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ELECTROMAGNETIC STIRRING SYSTEM

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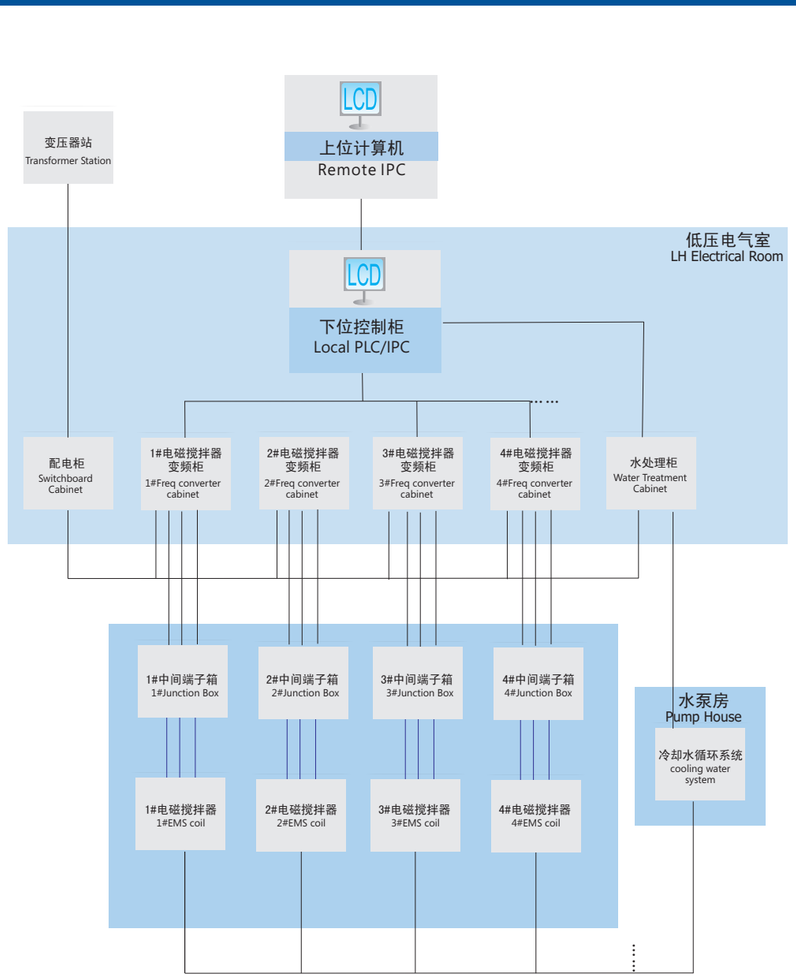
Electromagnetic Stirring System 电磁搅拌装置 | 概述

成套电磁搅拌装置系统构成
Complete EMS System Configuration

成套电磁搅拌装置由电磁搅拌器、电磁搅拌器电控系统和冷却水循环系 统三部分组成。其中电磁搅拌器电控系统由上位控制计算机、下位控制柜(PLC/IPC)和电磁搅拌变频柜组成。

EMS consists of coil, electric controller and cooling water system. Electrica l controller consists of remote IPC, local control cabinet (PLC/IPC) and frequency inverter cabinet.



成套电磁搅拌装置系统构成图
Complete EMS System Configuration Diagram

电磁搅拌器的技术特点
Technical Features of KEMEIDA EMS

・我公司和美国GL电磁场软件公司合作开发了赛金电磁场计算法。所谓赛金电磁场计算法就是在边界带采用新的带域磁场微积分方程和在区域内采用伽辽金磁场微分方程构成有效的赛金电磁搅拌计算方法。该计算方法的计算结果虚拟模型能直观的看到电磁场运动的形态和钢水被搅拌的形态。

A new algorithm has been developed by KEMEIDA and GL Electromagnetic Field Software Co., names AGILD EM STIRRING ALGORITHM, which uses New Strip Magnetic Field Differential Integral Equation.

・采用该计算软件对电磁搅拌器的电磁参数进行优化设计，使得电磁搅拌器的中心磁密高，电磁体积力大，搅拌效果好。

This software can design electromagnetic parameters optimized. EMS shall be with high magnetic induction and stirring force. So stirring effect shall be great.

・采用该计算软件，能快速、准确的计算出不同频率、不同电流情况下的电磁力，并能为用户提供最佳搅拌电流和频率。

Stirring force can be calculated by this software according different freq and current. So the best freq and current can be provided for user.

・采用该计算软件对L/D比值进行优化，适当加长电磁搅拌器的铁芯长度，扩大搅拌范围，提高搅拌效果.

Optimized design shall be done for L/D. Iron Core length shall be increased properly. So stirring effect shall be improved.

・我公司还具有末端电磁搅拌器安装位置的计算软件，根据现场工艺参数，能快速、准确地计算出末端电磁搅拌器的最佳安装位置。

Kemeida has also other software for designing F-EMS to calculate best position of F-EMS.

・电磁搅拌器采用低电压、大电流的设计原则，有效地防止高压峰值对绝缘的破坏，延长电磁搅拌器的使用寿命，提高冶金效果。

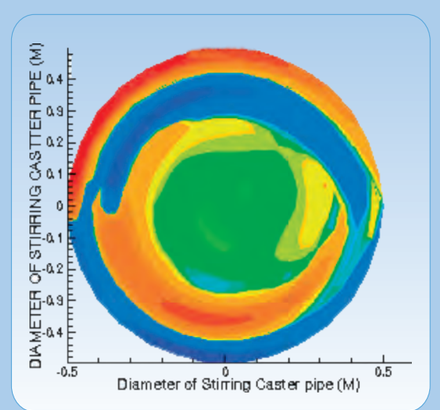
KEMEIDA EMS uses low voltage and large current, which can avoid damage of peak voltage to insulation. It shall make reduce current leakage and prolong EMS life.

・适当放宽电源频率范围，以确保能选用最佳搅拌频率。

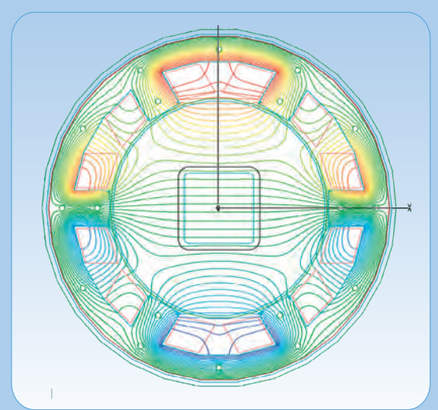
Freq arrange shall be widened to choose the best freq.

