filling slurry reaches a paste state with a low bleeding rate and high strength of fill mass. Simultaneous operation of overflow dewatering at the top of equipment bin and slurrying at the bin bottom enhances the filling capacity and realizes the purpose of closed-circuit recycling of mineral processing water.
- » There is no rake frame, which is energy-saving and environment-friendly.
- » All mechanical parts of package equipment can be made by steel structural members characterized by fast construction and convenient installation.

Intelligent filling automatic control technology is adopted. And intelligent algorithm is made based on the short-flow process to optimize and adjust key parameters including various level, flow and metering, etc. By self-adaptable intelligent process analysis and APP mobile terminal, the undisturbed switching between manual and automatic control is realized so as to accomplish “one-key filling” and ensure efficient and stable operation of filling production with remarkable benefits. Automatic filling control system performs a comprehensive analysis of various parameters in the filling process to produce production statement and statistical analysis diagram of production data, which simplifies process flow, enhances filling quality, lowers filling cost and investment, reduces manning and facilities management and maintenance.



智能尾砂充填成套装置

智能尾砂充填成套装置是由中国恩菲自主开发的具有国际领先水平的（全）尾砂浓缩、脱水、立仓式尾砂浓缩装置。适用于井下充填、露天坑、采坑区填充治理、尾砂浓缩排放。

该装置拥有授权专利10余项，获得2012年中国专利优秀奖，国家科技进步奖等多项奖励。2015年，中国恩菲“膏体及高浓度尾矿充填技术与装备”被国家安监总局列入第一批《金属非金属矿山新型适用安全技术及装备推广名录》，实现了矿山充填工艺中全尾砂以及分级尾砂低成本高质量浓缩脱水。

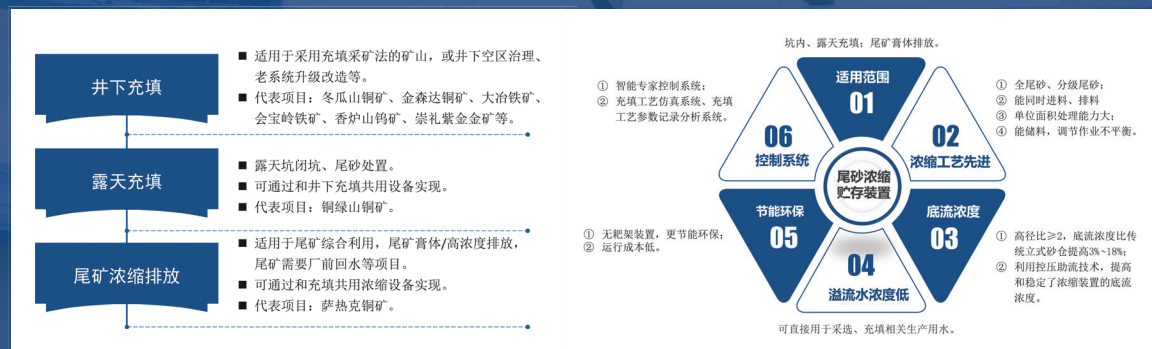
主要有Φ8.6m、Φ10m、Φ12m、Φ25m等多种规格系列，尾砂料进料流量为200~700m³/h，底流尾砂浓度为70%~80%，排放流量为60~160m³/h；满足不同类型充填法开采矿山的需求。

Intelligent Tailings Filling Package Equipment

Intelligent tailings filling package equipment is an internationally advanced device for unclassified tailings thickening and dewatering and vertical bin-type tailings thickening that is independently developed by China ENFI. It is applicable to underground filling, filling control of open-pit and mined-out area and tailings thickening & discharge.

With about 10 authorized patents, the equipment won multiple awards including 2012 China Patent Excellence Award and National Science and Technology Progress Award. In 2015, “Paste and high-density tailings filling technology and equipment” of China ENFI was listed in the first batch of Promotion List of New Applicable Safety Technologies and Equipment for Metal and Non-metallic Mines by the State Administration of Production Safety Supervision and Management. The low-cost and high-quality thickening and dewatering of unclassified and classified tailings has been realized in the mine filling process.

