

» With the current international/domestic forefront design concept, the preheating furnace completes the design flaws in early stage, meets the special requirements by temperature curve to preheating section and achieves rapid heating evenly, which satisfies the demands by clients.

» Special designed excess heat recycling system is for the exhaust from preheating furnace, and the recycling pipe discharges exhaust to heating zones of dry oven to supplement heating power of temperature zones and save energy.

» The high performance, environment friendly, fire resistant, insulation materials are applied to perform heat isolation. The surface temperature increase of brazing furnace is $\leq 35^{\circ}\text{C}$ to reduce empty loss effectively. The nitrogen purge and curtain design is reasonable with dedicate fabrication to lower nitrogen consumption, therefore the equipment is power saving and the operation cost is cut as well.

The temperature control accuracy is $\leq \pm 0.2^{\circ}\text{C}$ and the temperature uniformity in brazing zone $\leq \pm 3^{\circ}\text{C}$ at $(550^{\circ}\text{C} \sim 650^{\circ}\text{C})$ contributed by deliberate heat zoning, very accuracy meters, hardware applied, software adjustment as well.

The cooling capacity in each section of the chamber will be provided by cooperation of blow & exhaust fans that are low noise, less vibration. The cooling chamber is designed to maximize comfortable, cleanness of operators' environment.

The work of the motor is controlled by frequency inverters to stably transport workpiece and running time in each heating zone as well, the accurate heating curve of aluminum brazing can be achieved.

» The on-line monitoring system of high accurate oxygen meter is installed to monitor and measure inside atmosphere in real time.

The advanced and complete control system is incorporated to realize integration, intelligence management. The control, alarm, protection system, etc., ensures safety operation of production line.

脱脂炉

Debinding Furnace

脱脂炉采用电或天然气加热。芯体被搅拌机循环热风持续穿透去脱去油脂；在这一过程中，芯体上附带的润滑油被蒸发完并通入到焚烧炉中燃烧。在炉内网带有有效宽度范围内，炉温均匀度保持在 $\pm 10^{\circ}\text{C}$ 以内，脱脂炉温度控制通过PID调节。脱脂炉的工作温度 120°C 到 240°C 之间，最高温度不能超过 350°C ，标准的工作温度为 220°C 。

脱脂炉设计为多个相对独立的温区。热气流向为自下而上垂直穿透网带和芯体及工装夹具。热空气的流速足够快以保证快速加热芯体以期达到规定的工艺要求，网带上的风速不低于 4m/s 。芯体温度超过 160°C 的时间最小为3min。

在脱脂炉的入口及出口安装有幕帘，用以实现内外气流的平衡。幕帘材料为聚酯纤维，宽度为 200mm 。在脱脂炉的入口及出口设计有集烟罩、排气管道，用以产生 1m/s 流速的吸入气流。保证不会有烟气/一氧化碳排放到厂房内。

The degreasing furnace is heated by natural gas or electricity. The oil on the core will be removed by stir fan through circulating hot air. During this process, the lubricating oil will be evaporated, then burning in the incinerator. The temperature control of this furnace is adjusted by PID. Within the width of mesh-belt, the temperature uniformity will be within $\pm 10^{\circ}\text{C}$. The working temperature is from 120°C to 240°C and the highest temperature is no more than 350°C . The standard operating temperature is 220°C .



The furnace is designed with several independent temperature zones. The hot air flow through belt, core and fixture vertically from top to bottom. The air speed fast enough to ensure the core can be heated rapidly and meet process requirement. The speed is not lower than 4m/s . For the core temperature, it will need 3min at least to reach more than 160°C .

There are curtains installed in inlet and outlet of this furnace to meet the air flow balance. The curtains are made of polyester with the width of 200mm . The smoke collecting cover and exhaust pipe designed in the inlet and outlet are to produce inhaled air with a speed of 1m/s , which can guarantee no smoke/CO emissions to the factory.