・适当降低电磁搅拌器安装位置，使弯月面附近的磁场尽可能小，以保证可以采用较强的搅拌强度，而不至于引起弯月面的波动和卷渣。

Put EMS lower properly to make magnetic field around meniscus as little as possible to ensure strong magnetic field.



赛金磁场虚拟图
Agild Magnetic Field Virtual Diagram



旋转磁场瞬间分布图
Rotating Magnetic Field Distribution Diagram

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Electromagnetic Stirring System
电磁搅拌装置

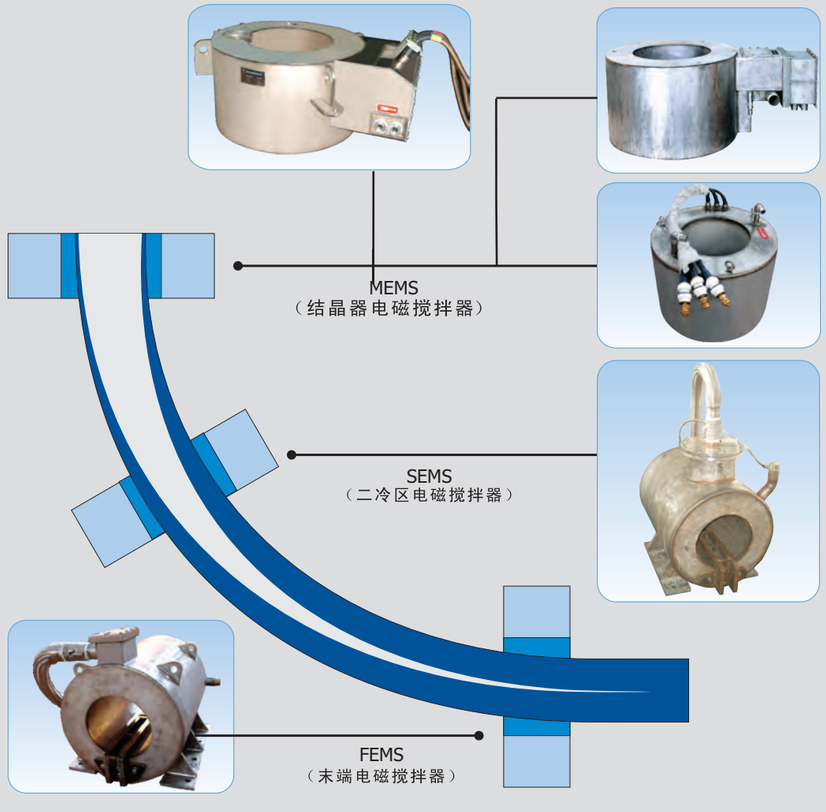
方（圆）坯电磁搅拌器
EMS for Bloom (Round)

方（圆）坯电磁搅拌器的分类
EMS for Bloom (Round)

电磁搅拌器原则上可以安装在连铸机整个冶金长度的任何位置上。根据具体安装位置，一般可分为下述三种：
There are three kinds of EMS according to installation position:

- 结晶器电磁搅拌器：M-EMS
  Mould Electromagnetic Stirrer : M-EMS
- 二冷区电磁搅拌器：S-EMS
  Strand Electromagnetic Stirrer: S-EMS
- 凝固末端电磁搅拌器：F-EMS
  Final Electromagnetic Stirrer: F-EMS

从目前使用情况看，大多数钢厂采用结晶器电磁搅拌器（MEMS）或结晶区和凝固末端两段组合搅拌（M+F–EMS)。
So far, most of steel plant use M-EMS or M+F-EMS.



方（圆）坯电磁搅拌器产品简介
Features of EMS for Bloom (Round)

一、结晶区电磁搅拌器
Mould EMS (M-EMS)

结晶器水冷却内置式电磁搅拌器：电磁搅拌器安装在结晶器水腔内，与结晶器共用一套冷却水系统，结构简单，使用方便，运行成本低，搅拌频率一般为 2 ~ 8 Hz（见图1）

EMS inside mould using mould water: EMS is installed inside the mould and uses cooling water system of the mould. It can be operated conveniently with low cost. Stirring freq: 2-8Hz.(Refer to Fig.1).

纯净水冷却内置式电磁搅拌器：电磁搅拌器安装在结晶器水腔内，电磁搅拌器单独使用一套冷却水循环系统，结构紧凑、水质好、使用寿命长，搅拌频率一般为 2 ~ 8 Hz（见图2）。

EMS inside mould using clean water: EMS is installed inside water jacket of the mould and uses a separate cooling water system. Structure is compact and life is long. Stirring freq: 2-8Hz.(Refer to Fig.2)

外水直冷外置式电磁搅拌器：电磁搅拌器安装在结晶器外，便于更换结晶器铜管，减轻结晶器振动臂负荷，适应铸坯断面尺寸的范围宽，一台电磁搅拌器可以搅拌多种断面。搅拌频率一般为 2 ~ 5 Hz（见图3）。

EMS outside mould: EMS is installed outside the mould with separate cooling water system. It is simple to change copper tube. EMS can be used for wide range of sections. Stirring freq: 2 ~ 5Hz.(Refer to Fig.3)

铜管内冷电磁搅拌器：电磁搅拌器安装在结晶器内或外，绕组采用克莱姆绕组，磁场均匀，无齿槽极化现象，但漏磁偏大，存在电磁污染严重，水质要求高，冷却水系统运行成本高.搅拌频率一般为1～6Hz（见图4）。

inner cooling type ems:can be installed inside or out the mould.cramer windings are adopted,which has even magnetic field without polarization.But magnetic leakage is too much with electromagnetic pollution cooling water quality has to be very strict and operation cost is higher.Stirring freq is 1~6Hz.

图1 结晶器水冷却内置式电磁搅拌器
1 EMS inside mould using mould water

图2 纯净水冷却内置式电磁搅拌器
2 EMS inside mould using clean water

图3 外水直冷外置式电磁搅拌器
3 EMS outside mould

图4 铜管内冷外置式电磁搅拌器
4 EMS outside mould with copper pipe water cooling

二、凝固末端电磁搅拌器（FEMS）
Final EMS (F-EMS)

末端电磁搅拌器采用旋转磁场，铁芯长，中心磁密高，搅拌范围大。可施加交替搅拌或间歇搅拌，有效地保证了搅拌效果。
F-EMS uses rotate field with long iron core. Central magnetic induction is strong and application range is wide. Stirring effect shall be ensured with alternating or intermittent stirring.