The equipment comprises multiple specifications including Φ8.6m, Φ10m, Φ12m and Φ25m, with the feed rate of tailings as 200-700m³/h, underflow tailings density as 70-80% and discharge flowrate as 60-160m³/h, which can meet the extraction demand of different mines by filling.



应用业绩：

序号	单位	提升系统	传动形式
1	金川集团股份有限公司龙首矿	双箕斗，罐笼-平衡锤等	交流(3500kW)、直流
2	招金矿业股份有限公司夏甸金矿	箕斗-罐笼	直流
3	铜陵有色金属集团冬瓜山铜矿	双箕斗	交流(4400kW)
4	中色非洲矿业有限公司赞比亚谦比希铜矿	双箕斗(缠绕式)	直流(4000kW)
5	中色卢安夏赞比亚巴鲁巴铜矿	双箕斗，罐笼-平衡锤(缠绕式)	直流(3800kW)
6	巴基斯坦杜达铅锌矿	箕斗-罐笼系统直流	直流
7	金川集团股份有限公司龙首矿(提升机集中控制)	各类系统共8套	交流、直流



中色非洲矿业有限公司赞比亚谦比希铜矿
主井：单绳缠绕 双箕斗3880kW
副井：单绳缠绕 罐笼-平衡锤 2013kW
进度：拆旧、换新、调试、验收，两套系统共45天，实施速度创造记录

Chambishi Copper Mine, NFC Africa Mining PLC
Main shaft: single rope winding, double skips 3880kW
Auxiliary shaft: single rope winding cage-counterweight 2013kW
Schedule: 45 days were spent on the demolition, replacement, commissioning, and acceptance tests of two hoist systems, at a record speed of execution.



铜陵有色金属集团冬瓜山铜矿
主井：多绳摩擦塔式提升，30t双箕斗，提升速度12m/s，4400kW
副井：多绳摩擦落地式提升，5180x3000罐笼-平衡锤，提升速度8.8m/s，900kW
提升高度1105m，2001年有色金属行业第一井

Dongguashan Copper Mine, Tongling Non-Ferrous Metals Group
Production shaft: Tower-mounted multi-rope friction hoist, 30t double-skip, hoist velocity 12m/s, 4400kW
Service shaft: Floor-mounted multi-rope friction hoist, 5180x3000 cage-counterweight, hoist velocity 8.8m/s, 900kW
Hoist height: 1105m; first service shaft of this kind of 2001 in nonferrous metal industry.

Applications:

S/N	Company	Hoist system	Form of driving
1	Longshou Mine, Jinchuan Group Co., Ltd.	Double skips, cage-counterweight, etc.	AC (3500kW), DC
2	Xiadian Gold Mine, Zhaojin Mining Industry Co., Ltd.	Skip-cage	DC
3	Dongguashan Copper Mine, Tongling Non-Ferrous Metals Group	Double skips	AC (4400kW)
4	Chambishi Copper Mine, NFC Africa Mining PLC	Double skips (winding type)	DC (4000kW)
5	Baluba Mine, CNMC Luanshya Copper Mines PLC (CLM), Zambia	Double skips, cage-counterweight, (winding type)	DC (3800kW)
6	Duddar Lead-Zinc Mine, Pakistan	Skip-cage system, DC	DC
7	Longshou Mine, Jinchuan Group Co., Ltd. (Centralized hoist control)	8 sets in total	DC, AC

矿山装备篇
Mine equipment

矿山深井提升机电控系统
Deep Shaft Hoist Electric Control System

II 矿山深井提升机电控系统

中国恩菲长期进行提升机电控系统科研开发、集成设计供货及安装调试工作，形成了具有自身特色的竖井提升核心专长技术。其电控系统搭配直传动、低压交流传动和中压交流传动等各种电气传动装置，可用于单绳缠绕式或多绳摩擦式的箕斗提升、罐笼提升或混合井提升系统。

