



Research Article

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Drainage device's research and development in the ceramic filter

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ABSTRACT

This paper introduced the working mechanism and structure of three drainage devices about the ceramic filter dewatering system, improved the design according to the shortcomings of drainage device, illustrated the improved design points and working mechanism of automatic drainage device. Through contrasting, analyzing and practical application proves, the improved automatic drainage device have stable performance, low failure rate and lower cost, suit for the application of modern filter. At last, further research directions of ceramic filter were pointed out, which provided reference for the development of it.

Key words: Ceramic Filter, Automatic Drainage Device, Development

INTRODUCTION

Ceramic filter is a kind of new, high-efficiency, and energy-saving solid-liquid separation equipment that appeared in the 1980s, which is consisted of host system, dehydration system, cleaning system and microcomputer automatic control system etc. Since its introduction to China in 1996, ceramic filter has been widely applied in various kinds of metal and nonmetal mines and tailings processing. Its application has also been extended to coal, chemical, pharmaceutical and food industries. Thus, it is the most important solid-liquid separation equipment currently used in China[1].

The working of the dehydration system is to accomplish solid-liquid separation (filter) and drainage in ceramic filter, and its working process is consisted of absorb fluid, gas-liquid separation and drainage. The used performances of drainage device and reliability have direct influence to the three processes. At present the used drainage device in the dehydration system have three kinds, which are filter pump drainage device, height drainage device and the automatic drainage device. With the extending of ceramic filter's application area and the improvement of auto control technology, the three drainage devices behavior different characteristics. This paper compares the working process of three drainage devices, and analyzes its future development.

2. The working principles and characteristics of three drainage devices[2]

2.1 The working principle of filter pump drainage device

The filter pump drainage device is depend on the suction of centrifugal pump to drain fluid from vacuum barrel, which is consisted mainly of distributing valve device, vacuum pump, centrifugal pump, discharge valve, etc, as shown in Figure 1. Filtrate flows into vacuum barrel through micro porous porcelain plate and distributing valve device under the negative pressure when ceramic filter works, then its bottom filtrate of the vacuum barrel discharge out by centrifugal pump after gas - liquid separation. Because of the pressure about -0.092 MPa in the vacuum barrel, there must be 2.5 ~ 3.5 m height difference requirements between centrifugal pump and the vacuum barrel to compensate for NPSH of centrifugal pump.

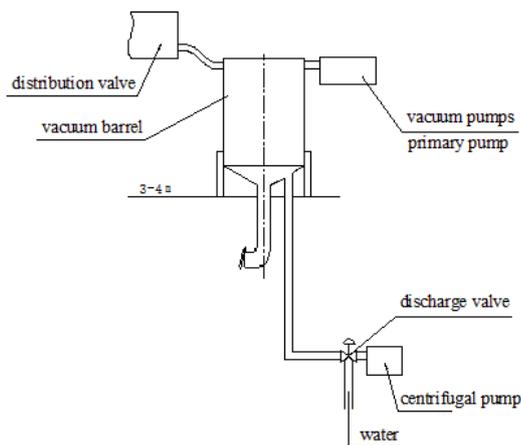


Fig.1 A schematic diagram for the filter pump drainage device

2.2 The working principle of elevation drainage device

The elevation drainage device is depend on itself weight to drain fluid from vacuum barrel, which is consisted mainly of distributing valve device, vacuum pump, vacuum barrel, drainage pipe and tank, etc, as shown in Figure 2. Filtrate flows into vacuum barrel through micro porous porcelain plate and distributing valve device under the negative pressure when ceramic filter works, then its bottom filtrate of the vacuum barrel discharge out by itself weight after gas - liquid separation. Because of the pressure about -0.092 MPa in the vacuum barrel, there must be 10 m height requirements between centrifugal pump and the vacuum barrel.

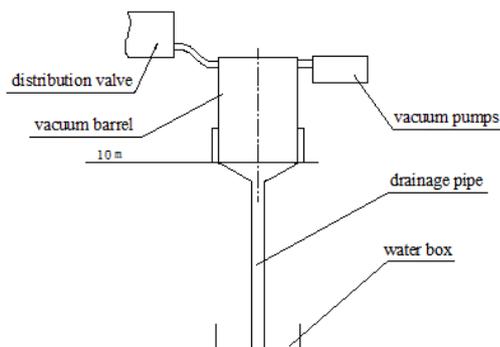


Fig.2 A schematic diagram for the elevation drainage device

2.3 The working principle of automatic drainage device

The automatic drainage device is depend on the gravity of the liquid to discharge liquid from drainage box, which have two kinds of hydraulic controlled quantitative type and equipped or electronic timing type. Hydraulic controlled quantitative type is early products, which have two types of float and electrode drainage device, while the equipped or electronic timing type is the lately products, which have 3-barrel float type and electronic 2-barrel 3-way valve type drainage device. Figure 1 is the structure diagram of electronic 2-barrel 3-way valve type drainage device. Its working process is to manipulate special 3-way valve with electromagnet, which controlled by the relay, and then the drainage box links the atmosphere and vacuum alternately to discharge periodically.