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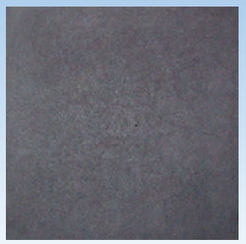
方（圆）坯电磁搅拌器
EMS for Bloom (Round)

方（圆）坯电磁搅拌的冶金效果
Metallurgical effect of EMS for Bloom (Round)

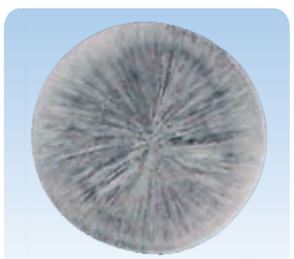
设备名称 NAME	冶金效果 METALLURGICAL EFFECT	适应钢种 STEEL GRADES
结晶器电磁搅拌器 MEMS	增加等轴晶率 Increase equiaxed zone 减少表面和皮下的气孔、针孔和夹杂物 Reduce air holes ¡ pinholes and inclusion in the surface and subsurface 坯壳均匀化 Equalize Billet Crust 稍稍改善中心疏松 Reduce central porosity a little 稍稍改善中心偏析 Reduce central segregation a little	低合金钢 Low alloy steel 弹簧钢 Spring steel 冷轧钢 Cold rolling steel 中、高碳钢 Medium and high carbon steel
二冷电磁搅拌器 SEMS	扩大等轴晶率 Increase Equiaxed Zone 改善中心偏析 Inprove Central Segregation 减少内裂 Reduce Inner Cracks 减少中心疏松和缩孔 Reduce central porosity and shringkage	不锈钢 Stainless steel 工具钢 Tool steel
末端电磁搅拌器 FEMS	细化等轴晶率 Make equiaxed zone fine; 有效改善中心偏析 Reduce central segregation 有效改善中心疏松和缩孔 Reduce central porosity and shringkage	弹簧钢 Spring steel 轴承钢 Bearing steel 特殊高碳钢 Special high carbon steel

铸坯断面硫印照片
Sulfur Print Photos of Section

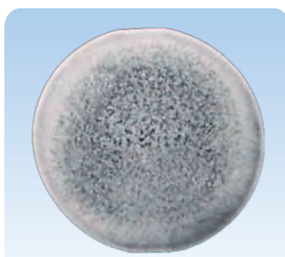
碳钢未搅拌铸坯断面
Without stirring (carbon steel)



碳钢已搅拌铸坯断面
With stirring (carbon steel)



不锈钢未搅拌铸坯断面
Without stirring (stainless steel)



不锈钢已搅拌铸坯断面
With stirring (stainless steel)

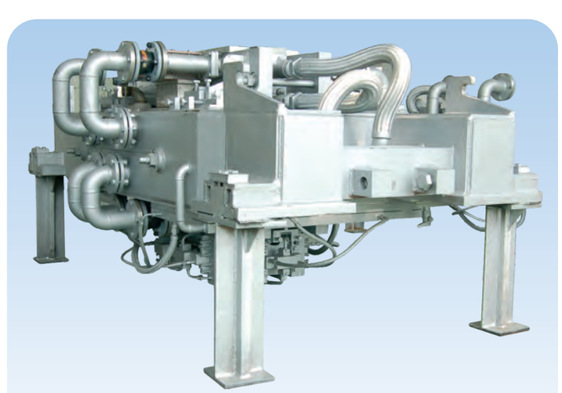
板坯连铸电磁设备
Electromagnetic Equipment for Slab

板坯连铸电磁设备分类
EMS/EMBR For Slab

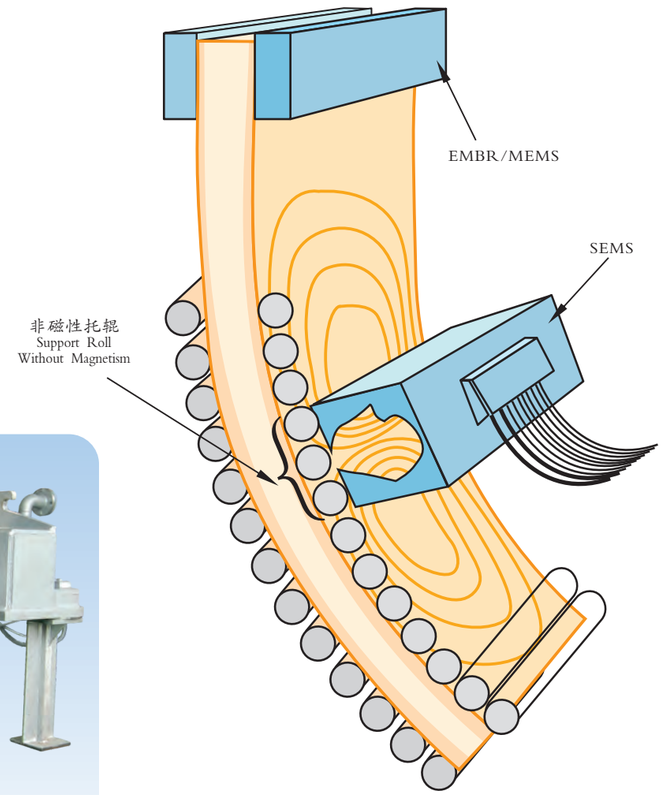
电磁制动：电磁制动可分为EMBR和FC Mold(流动控制结晶器)
EM BRAKE: EMBR and FC Mould

结晶区板坯电磁搅拌：结晶区板坯电磁搅拌可分为内置式电磁搅拌器、外置式电磁搅拌器。
M-EMS: EMS is installed inside or outside the mould

二冷区板坯电磁搅拌：二冷区电磁搅拌可分为辊后式板坯电磁搅拌器、插入式板坯电磁搅拌器和辊式板坯电磁搅拌器三种，二冷区板坯电磁搅拌在国内外连铸设备上使用较为广泛。
S-EMS: there are three modes: behind the rollers; insert the rollers; roller type



结晶区板坯电磁搅拌器
M−EMS for slab



板坯连铸机电搅安装位置示意图
Position of EMS for Slab Caster

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Electromagnetic
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电磁搅拌装置

板坯连铸电磁设备
Eleetromagnetic Equipment for Slab

板坯连铸电磁搅拌产品简介
EMS for Slab

一、结晶区板坯电磁搅拌器 M-EMS for slab

沿板坯宽面配置两台电磁搅拌器，安装于介于弯月面和水口侧孔之间，通以低频三相电源，产生行波磁场。主要应用于低拉速的中厚板连铸。

Two coils shall be installed along width direct between meniscus and side hole of outlet. Fed by triphase power, it will produce traveling wave field. It is mainly used for medium and thick slab with low casting speed

二、二冷区板坯电磁搅拌器 S-EMS for slab

• 辊后式板坯电磁搅拌器： EMS behind the rollers

电磁搅拌器安装在直弧形连铸机内弧侧或内、外弧两侧，安装方便，对连铸机改动少，能快速移动，便于在铸机发生漏钢时快速离开铸机，搅拌频率一般为0.5～5Hz。

EMS is installed behind the rollers, in one side or each side. It needs little change of caster and installation is simple. It can be moved promptly when breakouts happen. Stirring freq: 0.5 ~ 5Hz.

