

# Development Trend Analysis of High Purity Vacuum Suspension Melting Casting Equipment

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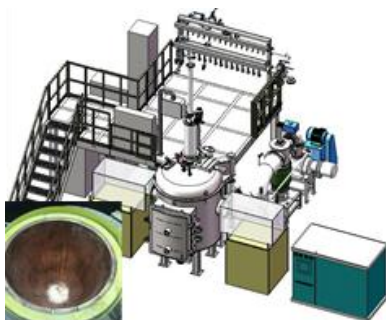
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**Abstract:** Aiming at the common problems of high temperature, high purity and refractory alloy materials, which are needed for the development of aviation, aerospace and other future Strategic Emerging industries, the high purity vacuum melting casting technology is put forward. The advantages of vacuum induction suspension melting casting equipment in preparing new materials in high purity vacuum melting casting technology and the development direction of equipment, process and technology are introduced. By analyzing the problems facing the current application market, the development direction of vacuum induction suspension melting equipment in the future is pointed out.

**Keywords:** high purity vacuum casting technology; floating melting; auto-control

## 1 Introduction

Materials are the material basis for developing the national economy and people's livelihood, strengthening the modernization of national defense, and improving the country's overall industrial strength. Before forming high-quality alloy materials, melting is the most important link, and the pollution problem in the melting process is almost a common problem faced by hot processing enterprises. With the introduction of the concept of high purity vacuum casting technology, the casting of many high temperature, high purity and refractory alloy materials has become a reality.



**Figure 1** Suspension melting equipment and water-cooled copper crucible diagram

In the high purity vacuum melting casting technology, the vacuum induction suspension melting casting technology is a special metallurgical process which combines the high

frequency and high power induction heating method with the slit water-cooled copper crucible to melt the alloy, and is the most ideal melting casting technology for high temperature, high purity and refractory alloy. The technology uses the water-cooled copper crucible as the carrier of the alloy material to completely eliminate the pollution of the alloy material in the melting process. The melt is stirred during the heating process to obtain a uniform superheat and chemical composition.

## 2 The development status of equipment, technology and technology

### Composition and shortcomings of suspension melting equipment

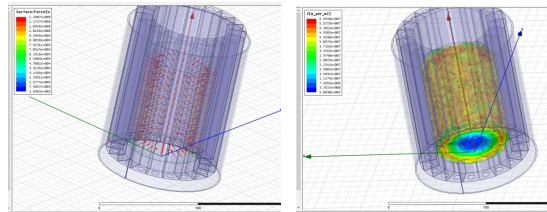
Vacuum induction suspension melting casting equipment is mainly composed of vacuum system, water cooling system, control system, induction melting system and water-cooled copper crucible, among which induction melting system and water-cooled copper crucible are the most critical components. However, with the continuous increase of the capacity of water-cooled copper crucible, it is difficult to promote industry due to the limitation of high-power and high-frequency induction power supply. Only suitable for scientific research institute laboratories, in recent years, the United States, Germany, Russia and other developed countries to promote cold crucible induction melting process, has a certain scale of cold crucible melting capacity has reached 100 kilograms.

### Research direction of large-scale special suspension melting equipment

Because the advantages of suspension melting equipment are very obvious, the suspension effect and alloy melting capacity have become the most concerned development direction. At present, the suspension effect is mainly optimized by improving the structural design of the crucible, changing the magnetic field frequency and magnetic field distribution state. We can find an optimal structural design and magnetic field distribution state through software simulation.

The melting capacity is 80 kg at home and 100 kg at abroad. With the diversification of functions and the innovative design of the structure, the maximum capacity can be more than 200 kilograms through multi-power joint casting, which truly meets the needs of actual production. Under the premise of realizing the diversity of functions, the interference problem between induction power supplies

is brought. Through the simulation and optimization of the magnetic field of the power supply under different layouts, the interference problem between induction power supplies is reduced, and the functional requirements of large capacity are met.



**Figure 2 Magnetic field state simulation**

### Development direction of suspension melting process

Suspension melting in the realization of pure melting, casting functions at the same time, the types of melting alloys are increasing, including: titanium aluminum alloy, aluminum-scandium alloy, high entropy alloy, tungsten alloy, amorphous alloy and many functional materials and so on. Equipment functions are also increasing, including: suspension ingot, suspension centrifugation, suspension continuous casting, etc., the increasing function represents the continuous improvement and innovation of the casting process. This requires engineers to understand the entire casting process and casting equipment, and realize the entire process through equipment.

### 3 Analysis of future development trend of suspension melting

#### Functionality tends towards modularity

In the future, it is necessary to consider the establishment of independent modules for different functions to facilitate the iteration of individual functional modules. Customized equipment functions according to process requirements. For example, real-time on-line monitoring of casting alloy temperature is realized by adding temperature measurement module; Equipped with a centrifugal module, it is possible to centrifuge castings that require specific centrifugal casting functions, and the centrifugal speed can be set according to the process requirements to optimize the performance of the alloy. In the future, the suspension melting equipment will meet the needs of the actual process through the combination of different modules, and prepare materials with better performance.

#### The system tends towards intelligence

The control system of suspension melting equipment is gradually developing in the direction of intelligence, to solve the problem that the system can complete the complex system according to the set procedure in the case of no intervention. At present, most equipment is still in the state of manual adjustment, manual observation and human

intervention when melting alloy materials. With the advent of the era of big data, it is entirely possible to combine the advantages of PLC and industrial computers to form an industrial Internet platform, through data accumulation, analysis, optimization, to develop the optimal process curve, to avoid human intervention caused by misoperation and uncertainty and other problems.

#### More diversified types and processes of melting alloys

The melting process generally refers to the process of melting alloy materials at high temperatures and casting. With the continuous increase of the types of smelting alloys, the casting process is constantly changing, and the process needs to be continuously refined and improved. Different melting processes will directly affect the performance of the final product, melting process will produce a lot of information, including power real-time parameters, electromagnetic field, charge, crucible, water temperature, water pressure and physical properties of alloy materials, casting process will also produce a lot of information, including casting materials, preheating temperature, whether centrifugal, casting speed and so on. Therefore, it is necessary to develop different melting casting processes according to different materials and different casting processes, to form a specific process route, to reduce human intervention in the melting casting process, so as to obtain more excellent alloy materials.

### 4 Conclusion

With the increasing requirements for cutting-edge alloy materials in national defense and military industry, high purity vacuum melting casting technology has become the most important process technology to meet the requirements, and the emergence of vacuum suspension melting equipment has promoted the development of high purity vacuum melting casting technology in the preparation of high temperature, high purity, refractory alloy materials preparation technology. In the future, with the rapid development of digital, visual and intelligent equipment, suspension melting and casting equipment will also be customized according to the needs of users, the system is intelligent, and the process is diversified to meet the development needs of new materials.

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