焚烧室

Combustion chamber



焚烧室的燃烧室材料为耐热钢310S。焚烧室的最高运行温度是 900°C 。炉温均匀度保持在 $\pm 20^{\circ}\text{C}$ 以内，焚烧室温度控制通过PID调节。焚烧炉系统最终排出的气体温度低于 300°C 。焚烧室马弗内设计有螺旋叶片，用以实现至少一秒钟的停留时间和95%的裂解效率。

脱脂炉排出的油气在进入焚烧炉的焚烧室燃烧排空之前，必须经过此热交换器进行热交换，焚烧炉热交换器热交换后出口排出的气体温度不低于 400°C 。热回收效率达50%以上。

The material of combustion chamber is heat resisting 310S steel and the highest working temperature is 900°C . The temperature uniformity is within $\pm 20^{\circ}\text{C}$. The temperature control is adjusted by PID and the final exhaust gas is below 300°C . The screw blades are designed in the muffle to achieve dwell time (1s at least) and 95% splitting efficiency.

Before entering the combustion chamber, the exhaust gas from degreasing furnace must be transferred by heat exchanger, and the temperature of exhaust gas after heat exchange is not lower than 400°C . The heat efficiency is more than 50%.

喷淋室 Spray chamber



整个喷淋室为“犀牛”室造型结构。

喷淋室设计有多扇窗，两侧均匀布置，用以观察不同功能区的内部情况。设备运行后，观察窗会被钎剂粉末附着，影响观察效果，基于此，每扇窗均设计有去离子水手动清洗功能以及观察窗照明功能。

喷淋室底部由多块大倾角钢板拼接而成，底部最低处的钢板上布满过滤孔，在方便清洗的同时，可有效防止异物掉落影响系统的正常使用。在喷淋室的底部，设计有钎剂悬浮液高液位报警装置，如果底部的悬浮液超过200L则产生报警，同时供料泵停止。

喷淋室钎剂回流彻底。基于其结构内部本身无死角，在喷淋过程中，钎剂气雾不易附着在死角处，不会堆积，容易清理；若回流不彻底将会造成大量钎剂在此沉淀，从而影响了钎剂的浓度，致使不合格品产生而未得到任何报警。现新“犀牛”式圆筒式结构回流效果极佳。

喷淋室的入口和出口都安装有排风管道。在排风风机之前安装的有水雾分离室。排风风机的机架和叶片采用304不锈钢。排风机设计确保喷淋室内部的粉、雾不会溢出。

顶部与喷淋室脱离的钢平台上放置有多台高压离心风机及排粉风机，由于满足了风刀口要求的风速，风机自身的噪音已不能满足工况要求，所以采取了在钢平台周围设计隔音箱，用以实现整体噪音分贝值不超过85分贝的承诺。

The whole spray chamber is designed in a shape of "Rhino".

Several windows are setting on both sides to observe the working status in different zones. Since the fluxes power will adhere to the window and influence the effect, each window is designed with manual cleaning and lighting function.

The bottom of spray chamber is spliced by some steel plates with large angle. There are filter holes on the lowest plate to facilitate cleaning and prevent troubles caused by fallen foreign objects. Also, there is alarming device for fluxes suspension level. When the suspension level on the bottom is over 200L, the device will give a warning and the pump will stop feeding.

The backflow of fluxes is completely in the chamber. Since there is no dead angle inside, it is difficult for flux spray adhere and easy to clean. Once the backflow is not thorough, there will be a lot of fluxes sediment and affect the flux concentration, in addition, there will be no warning for unqualified products. The backflow effects of this new type of "rhino" is excellent.

The exhaust duct is installed in the inlet and outlet of spray chamber. There is separation chamber for water mist before exhaust fan. The rack and blades of exhaust fans is 304 stainless steel. This design ensures the power and spray will not overflow.

There are several high-pressure centrifugal fans and exhausters on the top and steel platform. Since the wind speed requirements for blade mouth and the noise of fans cannot be satisfied at the same time, soundproof boxes are designed around the steel platform to ensure the noise no more than 85db.