• 插入式板坯电磁搅拌器： EMS inserting the rollers

两台电磁搅拌器相对置于铸机内、外弧侧，电磁搅拌器工作头较窄，能插入特制多分节小支承辊缝隙中充分贴近铸坯，功耗低，效率高，搅拌效果好，搅拌频率一般为6～20Hz。

Two coils are installed in each side of the curve. The head of EMS is small to insert between rollers and be near to slab. Stirring effect is good for its high efficiency and low energy consumption. Stirring freq: 6~ 20Hz.

• 辊式板坯电磁搅拌器： EMS of roller type

电磁搅拌器对置于弧形连铸机内、外弧侧，电磁搅拌器置于支承辊内，采用外水直冷方式；支承辊外壳采用非磁性、高CrNi耐热不锈钢制成。耐磨、耐热性能优良，使用寿命长；安装方便，不受连铸机结构影响，外形尺寸与普通辊完全相同，可以互换。工作面贴近铸坯表面，功耗低，效率高。一般采用2对搅拌辊组合使用，冶金效果更佳，搅拌频率一般为２～５Hz。

EMS shall be made with the same size of the roller, and placed of rollers, installed in each side of the curve. These two couple stirring rollers are of CrNi heat-proof stainless steel. It is simple to install EMS without limit of caster size. Stirring freq is 2 ~ 5Hz

辊后式电磁搅拌器 EMS behind the rollers

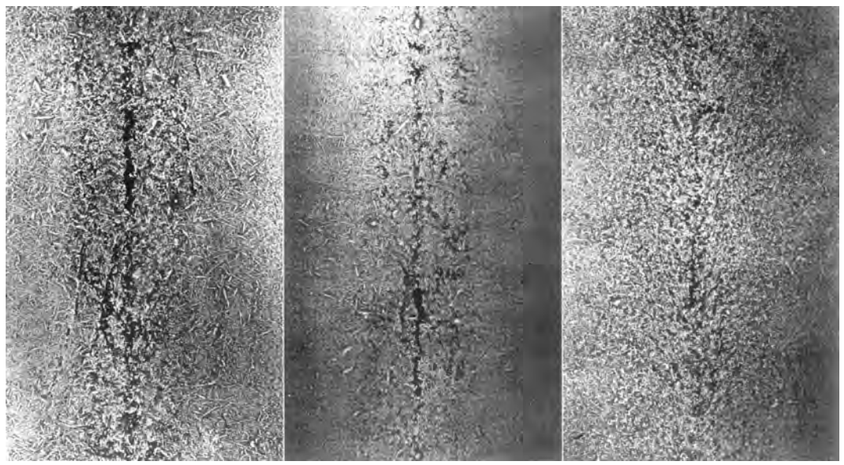
插入式电磁搅拌器 EMS inserting the rollers

辊式电磁搅拌器 EMS of roller type

板坯电磁设备的冶金效果
Metallurgical Effect of EMS/EMBR for Slab

设备名称 NAME	冶金效果 METALLURGICAL EFFECT	主要适应 STEEL GRADES
电磁制动 EMBR	减少铸坯内夹杂物 Reduce slag 改善铸坯内部组织 Improve inner struction 改善结晶器内液面波动 Reduce wave of liquid metal	薄板坯 Thin slab
结晶器电磁搅拌器 MEMS	均匀铸坯表面温度 Make surface temperature of slab symmetrical 降低裂纹、提高表面质量 Reduce cracks & improve surface quality 控制钢液面速度 Control speed of liquid steel	中厚板坯 Medium and thick slab
二冷电磁搅拌器 SEMS	扩大板坯中心等轴晶区 Make equiaxed zone fine 减少中心偏析和中心缩孔 Reduce central porosity and segregation 改善铸坯内部质量 Improve inner quality	中厚板坯 Medium and thick slab

铸坯断面硫印照片
Sulfur Print Photos of Section



无搅拌 Without EMS　　结晶区搅拌 With M-EMS　　结晶区+二冷搅拌 With M+S-EMS

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Electromagnetic Stirring System
电磁搅拌装置

熔炼炉电磁搅拌器
EMS for Melting Furnace

熔炼炉电磁搅拌器简介
EMS for Melting Furnace

一、熔炼炉电磁搅拌器的工作原理　Working Principle

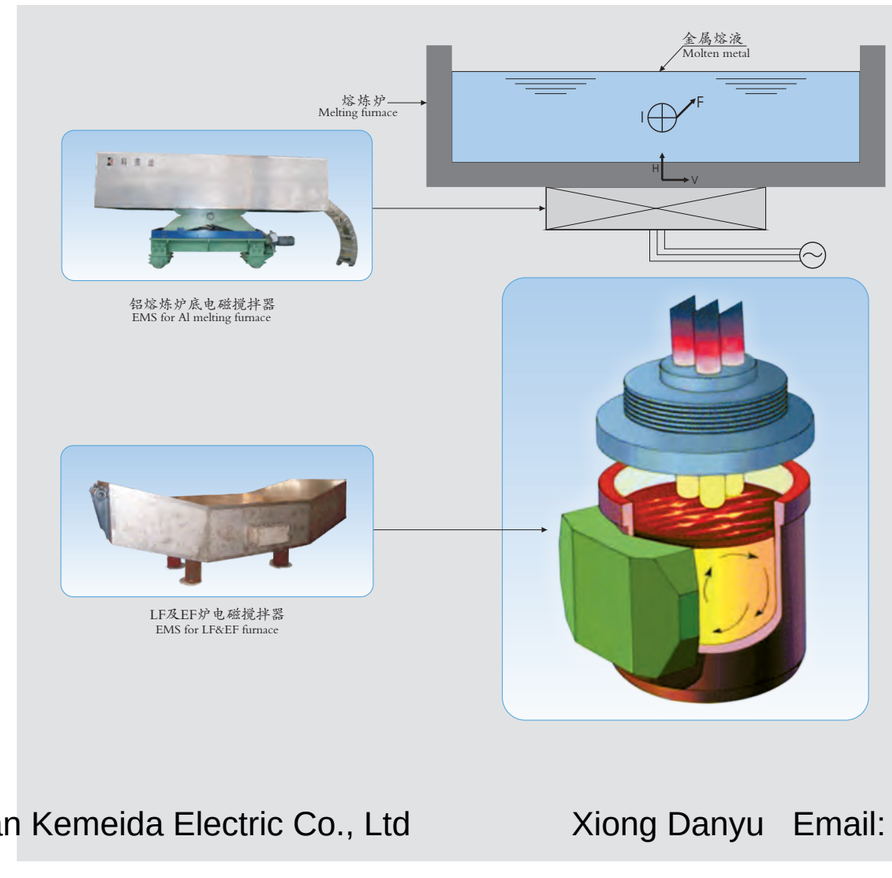
熔炼炉电磁搅拌器应用了直线电机的工作原理，是一种非接触式搅拌装置。在炉底（或炉侧）设置熔炼炉电磁搅拌器，当馈给熔炼炉电磁搅拌器两相（三相）交流电时，就产生行波磁场，由于该磁场的作用，在熔液内.产生感应电动势，从而产生感应电流（遵循右手定则）。该感应电流与当地磁场相互作用在熔液内产生电磁推力，推动熔液作定向运动。