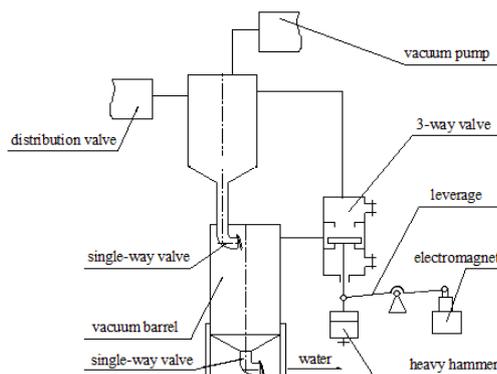


Figure 3 A schematic diagram for the automatic drainage device

3. The application analysis of three drainage devices

Through above analysis, we know that the three drainage devices show their own application characteristics, and the application of automatic drainage device will received much attention while the application of filter pump drainage device will decrease.

3.1 The application analysis of filter pump drainage device

Pump drainage devices is the earliest product. Because of its discharge outside by centrifugal pump, it not only waste much power, but also influence the discharge effect seriously with the wear of impeller and the decline in inhalation ability, and sometimes even can't filtrate. And in the meantime, the centrifugal pump has a higher probability of damage. But because of the advantages of simple structure and convenient installation, there are still a smaller applied at present.

3.2 The application analysis of elevation drainage device

The elevation drainage device is depend on weight to overcome the vacuum negative pressure within the barrel, and avoid using centrifugal pump. At the same time, because of the advantages of simple structure, low failure rate, low running cost, it has been used in a certain degree. Therefore its installation must be the height of 10 m, which require a higher requirement of using environment, and the negative pressure of vacuum barrel is not stable before and after drainage, which directly affect the filtering effect, at the same time it is hard to achieve automatic control, so the application of elevation drainage device has been affected to some degrees

3.3 The application analysis of automatic drainage device

The application of automatic drainage device changed the traditional drainage way by gravity and filter pump, which is not necessary to install gas-water separator in high, and can saves the filter pump to simplify the filtration system. But by long-time used people found that the automatic drainage device exists disadvantages such as complex structure, frequent breakdowns, difficult maintenance and bad separation effect etc, sometimes even engender spill-sewage accidents for action failure (means the filtrate all discharge from the vacuum pump), which not only affect the service life of the vacuum pump, but also can make the vacuum of filtration system reduced, and the water of filter cake increased.

With the application fields of ceramic filter extending, especially those application of polymer filter plate and large dewatering capacity model, the requirements on drainage device become more and more high. As the filter pump and elevation drainage devices show fatal flaws: filter pump drainage device is too high cost and frequent breakdowns, and the pump seal of elevation drainage device frequent damage, so that the production is affected normally. So we have to improve the drainage device to adapt the application to the polymer plate and large capacity type.

4. The improvement design of automatic drainage device[5]

4.1 Key points of design

According to the above shortcomings of the automatic drainage device, we improve the original structure, and now several key points are explained as follows:

1) Drainage box adopts upper and lower structure of 2-barrel

Drainage box adopts upper and lower structure of 2-barrel, that will help the filtrate flow in the box, and enhance the separation effect. It also ensures that the filter can works normally with the upper barrel collection when the lower barrel drains. In order to further boost gas-liquid separation effect of the drainage, the separation board and baffle may be installed in the upper barrel, which makes the filtrate separate fully with gravity and inertia. This prevents the filtrate even particle enter vacuum pump, ensures the filter system vacuum and vacuum pump service life.

2) Increase the auxiliary vacuum pump

Increase the auxiliary vacuum pump above the lower barrel and connection the upper and lower barrels with by-pass valve can make the liquid barrel from the upper barrel into the lower barrel, which can prevent the use of control mechanism with three-way valve, simplify the structure of the system, and reduce the failure rate. At the same time with the use of assistant vacuum pump to the lower barrel, the upper and lower barrels can be connected when the vacuum of lower barrel reduce to a certain degree, which can ensure effectively the steady of the vacuum to upper barrel, this make little changes in water to filter cake and remain unchanged.

Use fission style structure to large capacity filter can collect the filtration liquid to upper barrel and automatic discharge liquid from the upper barrel. This avoids the use of big drainage box, reduces the size of the drainage device, especially the height size, and ensure the filter used in the large capacity model. Also this simplifies the drainage box structure, reduce the failure rate, and make easy to install and maintain.

4.2 The working principle of improved automatic drainage device[6]

Figure 4 is the schematic diagram for the improved automatic drainage device. As you can see in the above figure, when the automatic drainage vacuum barrel draw water normally, the primary and the auxiliary vacuum pumps will exhaust respectively to the upper and the lower barrels, and by-pass valve is opened, so the upper and lower barrel's pressure equal, self-suction valve of the lower barrel is opened, self-suction discharge valve is closed, the liquid flow from the upper barrel to the lower barrel by self-suction valve. When the liquid level of lower barrel gets to the up-line position, the by-pass valve is closed, the auxiliary vacuum pump don't air to the lower barrel, which connect atmosphere, and self-suction valve of the lower barrel is closed, self-suction discharge valve is opened, the lower barrel water. When the liquid level of lower barrel gets to the down-line position, the auxiliary vacuum pump air to the lower barrel, and self-suction discharge valve is closed. When the vacuum of lower barrel reach a certain degree, the by-pass valve is opened. When the upper and lower barrel's pressure equal, self-suction valve of the lower barrel is opened, and the liquid flow from the upper barrel to the lower barrel by self-suction valve. Circulate repeatedly so, realize automatic discharge.

