

Research and Application of Intelligent Control Systems for Vacuum Induction Suspension Furnace

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Abstract: Vacuum induction furnaces mainly is the production of high entropy alloys, high temperature alloys, titanium alloy vacuum smelting equipment high-quality special alloy materials, the vacuum smelting process is realized by using PLC and touch screen the design of the automatic monitoring and control, between the various components of the automatic implementation logic, booster pump, the oil temperature control, and security monitoring, under the premise that meet the requirements of production technology, make the system to achieve the optimal state of control, system maintenance, easy to use, safe, stable and accurate operation, automatic monitoring system for safety production and improve product quality play an important role.

Keywords: vacuum induction furnace; interval temperature; PLC

1 Introduction

Since the 1960s, vacuum induction melting technology has been rapidly developed in China. A vacuum induction suspension furnace is an important vacuum smelting equipment for the production of high entropy alloy, high temperature alloy, titanium alloy and other high quality alloys, precision alloy, ultra-high strength steel and special steel^[1].

A vacuum induction suspension furnace is developed on the basis of an ordinary vacuum induction furnace, with the purpose of melting higher-quality alloy materials. Under vacuum conditions, the vacuum induction suspension furnace uses alternating current to act on the induction coil to generate an alternating magnetic field, and the alternating magnetic field induces alternating current - "eddy current" on the charge, and the charge is heated and melted by "eddy current", thus melting metal ^[2]. Compared with other types of electric furnaces, the functions and system components of each part of the intelligent control system of a vacuum suspension furnace are analyzed.

The PLC control system is the core part of the whole vacuum furnace control, other functions must be calculated by PLC, command control, PLC selected Siemens S7-300, this component belongs to the more advanced products of similar components, with no pollution, fast computing speed, high precision, strong anti-interference ability, highcost performance advantages. The touch screen is the main operation panel in the automatic control of the vacuum furnace, which is the function of controlling the operation of each valve, displaying the value, recording the curve, displaying the alarm and so on. The function of the encoder is to measure the rotation Angle of the furnace body, and the pulse sent by the encoder is converted into the corresponding furnace body Angle after PLC collection and calculation. The sensor includes temperature, pressure, and flow detection, and all analog and switching quantities are collected and controlled by PLC in real-time.

2 Realization method of intelligent control system of vacuum induction suspension furnace

The vacuum induction suspension furnace smelting starts from the melting of solid raw materials or scrap steel and goes through four stages: melting period, refining period, alloying period and pouring. The whole process is completed in the vacuum chamber, and the process is highly compact and concentrated. The software for programming and application is STEP7-V5.5 and MCGS-7.2. Among them, STEP7-V5.5 is to realize the data acquisition and control function of the PLC of the lower computer, and MCGS-7.2 is the upper configuration interface, which is to realize the upper configuration and data display and operation control function. As shown in Figure 1, this is the touch screen operation interface of the whole vacuum furnace, including the main charging chamber, vacuum chamber, pump control and valve control. The operation interface and the physical object correspond to a clear layout, easy to use, safe and reliable.



Figure 1 Intelligent operation interface of vacuum induction suspension furnace

Figure 2 shows recording historical data, statistical reports, and saving data to facilitate users to query historical



data records. In addition, the most important is that you can use the U disk operation, U disk to check the touch screen in the start time and end time box to enter the period, automatically all records during this period in the form of an Excel spreadsheet exported to the U disk, convenient for leaders to view and test.

	mcgs-time		Electroplate		er	Molten steel temperature		e Vacuum degre
1	2018-04-19 09:57:20	0.00	Kwh	0.00	Kw	0.00	Ċ	0.00
2	2018-04-19 09:57:30	0.00	Kwh	0.00	Kw	0.00	С	0.00
3	2018-04-19 09:57:40	0.00	Kwh	0.00	Kw	0.00	C	-2.33
4	2018-04-19 09:57:50	0.00	Kwh	0.00	Kw	0.00	C	234543.55
5	2018-04-19 09:58:00	0.00	Kwh	0.00	K#	0.00	С	234543.55
6	2018-04-19 10:02:21	0.00	Kwh	0.00	Kw	0.00	C	0.00
7	2018-04-19 10:02:31	0.00	Kwh	0.00	Kw	0.00	С	1000000000.00
8	2018-04-19 10:02:41	0.00	Keth	0.00	Kw	0.00	С	1000000000.00
9	2018-04-19 10:02:51	0.00	Kwh	0.00	Kw	0.00	С	3553554432.00
10	2018-04-19 10:03:01	0.00	Kwh	0.00	Kw	0.00	C	1000000000.00
11	2018-04-19 10:03:11	0.00	Køh	0.00	Kw	0.00	C	1000000000.00
12	2018-04-19 10:03:21	0.00	Kwh	0.00	Kw	0.00	č	34344.00
13	2018-04-19 10:03:31	0.00	Kwh	0.00	K#	0.00	С	-244344.00
14	2018-04-19 10:03:41	0.00	Kwh	0.00	K#	0.00	С	-244344.00
15	2018-04-19 10:03:51	0.00	Kwh	0.00	Kw	0.00	С	-244344.00
	Start time		End time			Dat	a expo	ort

Figure 2 Data saving and exporting

3 Field application of vacuum induction suspension furnace

Figure 3 shows the overall structure and the included parts of the vacuum induction suspension furnace. The charging chamber is the function of adding alloy ingredients and thermocouple temperature detection. The vacuum melting chamber contains an induction ring for melting molten steel and melting molten steel in a suspended vacuum state. After the molten steel composition is qualified, the ingot mold is put into the pouring position in the ingot mold chamber for pouring, and the whole process is completed in the vacuum state. The lid has a viewing window and infrared temperature measurement. There is a regulating valve at the side of the furnace to fill the furnace with an argon gas channel. The whole system has a gas path system and a water system. The water system is to cool the furnace body and the medium-frequency induction power supply, and the gas path system is to control the switch of each valve.



Figure 3 Vacuum suspension melting field practical application

4 Conclusion

As a kind of special metallurgical equipment, the safety and intelligence of vacuum induction melting furnaces are more and more important in their design and manufacturing process. Aiming at the application of an automatic monitoring system for vacuum induction furnaces, this paper adopts self-programmed control software to realize automatic monitoring function, improves the control method of vacuum furnaces, and solves the trouble of manual operation and manual writing records. By analyzing the characteristics and application scope of the design idea, the reliability and authenticity of the records are increased. Because PLC and touch screen man-machine interface are used in the system design, the control is more simple, convenient, safe and reliable.

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