It's a stirring equipment of no-touch type which adopts the principle of linear Motor. When fed two phrases AC power to EMS, it shall produce traveling wave field, which thus produces induced electromotive force and then arises induced current (right-hand rule). Under the mutual function of the current and the field, a magnetic force occurs which shall push molten metal to move.

二、熔炼炉电磁搅拌器的应用　Application

该产品主要安装于熔炼炉底（或炉侧），应用于铝行业的合金铝或高纯铝的配制；应用于钢铁行业的LF及EF炉的配料和温度的均匀化，降低能耗、精确控制熔液的温度。

This kind of EMS is mostly installed under or beside furnace to produce Aluminium or Al alloy. It can be also used in LF or EF furnace to mix ingredients control temperature precisely.



铝熔炼炉底电磁搅拌器
EMS for Al melting furnace

LF及EF炉电磁搅拌器
EMS for LF&EF furnace

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Electromagnetic Stirring System
电磁搅拌装置

电磁搅拌电控系统
Electrical Controller

电磁搅拌电控系统简介
Electrical Controller

本系统利用了现代微电子技术、电力电子技术及计算机技术的一些最新成果，是针对电磁搅拌技术要求和特点自行研发的具有独立知识产权的全新控制系统。本系统采用交—直—交大功率变频电源和大规模集成电路，技术先进，结构简单，其功能和可靠性已达到国际先进水平。我公司现有产品按控制模式可分为两种：一种为以工控机（IPC）为核心的控制系统；一种为以PLC为核心的控制系统。

Control system combine latest micro-electronic and electrical technology, which uses VVVF and large scale integrated circuit (LSI) with compact structure. This technology is advanced in the world.There are two control modes:IPC and PLC.

工控机（IPC）为核心的控制系统主要功能及特点
Features and Functions of IPC Control

1、实时控制和监控均采用最新的嵌入式工业计算机（IPC）。功能强大，运行稳定可靠，人机界面友好。
It uses IPC with high reliability and friendly Human Machine Interface(HMI);

2、系统内含PLC，具有全屏幕PLC梯形图编辑]编译、调试功能。
It uses PLC with ladder diagram. User can adjust it conveniently;

3、控制精度高，电流超调和电流波动均小于2%，频率误差小于0.05Hz。
It has high control precision. Electric overshoot and fluctuation less than 2%. Freq error <0.05Hz

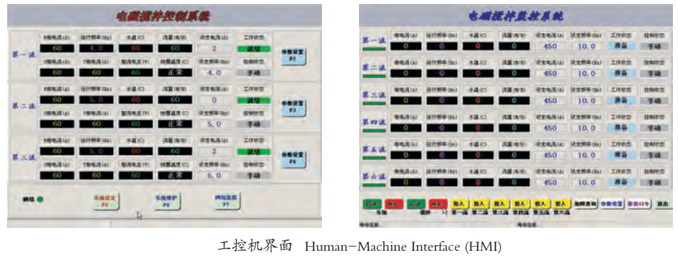
4、能准确而及时地采集和处理现场数据和信息，具有数据库管理功能。
It can select and handle data of site and has database.

5、具有强大的通信功能，能与多种外设进行多样通信。
It have powerful communication function and can communicate with other devices.

6、完善的监控保护体系，以光、声、PLC梯形图和计算文字显示四种方式告知用户。
It has perfect monitoring and alarm function with light, sound or PLC ladder.

7、功率因数0.95以上。
Power factor: more than 0.95.

电磁搅拌变频电源控制柜　Control Cabinet



工控机界面　Human-Machine Interface (HMI)