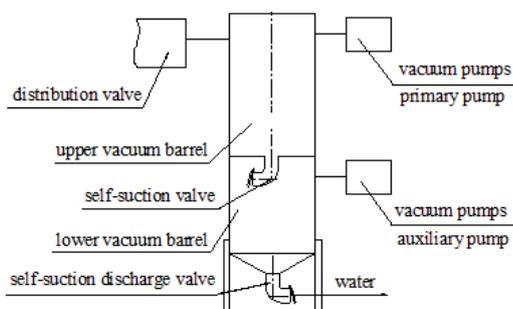


Figure 4 A schematic diagram for the improved automatic drainage device

4.3 The application Comparison of three types drainage device

The improved automatic drainage device may apply to all of the capacity model and polymer filter plate. Shown in Table 1 are the application comparison of three types drainage device by summarizing the experiences of live production.

Table 1: The application Comparison of three types drainage device for ceramic filter

Drainage way	Filter pump drainage device	Height drainage device	Automatic drainage device
Filter pump	Yes	No	No
Installation height	3-4 m	9-10 m	2.5 m
Application scope	Used in ceramic filter board	Used in ceramic filter board and polymer plate	Used in ceramic filter board and polymer plate
Failure rate	26%	3%	8%
Common faults	Filter pump seal	Less	Less
Operation cost	High	Low	Low

Table 1 shows that the improved automatic drainage device has the advantages of simple structure, easy installation, application range, low failure rate, and its operation cost is low. In order to reduce effectively the drainage system failure rates and improve operation reliability of the ceramic filter, the automatic drainage device should be selected first.

5. The development of ceramic filter

As a kind of solid-liquid separation equipment, ceramic filter has achieved good economic benefit in metallurgy, mining, chemical, pharmaceutical and other industries. Since its introduction to China in 1996, ceramic filter had gone through the stages of introduction, digestion absorption, self-designed, and obtained the unprecedented application and the development, market at home and abroad is becoming larger and larger. In view of the market demand at home and progress, ceramic filter will do some further research on the economy, adaptability, safety, improve the ability of scope of work and study, etc. According to practical situation of China, the author thinks that in recent years the research of ceramic filter can be supported mainly in the following several ways:

5.1 The study of adaptation

At present, there have established a certain scale of ceramic filter manufacturers at home, also basically realized the production serialization, but research institutions on the application of ceramic filter is few in china. As a kind of high-efficiency, energy-saving solid-liquid separation equipment, there is a very large application area, but the

ceramic filter cannot be applied on many particular occasions, such as coal mine, aluminum ore and environment, etc. How to broaden the application field of ceramic filter, design the filter plate with specific functions, will be the one of next research content.

5.2 The study of automation

Automation of ceramic filter is a new direction in the development of filter. Its application in ceramic filter includes self-adaptive technique, automatic drainage technology, automatic cleaning technology and automatic control technology, etc. Although most of the filter can basically achieve filter actions of automatic control, but there are much to be got further research, such as how to carry on the intelligent control to attribute of material, and self-cleaning to filter boards, etc.

5.3 The study of green manufacturing

As an advanced manufacture technology, green manufacturing has its unique advantages in minimum resource consumption, minimum negative effects to the environment, and getting the best match between the economic benefit and social benefit to enterprise. So it is more and more valued by the designers, and has been used more and more widely areas. According to the bad working environment (such as water treatment, erase materials handling, noise filtering, etc.) and expensive price, how to make the advanced manufacturing technology of green manufacturing applied in ceramic filter, so that to reduce the use cost, improve the working environment, prolong service life, improve work efficiency, and achieved good economic benefit, will be an important research direction in the future.

5.4 The study of filter plate

Along with the development of the manufacturing equipment industry in China and promoting the use of ceramic filter, the filter manufacturers and models is increasing, but the performance of key components as filter plate has not been fundamentally improved, while the performance of filter plate has a direct effect on result of filter. With the application of large dewatering capacity model and new types of filter medium, the ceramic plate main used in current shows its inherent deficiencies such as low corrosion resistance, low strength, not easy to clean and renewable, etc. How to study new type filter plate to meet the requirements of higher performance of ceramic filter will be a study direction in the future.

CONCLUSION

Drainage device is an important auxiliary equipment of the filtration system, this article analyzed and compared their principle and structure of three kinds of ceramic filter drainage devices. And aiming at the shortcomings of the three types of drainage devices and their application situation, the automatic drainage device was improved, and its application characteristics were comparative analyzed. The actual production and use have proved that the improved automatic drainage device has stable performance, low failure rates, good drainage effect, and can be applied to all capacity models. Also this study discussed the further study of filter and provided references for the development of our ceramic filter.

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