烘干炉系统 Dry oven system



烘干炉采用天然气加热。来自钎剂喷淋室的湿芯体将会在烘干炉中完全蒸发掉水分。在网带范围内，炉温均匀度保持在 $\pm 10^{\circ}\text{C}$ 以内，烘干炉温度控制通过PID调节。烘干炉自 150°C 到 350°C 的升温时间的最大值为20min，包括利用预热炉的余热。

烘干炉设计为多个相对独立的温区。热气流向为自下而上垂直穿透网带和芯体及工装夹具。热空气的流速足够快以保证快速加热芯体以期达到规定的工艺要求，网带上的风速不低于 4m/s 。芯体温度超过 200°C 的时间最小为5min。

在烘干炉的入口及出口安装有幕帘，用以实现内外气流的平衡。幕帘材料为聚酯纤维，宽度为200mm。预热炉中的热量回收至烘干炉中，在烘干炉的入口及出口设计有集烟罩、排气管道，用以产生 1m/s 流速的吸入气流。保证不会有烟气/一氧化碳排放到厂房内。

在易形成残渣的第一温区的两侧设置有清渣口。

The dry oven is heated by natural gas. The wet core from spray chamber will evaporate moisture completely in the dry oven. The temperature control is adjusted by PID. Within the width of mesh-belt, the temperature uniformity will be within $\pm 10^{\circ}\text{C}$. The maximum time for heating up from 150°C to 350°C is 20min, including excess heat from preheating furnace.

The dry oven is designed with several independent temperature zones. The hot air flow through belt, core and fixture vertically from top to bottom. The air speed fast enough to ensure the core can be heated rapidly and meet process requirement. The speed is not lower than 4m/s . For core temperature, it will need 5min at least to reach more than 200°C .

There are curtains installed in inlet and outlet of the dry oven to meet the air flow balance. The curtains are made of polyester with the width of 5mm. The smoke collecting cover and exhaust pipe designed in inlet and outlet of dry oven are to produce inhaled air with a speed of 1m/s when heating from preheating oven is recycled to the dry oven, which can guarantee no smoke/CO emissions to the factory.

There is residue mouth on both sides of the first temperature zone.

预热室

Preheating chamber

与前幕帘室相连的预热炉，采用天然气加热。每一区安装有4个烧嘴，烧嘴的运行分为四个大火，两个大火两个小火交替，四个小火，两个小火（对角线位置）两个关，四个全关交替进行。

在整个网带宽度范围内，炉温均匀度控制在 $\pm 5^{\circ}\text{C}$ 之内（以运动工件同一截面上测量为准），多层焊接时芯体中心的温度偏差在 $\pm 2^{\circ}\text{C}$ 之内。为了达到预期的炉温均匀度，每个预热区均需安装一台搅拌循环风机。搅拌风机需要配置日本NSK耐高温轴承，并采用氮气对其冷却。

预热炉马弗底部的清理方便进行，对于底部的钎焊沉淀物，可通过移出用于支撑网带的鱼骨状不锈钢条孔板。精细计算后加工的条孔板与马弗内导流板相应配合，性能卓越的搅拌风机提供所需动能，以其实有效宽度网带上2m/s的风速要求。

炉壳用型钢框架及折弯钢板焊接而成。炉顶为可拆卸结构，与侧壁用螺栓连接。两侧设有烧嘴安全防护栏，以防止人员触电造成危险并可保护燃气系统。炉底矩形管钢梁支撑马弗，侧壁、底部采用高铝砖砌筑，炉顶预制“派罗块”保温棉结构并背覆耐热钢板。炉膛内满足烧嘴火焰流速70m/s的极限要求。

预热炉温度控制通过PID调节。马弗采用厚度为6mm的316L不锈钢制作。焊缝要求尽可能少。马弗底部采用波浪底设计。马弗内部净宽要比网带大100mm以上，这样可以避免在任何情况下金属网带与马弗侧壁摩擦。

The preheating furnace is connected to the inlet curtain box and heated by natural gas. There are 4 nozzles in each zone, which is operated in four big fire, two big fire and two small fire alternation, four small fire, two small fire(in diagonal position) and two off, four off.

Within the width of whole belt, the furnace temperature uniformity will be within $\pm 5^{\circ}\text{C}$ (Based on the same section of moving workpieces). The temperature divation of core will be within $\pm 2^{\circ}\text{C}$ while multi-layer brazing. A stir circulation fan is needed in each preheating zone to ensure the temperature uniformity. In addition, the fan is equipped with heat resistant bearings of NSK.Japan and cooled by nitrogen.

The precipitate on the bottom of muffle can be easily cleaned by removing fish-bone type stainless steel orifice plate which is used for supporting belt. The coordination of orifice plate and air deflector and the power provided by stir fans, the wind speed on belt can reach to 2m/s.