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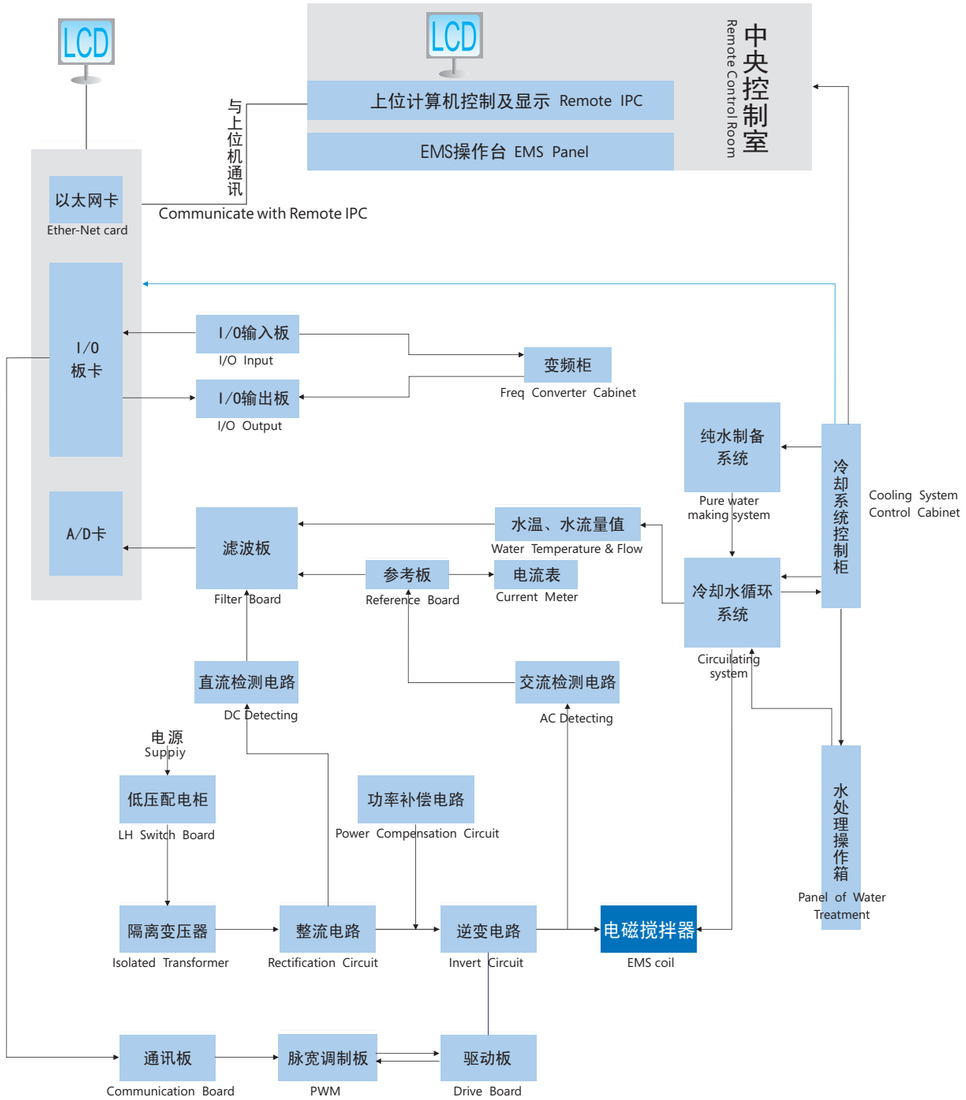
电磁搅拌电控系统
Electrical Controller

工控机（IPC）为核心的控制系统方框图
System Block Diagram Based IPC

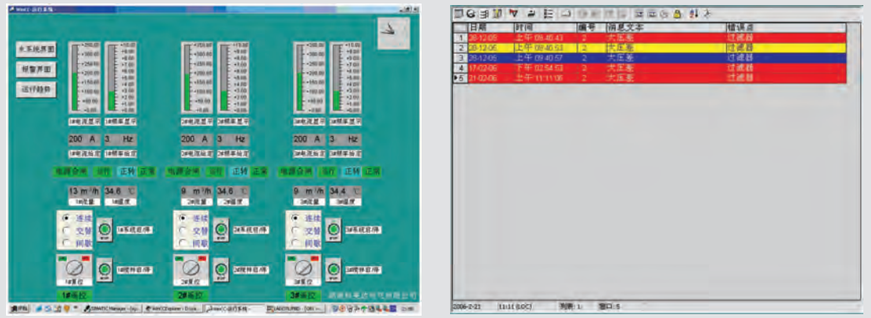


·以PLC为核心的控制系统主要功能及特点　System Feature Based PLC

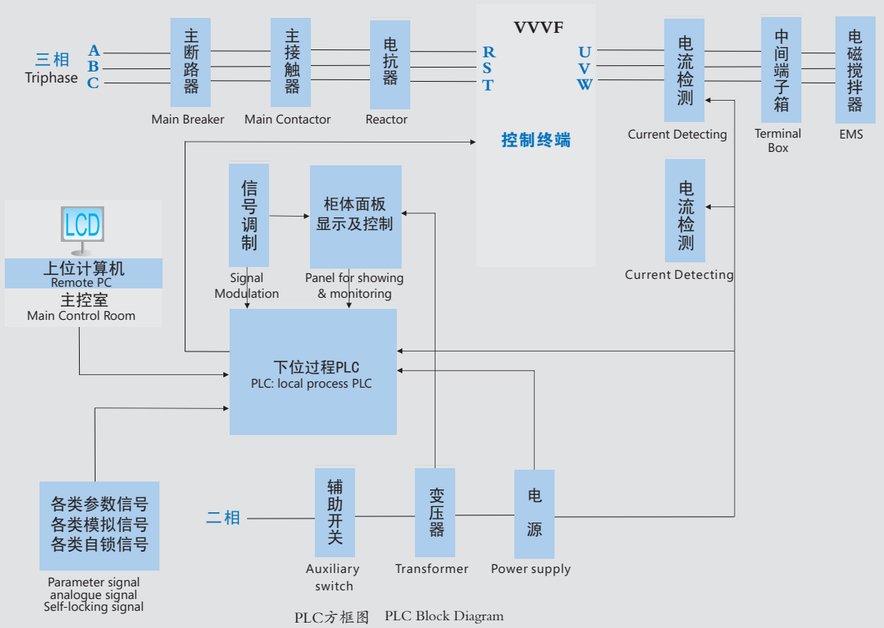
1、实时控制和监控均采用PLC（西门子）。 Instant control or monitor is through PLC (Siemens);

2、监控显示为Wincc。 Monitor shown as Wincc;

3、低频电源采用原装进口变频器，运行可靠。 LH power is of imported frequency inverter which is high reliable.



PLC主界面图　PLC Interface



PLC方框图　PLC Block Diagram

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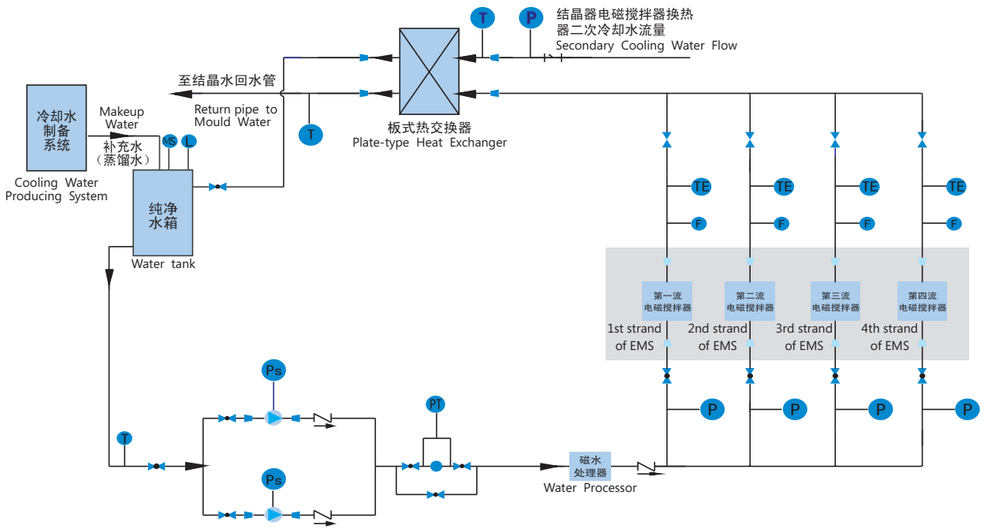
电磁搅拌器冷却水系统
Cooling Water System for EMS