目前中国恩菲完全掌握了世界先进的电控系统控制技术，结合国产机械的特点与运行经验，进行了系统集成创新，包括：挽救制动闸失效的控制技术、防止提升机超重运行的控制技术、防止提升容器关闭不到位的控制技术、防止人工误操作的智能控制台的优化设计、按选定减速度安全制动等，获部级科技二等奖。

Deep Shaft Hoist Electric Control System

Long engaged in the R&D, integrated design & supply, and installation & commissioning of hoist electric control systems, ENFI has accumulated its own expertise in shaft hoisting. Used with various electric drives including DC drives low-voltage or medium-voltage AC drives, ENFI's electric control systems can serve shaft hoisting systems of all kinds: single-rope winding type, multi-rope friction type, skip hoisting, cage hoisting and combination.

ENFI has fully mastered the control techniques of the world's advanced electric control systems. With thorough knowledge of the characteristics and operation practices of Chinese machinery, ENFI has developed a number of innovations in system integration, including: control over break failure, control over overload operation, control over incomplete shut of hoist vessel, optimized design of misoperation-proof control console, and safe break according to selected deceleration. These have won ENFI ministerial second awards for technological achievements.

设备规格：

- » 按电气传动形式分类：直流电控系统（6脉动，并联12脉动，串联12脉动）和交流电控系统（380V、690V、3kV、6kV、10kV）
- » 按提升容器形式分类：罐笼电控系统、箕斗电控系统、箕斗-罐笼电控系统

产品特点：

- 安全、高效、节能、智能
- » 安全：控制系统保护功能完善，可实现多项关键冗余保护，确保系统安全运行；电气传动装置工作稳定，故障率低
- » 高效：融合信号与控制，箕斗无人化；缩短调速时间、爬行时间，提升循环；缩短装矿时间，避免欠载和超载；首故障判断，缩短检修时间
- » 节能：停车节能，避免重复启停对准；磁场节能，节约75%的驻车磁场损耗，通风节能，节约100%驻车通风损耗；传动节能，以低速同步电机或异步电机替代低速直流电机，节能10%，显著减小维护工作量
- » 智能：控制功能完备自动化程度高，可实现无人值守和多台提升机远程集中监控有效减少劳动定员；支持远程维护，有效降低故障停机时间

Specifications:

Classified by drive types: DC control (6 pulsations, shunt 12 pulsations, 12 pulsation in series) and AC control (380V, 690V, 3kV, 6kV, 10kV)

Classified by hoist vessels: cage hoisting electric control system, skip hoisting electric control system, skip-cage combo hoisting electric control system.

Features:

Safe, efficient, energy-saving, and smart

- » **Safe.** The control system provides well-rounded protection, including redundant protection in multiple key parts; the drive has a stable performance and a low failure rate.
- » **Efficient.** Automated skip operation supported by fused signaling and control; shorted hoist cycle with less time for speed regulation and crawl; faster loading with underload/overload prevention; faster maintenance helped by automatic initial fault diagnosis.
- » **Energy-saving.** The system saves energy at hoist stop: no repeated alignment is needed at hoist start/stop; saves energy at magnetic fields: saves about 75% energy consumption induced by magnetic fields during hold; saves energy in ventilation: saves about 100% energy for ventilation during hold; saves energy during driving: saves energy by 10% by replacing low-speed DC motor with low-speed synchronous motor or asynchronous motor, and significantly reduce maintenance load.
- » **Smart.** Full-fledged, highly automated control. Can effectively reduce workforce by providing remote, centralized monitoring for multiple hoists at once; convenient, remote maintenance supported, which reduces down time.