The furnace shell is welded by profiled steel and bending steel panel. It can be removed from top and is connected with side wall by bolts. There are nozzle safety barrier on both side to prevent any electric risk to operators. The steel beams are laid on bottom to support muffle. The high-alumina bricks are designed on side walls and bottom of furnace. The cotton insulation structure with heat resisting steel plates is designed on the top. Then the nozzle flame rate can reach to 70m/s.

The temperature control of preheat furnace can be adjusted by PID. The muffle adopts 316L stainless steel with the thickness of 6mm and the bottom adopts wavy design. The net width of muffle is 100mm bigger than mesh-belt, in this way, the friction between belt and muffle in any condition can be avoided.



钎焊室

Brazing chamber



插入式加热元件分布在多个加热区对钎焊室进行电加热，将工件加热到钎焊温度。对于不同工件和不同的加热速率，各加热区的输入功率具有较大的灵活性。单独的SCR（调功器）用于平衡每一钎焊区的热量需求。在整个网带宽度范围内，炉温均匀度在 $\pm 3^{\circ}\text{C}$ 之内（以运动工件同一截面上测量为准）。

炉壳用型钢框架及折弯钢板焊接而成。炉顶为可拆卸结构，与侧壁用螺栓连接。两侧设有罩板，以防止人员触及加热元件接线头造成危险。炉底矩形管钢梁支撑马弗，侧壁、炉顶预制折叠保温棉结构。耐火保温层具有极好的隔热能力和低积蓄热能力，减少了炉子的热量损失，降低了炉子的表面温升，为客户节约能源。

钎焊炉温度控制通过PID调节。马弗采用厚度为6mm的316L不锈钢制作。焊缝的最大数量为两条。马弗底部采用波浪底设计。马弗内部净宽要比网带大100mm以上，这样可以避免在任何情况下金属网带与马弗侧壁摩擦。



The inserted heating elements are arranged in multiple zones to heat up workpiece to brazing temperature. It is flexibly designed the heating speed as per different workpiece and process requirement. The individual SCR is used to balance heating demand in each zone. Within the range of whole belt width, the furnace temperature uniformity will be within $\pm 3^{\circ}\text{C}$ (Based on the measurement on the same section of moving workpieces).

The furnace shell is welded by profiled steel and bending steel panel. It can be removed from top and is connected with side wall by bolts. There are shield panels on both side to prevent any electric risk to operators. The fire resistant/insulation brick are laid on bottom to support muffle. The prefabricated insulation wool blocks are designed on side walls and top of furnace. The insulation can minimize heat loss, surface heat-up by insulation and low heat regeneration capability. The energy can be saved accordingly.

The temperature control of furnace can be adjusted by PID. The muffle adopts 316L stainless steel with the thickness of 6mm and the bottom adopts wavy design. There are 2 welding lines at the most. The net width of muffle is 100mm bigger than mesh-belt, in this way, the friction between belt and muffle in any condition can be avoided.

马弗泄露检查

Leak check for muffle

对于整套系统中，以上所列马弗的气密性泄露检查必须在出厂前的制造现场严格执行。所用检漏方法为下列的其中一种或多种组合同时采用，甚至全部采用，直至客户认可结果。

For the whole system, the air tightness leak check of above muffles must be implemented strictly in the manufacturing site before leaving factory. The following leakage detection methods can be adopted for one or more, even all to meet the requirements by clients.

- » 气泡法—通过压缩空气注入到密闭的马弗内，焊缝处刷涂玻璃水观察并保压
- » 氦检法—通过浓度超过10%的氦气注入到密闭的马弗内，使用Agilent (PHD-4) 氦检漏仪检测
- » 渗透法—将焊缝能够作为检查的一面清理干净，涂上白浆粉，待晾干后在焊缝的背面涂以有高渗透性的煤油，使表面足够浸润后，经半小时渗透，视已涂有白浆粉的地方有无被浸润了的油渍。无油渍为合格，有油渍时应进一步查明渗漏通道并进行处理。
- » 着色法—清理焊缝、预清洗（清洗剂）、渗透（渗透剂）、去除、显像（显像剂）、观察、评定。

» For the whole system, the air tightness leak check of above muffles must be implemented strictly in the manufacturing site before leaving factory. The following leakage detection methods can be adopted for one or more, even all to meet the requirements by clients.