电磁搅拌器冷却水系统由冷却水循环系统和冷却水（纯净水/蒸馏水）制备系统组成。
循环冷却水系统由水泵、板式散热器、磁水处理器、精密过滤器、纯水箱、网管系统、控制仪表、循环水控制系统等组成。
冷却水制备系统由RO程控反渗透机组及自动补水装置组成。

The system consists of cooling loop and cooling water (purified or distilled water) producing system.

Cooling loop consists of Pump, Plate-type radiator, magnetic water processor, fine filter, water tank, pipes, control meters and electrical controller, etc.

Water Producing system consists of RO and makeup water equipments.



冷却水循环系统主机
Main Body of Cooling Water System

磁水处理器
Magnetic Water Processor

电磁搅拌器型号说明
EMS for Model Designation

连铸电磁搅拌器型号说明
EMS for CCM

DJ □ □–□ □ □□

- 冷却形式 CoolingType
  - N–内置式 Internal type
  - NC–纯净水内置式 Internal type with pure water
  - NG–铜管内冷内置式 Internal type with water going through hollow windings
  - W–外置式 External type with pure water
  - WG–铜管内冷外置式 External type with water going through hollow windings
- 铸坯断面尺寸(cm) Cross Section(cm)
  - 圆坯(Round): Φ□
  - 方坯、矩形坯、板坯(Square,Rectangular, Slab): □□
- 电磁搅拌器磁场形态 Magnetic field type
  - R–旋转磁场(Rotary field)
  - T–行波磁场(Traveling field)
- 电磁搅拌器的安装位置 Installation position of EMS
  - M–结晶区(M–EMS)
  - I–结晶器下(I-EMS)
  - S–二冷段(S-EMS)
  - F–凝固末端(F-EMS)
- 电磁搅拌器系列号（EMS)

炉底电磁搅拌器型号说明
EMS for Melting Furnace

DJ □ –□ □

- 电磁搅拌器安装位置 Installation Position of EMS
  - D– 炉底 Under the Furnace
  - Z – 炉侧 Beside the Furnace
- 熔炼炉的容量(T) Capacity of Furnace
- 熔炼炉的种类 Furnace Type
  - L– 熔铝炉 Al melting Furnace
  - G–钢包炉 Ladle Furnace
- 电磁搅拌器系列号 (EMS)

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电磁搅拌器主要技术参数
Data sheet of EMS

型号 Model	安装位置	磁场形式 Magnetic Field	最大搅拌断面 Section (mm²)	容量 Power (kVA)	电流	频率 Freq. (Hz)	最大外形尺寸 (mm)	自重 Weight (Kg)	配套电源设备 Controller	冷却方式 Cooling
DJMR-1313NC	结晶器内 Inside mould	旋转磁场Rotary	130×130	118	300	3-10	440×420	160	DJKX-120KVA	外水直冷 Coil submerged in pure water
DJMR-1515NC		旋转磁场Rotary	150×150	130	300	3-11	Φ580×420	300	DJKX-130KVA	
DJMR-1616NC		旋转磁场Rotary	160×160	135	300	3-12	Φ660×420	320	DJKX-140KVA	
DJMR-2020NC		旋转磁场Rotary	200×200	150	350	3-12	Φ670×420	360	DJKX-150KVA	
DJMR-2222NC		旋转磁场Rotary	220×220	180	400	3-12	Φ680×420	360	DJKX-180KVA	
DJMR-2525NC		旋转磁场Rotary	250×250	220	400	3-12	Φ700×420	400	DJKX-220KVA	
DJMR-3228NC		旋转磁场Rotary	280×320	260	500	2-10	Φ820×420	540	DJKX-260KVA	
DJMR-1313W	结晶器外 Outside mould	旋转磁场Rotary	130×130	260	300	2-10	Φ730×510	630	DJKX-260KVA	
DJMR-1515W		旋转磁场Rotary	150×150	280	500	3-12	Φ830×530	880	DJKX-280KVA	
DJMR-2218W		旋转磁场Rotary	220×180	300	500	2-10	Φ880×480	980	DJKX-300KVA	
DJMR-2424W		旋转磁场Rotary	240×240	320	550	2-10	Φ920×450	850	DJKX-320KVA	
DJMR-3131W		旋转磁场Rotary	310×310	350	600	1-9	Φ1010×560	1200	DJKX-350KVA	
DJMR-3828W		旋转磁场Rotary	380×280	400	360	1-9	Φ1270×580	1800	DJKX-400KVA	
DJMR-2020WG		旋转磁场Rotary	200×200	200	360	2-12	Φ830×350	680	DJKX-200KVA	纯水内冷 pure water going through tubes
DJMR-2222WG		旋转磁场Rotary	220×220	240	360	2-10	Φ900×480	850	DJKX-240KVA	
DJMR-2825WG		旋转磁场Rotary	280×250	260	360	1-9	Φ1120×470	1100	DJKX-260KVA	
DJMR-3828WG		旋转磁场Rotary	380×280	350	500	1-9	Φ1240×500	1600	DJKX-350KVA	
DJST-17025G	二冷区 Strand	行波磁场traveling	1700×250	250×2	680×2	6-20	1610×600×500	1300×2	DJKX-500KVA	
DJST-19025G		行波磁场traveling	1900×250	130×2	700×2	4-10	1610×610×500	1400×2	DJKX-260KVA	
DJST-19030G		行波磁场traveling	1900×300	250×2	700×2	4-12	1610×610×500	1500×2	DJKX-500KVA	
DJST-2828		行波磁场traveling	280×280	430	1000	50	1610×624×563	630	DJKX-430KVA	外水直冷 Coil submerged in pure water
DJST-2020Y		行波磁场traveling	200×200	130	180	50	760×600×340	450	DJKX-130KVA	油-水双冷 oil & water
DJFT-2020Y	凝固末端 Final	组合旋转combi	200×200	150×2	230×2	50	530×520×500	250×2	DJKX-300 KVA	
DJFR-2020		旋转磁场rotary	200×200	260	300	6-12	Φ780×520	680	DJKX-260KVA	纯水内冷 pure water going through tubes
DJFR-2222		旋转磁场rotary	220×220	260	300	6-12	Φ730×550	720	DJKX-260 KVA	
DJFR-2825		旋转磁场rotary	280×250	300	350	6-12	Φ820×550	930	DJKX-300 KVA	