提升机电控系统监控画面

Screenshots showing hoist electric control monitoring

应用业绩:

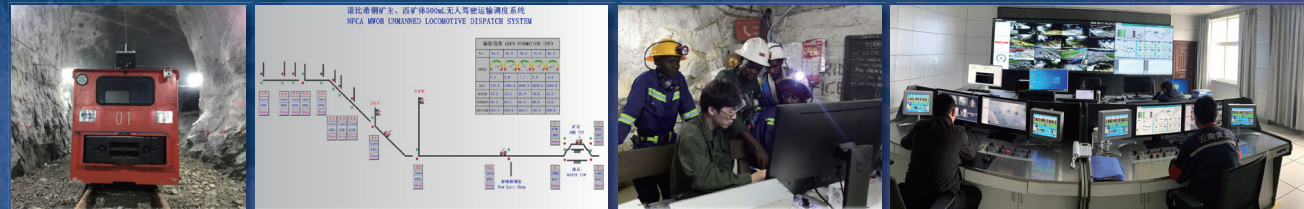
中国恩菲自2011年启动无人电机车自动化采矿综合技术研发以来，已成为国内唯一掌握无人驾驶电机车双机牵引、双机联动技术的单位。目前，中国恩菲自主开发的无人驾驶有轨电机车已成功应用于铜陵有色金属集团冬瓜山铜矿、云南黄金集团红牛铜矿、赞比亚中色非洲矿业公司谦比希主西矿体等国内外地下矿山项目，有效帮助客户提高生产率、降低成本、解决劳动力短缺等问题。

美誉殊荣:

中国恩菲无人驾驶技术共获得各类专利授权30余项，在核心刊物公开发表技术论文11篇。“有轨运输无人驾驶”研究成果被中国有色工业协会鉴定为“国际领先”，并获中国设备管理协会全国设备技术及管理创新成果特等奖一项、中冶集团技术发明一等奖一项、中国有色金属工业协会科技进步二等奖一项、中国有色金属工业协会优秀工程咨询二等奖一项、云南省工业互联网“三化”改造试点示范项目一项。



冬瓜山铜矿无人驾驶系统
Unmanned driving system of Dongguashan Copper Mine



赞比亚谦比希铜矿主西无人驾驶系统
Unmanned driving system of Main Orebody and West Orebody of Chambishi Copper Mine in Zambia



红牛铜矿无人驾驶EPC项目
Unmanned driving system (EPC) of Hongniu Copper Mine

Applications:

Since the start-up of the comprehensive research and development on automated mining technology of unmanned electric locomotives in 2011, China ENFI had become the only company in China that has mastered the technology of double-locomotive traction, double-locomotive linkage and load balancing of unmanned electric locomotives. Up till present, the unmanned rail electric locomotive independently developed by China ENFI has been successfully applied to underground mines both in China and abroad, namely Dongguashan Copper Mine of Tongling Nonferrous Metals Group, Hongniu Copper Mine of Yunnan Gold Mining Group, and Chambishi Main Orebody and West Orebody of Africa Mining Company of China Nonferrous Metal Mining (Group) Co., Ltd. in Zambia, effectively improving productivity, reducing costs and solving such problem as labor shortage.

Honors and awards:

China ENFI's unmanned driving technology has obtained more than 30 patents, and 11 professional papers on this technology have been published in core publications. The research achievements of Unmanned Rail Transportation were recognized as International Advanced Level by China Non-Ferrous Metals Industry Association, and won one Special Award for National Equipment Technology and Management Innovation Achievements by China Association of Plant Engineering, one First Prize of Technological Invention of China Metallurgical Group Corporation, one Second Prize of Science and Technology Progress Award by China Nonferrous Metals Industry Association, one Second Prize of Outstanding Engineering Consultation Award by China Nonferrous Metals Industry Association, and one Pilot Demonstration Project of Digitization, Networking and Intelligentization of Department of Industry and Information Technology of Yunnan Province.