- » Bubble method -- put the compressed air into the airtight muffle and spray glassy water in the seam, then observe and keep pressure.
- » Helium testing—put helium with the concentration over 10% into the airtight muffle and do the test by helium leak detector of Agilent (PHD-4) .
- » Penetration—Clean the surface of welding line, and brush pulp power on it. After the white pulp power dried, brush high permeability kerosene on the back of welding line and guarantee the surface is fully infiltrated. Half an hour later, you can observe if there is infiltrated oil stain. If yes, find out the leakage channel and make further processing; if not, the muffle will be proved to be qualified.
- » Colouring— clean welding line 、precleaning (cleaning agent) 、penetrate (penetrant)、remove、(imaging agent)、observe、

氮气系统

Nitrogen system

整个氮气系统自成一体系，配置有电接点压力表监控供气压力，压力过低即会报警。通过先导活塞式减压阀来实现压力恒稳控制。各系统气氛供应可独立控制，通过设定相应不同的温度可以开启和关闭管道电磁阀，在主管道电磁阀旁路上设置手阀，以做电磁阀故障时备用。一台总流量计能够显示工况流量、标况流量、累积流量、温度、压力等参数，实现远程通讯。在不同的需求部位均设置有单独的流量计，满足不同部位的相应需求。

The nitrogen system stands by itself and is equipped with pressure meter. When pressure is lower, the pressure meter will give a warning. The steady control of pressure can be achieved by piston reducing valve. There is hand valve beside solenoid valve in case of any failures. The parameters can be displayed on the total flow meter, such as working condition, accumulated flow, temperature, pressure etc. Also, there is an individual flow meter installed in different parts to meet different needs.



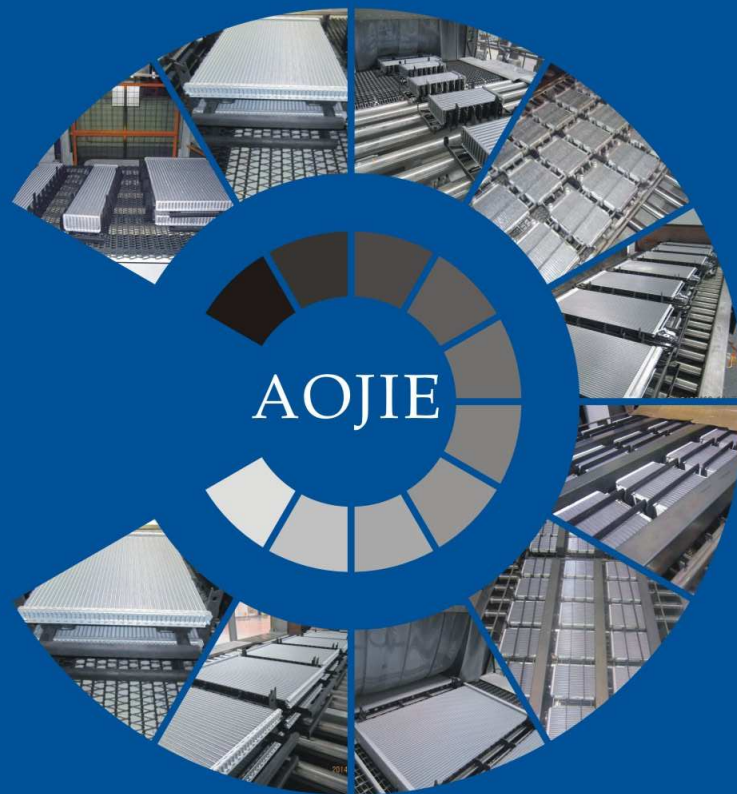
控制系统 Control system

控制系统由配电系统, PLC控制系统、变频控制系统、加热控制系统和上位机组态系统组成。本系统具有实时控制、测量、采集、显示等功能。通过人机界面可对设备进行操作控制并通过计算机面板上的相应功能按键, 即可实现对系统的控制操作、参数设定修改、状态查询记录、报警查看定位等功能, 实时的监视铝钎焊生产线的运行情况。

The control system consists of power distribution, PLC, frequency conversion, heating and upper computer with functions of control, measure, acquire, display. There is HMI to control equipment operation and the function keys on computer panel, such as control operation, parameter setting/amending, alarm etc., to monitor aluminum brazing production line timely.



典型产品 Typical products



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