说明：由于各钢厂连铸机具体参数不同，此技术参数表仅供参考。
Note:The sheet of EMS is only for reference because different CCM has different parameters

电磁搅拌器选型指导
Guide to Select EMS

钢种 Steel Grade	浇铸方式 Casting Mode	要求的冶金效果	M-EMS	S-EMS	F-EMS
低碳钢（拉拔用） Low carbon steel	敞开 Open	表面气孔，表面夹杂 Decrease air holes and slag in the surface	+		
代沸腾钢 Rimming Steel	敞开 Open	表面气孔，表面夹杂和皮下气泡 Decrease air holes ,slag in the surface;bubbles in subsurface	++		
冷镦钢 Cold heading steel	浸入 Submerged	皮下夹杂，凝固组织 Decrease inclusion & increase equiaxed zone	++		
中碳钢（光亮棒材） Medium Carbon Steel	敞开/浸入 Open/ Submerged	皮下夹杂，凝固组织 Decrease inclusion & increase equiaxed zone	++	+	
碳素和合金钢（热成型，锻造） Alloy Steel	浸入 Submerged	皮下夹杂，凝固组织 Decrease inclusion & increase equiaxed zone	++	+	
无缝钢管用钢 Steel for seamless pipe	浸入 Submerged	凝固组织 Incresse equiaxed zone	+	+	
弹簧钢 Spring Steel	浸入 Submerged	皮下夹杂，偏析,凝固组织 Decrease inclusion and segregation & increase equiaxed zone	++		
高碳钢（钢线） High Carbon Steel	敞开/浸入 Open/Submerged	碳偏析，皮下纯净度 Decrease segregation	++		+
轮胎缘和子午线用钢Steel for meridian tyre	浸入 Submerged	碳偏析 Decrease segregation	++		++
高碳工具钢 H-Carbon Tool Steel	浸入 Submerged	碳偏析，纯净度凝固组织，中心疏松 Decrease segregation & porosity; increase equiaxed zone	++		++
轴承钢 Bearing Steel	浸入 Submerged	碳偏析，凝固组织，中心疏松 Decrease segregation & porosity; increase equiaxed zone	++		++
铁素体和低合金奥氏体不锈钢 Ferrite&Low alloy austenite steel	浸入 Submerged	凝固组织，中心疏松 Decrease porosity & increase equiaxed zone	++	+	
低碳马氏体不锈钢 L-carbon martenste steel	浸入 Submerged	凝固组织，中心疏松 Decrease porosity & increase equiaxed zone	++		
高碳马氏体和高合金奥氏体不锈钢 L-carbon martensite&high alloy austenite steel	浸入 Submerged	凝固组织，中心疏松，偏析 Decrease inclusion & porosity; increase equiaxed zone	++	+	++

说明：+表示冶金效果一般，++表示冶金效果好。
Note:"+"means good metallurgical effect. "++"means better metallurgical effect.

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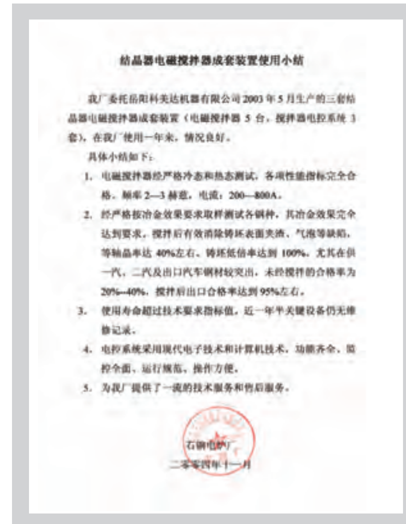
Certificates of Patented Products

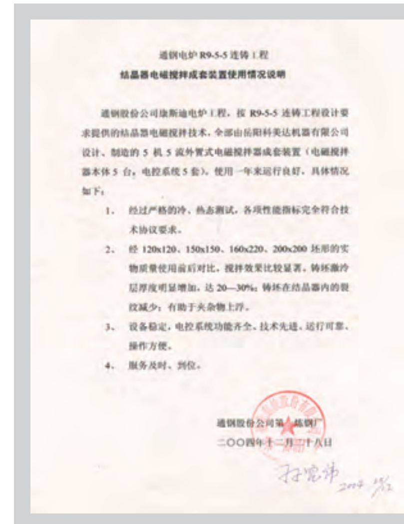
Electromagnetic Stirring System
电磁搅拌装置
KEMEIDA

客户反馈
Customer's Feedbacks


实用新型专利证书

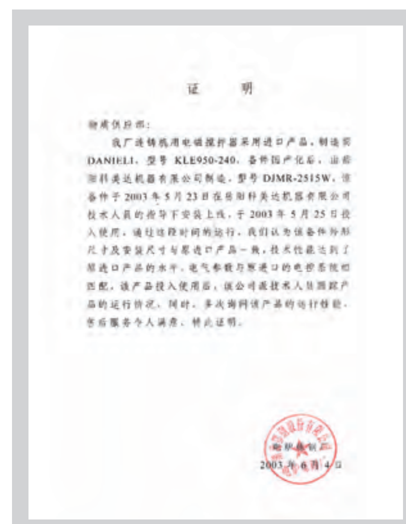

实用新型专利证书


结晶器电磁搅拌器成套装置使用小结




成套电磁搅拌设备使用情况


关于结晶器电磁搅拌器成套设备使用情况说明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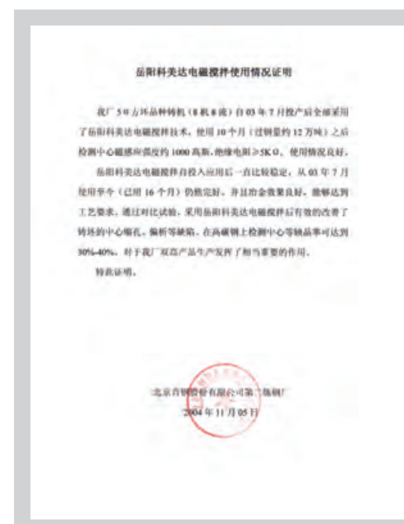

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