矿山装备篇

Mine equipment

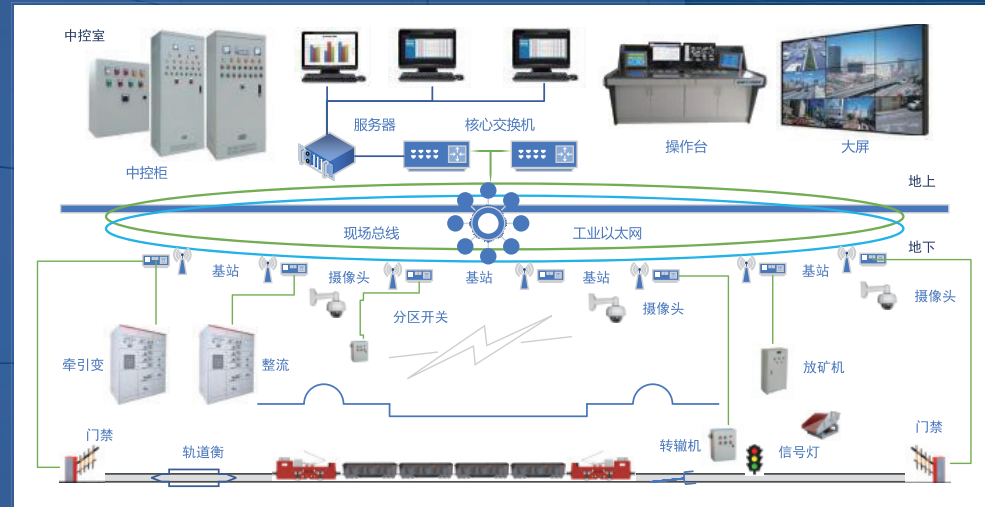
有轨运输无人驾驶系统

Unmanned Driving System for Rail Transportation



II 有轨运输无人驾驶系统

有轨运输无人驾驶系统是中国恩菲自主开发的专利产品，于2012年实现亚洲首例有轨运输无人驾驶系统的应用。该系统针对有轨运输环节工作环境恶劣、工作效率低、人工作业强度大、系统分散和智能化水平低等难题，以中国恩菲无人驾驶电机车系统的自动运行和运输全环节的融合化控制为基础，解决了矿山生产运输环节的本质安全问题，彻底取消了矿山有轨运输环节的现场操作人员，可减少75%操作人员，大幅提升运输效率，并全面提升矿山运输工艺环节的信息化水平。



Unmanned Driving System for Rail Transportation

Unmanned driving system for rail transportation, China ENFI's proprietary product, was first applied in Asia in 2012. The system addresses the problems existing in the rail transportation such as poor working environment, low work efficiency, high manual work intensity, decentralized system and low intelligentization level. Based on automated operation of the unmanned electric locomotive system and the integrated control of the entire transportation section, the safety hazards existed in the mine production and transportation section is uprooted, on-site operators are no longer needed in the mine rail transportation section and 75% of the operators can be reduced, which results in great improvement in the transportation efficiency and the informatization level of the mine transportation process.

产品特点:

- » **严苛环境适用性:** 实施了中国海拔最高的无人驾驶系统、实施了千米深井无人驾驶系统、在国内外都有成功实施案例
- » **高可靠性:** 多达40项的安全保护功能，车载设备元件级的防震设计，元件级的故障自诊断。具备完备的无人驾驶健康诊断系统

技术介绍:

- » **双机牵引技术:** 中国恩菲是国内唯一掌握无人驾驶电机车双机牵引、双机联动、负载平衡技术的单位
- » **网络技术:** 中国恩菲是国内唯一实现基于不同技术的双无线热冗余网络系统、信息多路径最优切换技术的单位
- » **融合技术:** 规划运输中段智慧矿山“一张网”系统，采用融合技术，实现“多网合一”、多系统合一
- » **信息化技术:** 全运输环节的生产数据、设备数据、运行数据自采集自分析，全面提升矿山运输的管理水平
- » **远程运维技术:** 依托中国恩菲的中国矿业信息化协同创新中心北京市工程研究中心，实现对现场系统的实时远程运维

Features:

- » **Adaptability to harsh environment.** China ENFI has successfully implemented unmanned system at the highest altitude in China as well as 1000m+ deep shaft unmanned systems with records made inside and outside of China.
- » **High reliability.** It has more than 40 safety protection functions, component-level anti-vibration of the on-board equipment as well as component-level breakdown auto-diagnosis. This system is also equipped with complete health diagnosis system.

Introduction of the technology:

- » **Double-locomotive traction technology.** China ENFI is the sole company in China that has mastered the technology of double-locomotive traction, double-locomotive linkage and load balancing for unmanned electric locomotives.
- » **Network technology.** China ENFI is the only company in China that has realized double wireless and thermal redundancy network system based on different technologies, and optimal information path selection technology out of multi-path to realize real-time switch.
- » **Integration technology.** Smart mine One Network system is programmed for the transportation section where integration technology is adopted to achieve Multi-network Integration and Multi-system Integration.
- » **Informatization technology.** Automated collection and analysis of the production data, equipment data, and operation data of the entire transportation section is realized to overall improve mine transportation management level.
- » **Remote operation and maintenance technology.** Relying on China Mining Innovation Center Beijing Municipal Engineering Research Center, real-time remote operation and maintenance of the on-site systems is achieved.

矿山装备篇

Mine equipment

底侧卸式矿车及卸载站

Unloading Bottom Dump Car and Unloading Station



|| 底侧卸式矿车及卸载站

由中国恩菲自主开发的专利产品，广泛应用于井下金属矿山有轨运输。

中国恩菲具有6m³、10m³、20m³底侧卸式矿车的全套技术，可以向矿山企业提供多种不同规格的矿车和卸载站。可根据不同矿石性质、不同生产规模设计、选用不同类型矿车适应矿山具体情况，在大、中、小型金属非金属矿山都有非常成熟的应用，并取得了良好的口碑。

产品特点：

- » **矿车采用双轴结构：**车轮采用铸钢结构、双圆锥滚子轴承。轮对承载能力大、坚固耐用、矿车和卸载站寿命长达10~15年
- » **矿车车箱和底架都采用重型箱式焊接结构，大大加强了矿车的强度和稳定性**
- » **矿车车箱采用倒梯形结构，且装矿时，两个车箱的上部相互搭接，以避免列车移动装载时撒落矿石**
- » **优化了矿车支撑弹簧的结构以及橡胶弹簧支座的结构：**弹簧的支撑角改为30° 弹簧支座的结构由钢板焊接改为铸钢结构，抵抗变载荷冲击的能力大幅度增加，使用寿命延长

应用业绩：

成功应用于安徽冬瓜山铜矿、赞比亚谦比希铜矿、甘肃金川有色集团公司二矿区等。

Unloading Bottom Dump Car and Unloading Station

Unloading bottom dump car and unloading station, China ENFI's proprietary products, are widely used for underground rail transportation of metal mines.

With a full set of technologies for 6m³, 10m³, 20m³ unloading bottom dump cars, China ENFI can supply such cars with different specifications to the mining companies. It can be tailor-designed to cater for different mines according to the ore property and production scale. It has been well applied in large, medium and small metal and non-metal mines, thereby achieving a sound reputation.

Features:

- » **The dump car adopts a dual-axle structure.** The wheels are of cast steel structure and double tapered roller bearings which endows the wheel set with large bearing capacity, sturdiness and durability. The car and the unloading station has a service life up to 10 to 15 years.
- » **The car carriage and underframe are of heavy duty box-type welded structure which greatly enhances the strength and stability of the car.**
- » **The carriage adopts an inverted trapezoidal structure and the upper part of the two carriages overlap each other during ore loading to avoid ore spilling when the car is moving and loading.**
- » **The car has an optimized support spring structure and rubber spring bearing structure.** The support angle of the spring is changed to 30° and the structure of the spring bearing is changed from steel plate welding to a cast steel structure, which greatly increases the resistance to variable load impact, thereby extending the service life.

Applications:

Successful applications in Dongguashan Copper Mine in Anhui province, Chambishi Copper Mine in Zambia and Mine Area II of Gansu Jinchuan Group Co., Ltd.