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ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (22): 6548-6552, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.6548.6552

Study and Development on the Key Technologies of TT Series Ceramic Filter Design

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Abstract: As a main solid-liquid separation equipment, the ceramic filter is used more and more. The study analyzed several key technologies of TT Series Ceramic Filter such as water-gas combined cleaning technology, backwashing pressure fluctuation technology, automatic drainage device, whole machine integration technology and Polymer board which are manufactured in AnHui TongGuan Machine Incorporated Company. Then the developments are discussed which give several references to the development of our TT Series Ceramic Filter.

Key words: Ceramic filter, solid-liquid separation, pressure fluctuation, automatic drainage device, high polymer filter plate

INTRODUCTION

With the rapid development of mineral processing equipment, ceramic filter has become a major solid-liquid separation equipment in mining enterprises because of its high degree of automation, high efficiency, low production cost etc. It is of importance to speed up the mining construction, expand the scale of processing, improve labor productivity and economic benefit.

China being a mining power in the world, more and more mining enterprises use ceramic filter for solid-liquid separation. Since the 1990s ceramic filter has grown out of nothing, from small to large, from single variety to many varieties, from imitation to developed independently andhas basically produced in series. The quality and performance of ceramic filter is becoming more and more perfect. The ceramic filter had obtained widespread application in domestic andthere are many domestic manufacturers such as Shanghai Langdong filtering equipment Co., Ltd., Yantai Yunfan filtering system Co., Ltd, Lianyungang Yunfa mining machinery Co., Ltd., Anhui Tongguan machinery Co., Ltd., etc.

MAJOR PERFORMANCE OF TT SERIES CERIES FILTER

Anhui Tongguan Machinery Co., Ltd. is specialty corporation manufacturing trackless equipments and environmental equipments andnow has an annual production capacity of 200. The TT series ceramic filters were used in Anhui Dongguashan copper mine and Yunnan Tin Co., Ltd. which have achieved good economic results (Zhang and Wang, 2002). At present the company mainly produces a variety of specifications of TT series ceramic filters from $8m^3$ to $80m^3$ andalso can design other size according to the needs of customer.

As a domestic famous brand, TT series ceramic filter resulted from the integration of electromechamical, automation, ultrasonic cleaning and micropore ceramic filtering. They bear high efficiency in separation and energy consumption, high degree of automation andlow cost. In addition, they provide clear filtrate. Filtration involves some varieties of concentrate and tailings dehydration, such as gold, copper, iron, gypsum, sulfur, silicon, zinc, cobalt, tin, cyanide residue and others etc, as well as the filtration treatment of waste acid, sewage and waste residue dewatering in chemical industry and environmental protection. The granule fineness covers 75 microns (50%) to 38 microns (90%) and other ultra-fine fineness. Because TT series ceramic filters are adaptable to filtering medium andfiltration board is made of microporous ceramic materials, they have excellent properties including resistance to high temperature and corrosion as well as adjustable microporous aperture andwere widely used in such trades as dressing, metallurgy, environmental protection, chemical industry, sewage treatment, coal and so on (Wang and Bian, 2007).

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KEY TECHNOLOGY OF TT SERIES CERAMIC FILTER

The machine of TT series ceramic filter is consisted of host system, mixing system, cleaning system, gas path system and automatic control system etc. Considering the performance and cost of the machine, optimizing machine system guarantee the working environment, operation convenience and reliability. The study mainly studied the following several key technologies of TT series ceramic filter design.

Water-gas combined cleaning technology: It is very important to regenerate the ceramic plates in the application of ceramic filter. The customer can just choose the way of working according to his own actual condition, including washing, gas washing and water-gas combined cleaning. This study concisely analyzed about the gas washing technology because of the ripe technology of washing. Figure 1 is the schematic diagram for washing system.

On condition that the ceramic filter runs normally, the pneumatic valve1 should be shut off first. By opening the air compressor and pneumatic valve 2, adjusting air control valve 3, the maximum efficiency of cleaning and dredging ceramic plate can be obtained while the pressure gauge showed the best cleaning pressure (0.05-0.07 Mpa) and gas flow (Zuo, 2005).

The air back-flushing can effectively avoid the secondary congestion of impurities in backwash water to ceramic plates and the dilution of filtration in filter tank anddramatically reduced the flow resistance in backwashing pipe as well. Air back-flushing takes advantages of such cleaning without impurities, small flow resistance, high speed, low pressure fluctuations, etc. which can effectively improve the work efficiency to 20-30%, especially for superfine material cleaning filter plate, its effect is more obvious. With TT-45 filter, for example, it can save water 120-130 t one day andgreatly extend the usable life of ceramic plate, effectively reduce useful cost as well.

Technology of backwashing pressure fluctuation: When ceramic filter is used in industry, it was observed that recoil washing pressure exhibits large fluctuation. By way of analysis (Zhang, 2013) pressure fluctuations can be reduced through pressure absorption from hydraulic components or via releasing the energy from the pressure fluctuation. Alternatively, the reduction in pressure fluctuation can also be achieved by extending cleaning time through changing the internal structure of the distribution valve. TT series ceramic filter respectively use the above methods to improve the flushing pressure fluctuations. Figure 1 is a schematic diagram showing the backwashing pipeline with accumulator (Anonymous, 2008). Because the pressure fluctuation mainly appears in recoil washing pressure gauge, we placed the accumulator at the location depicted in Fig. 2. Shown in Table 1 are the pressure fluctuations observed at the back washing gauge on a TT-12 type ceramic filter at room temperature.

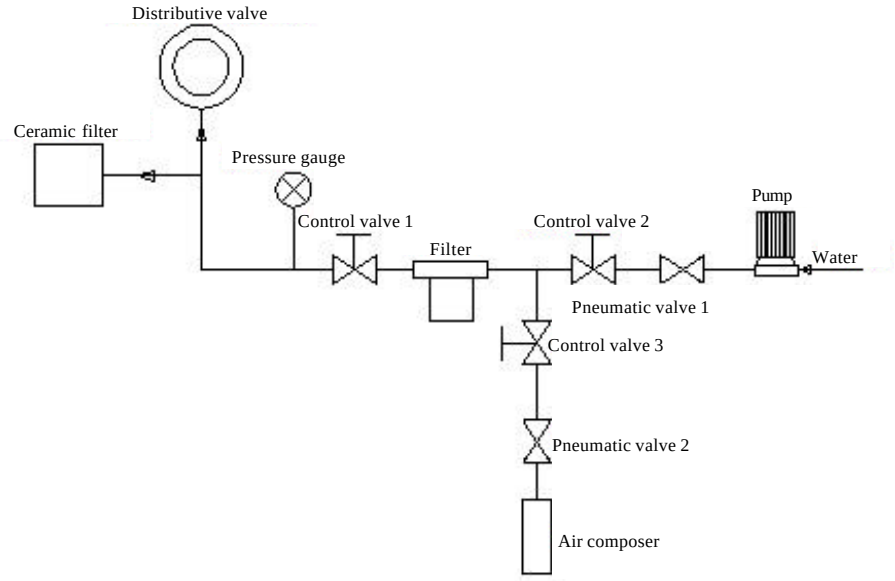

Fig. 1: A schematic diagram showing water-gas combined cleaning

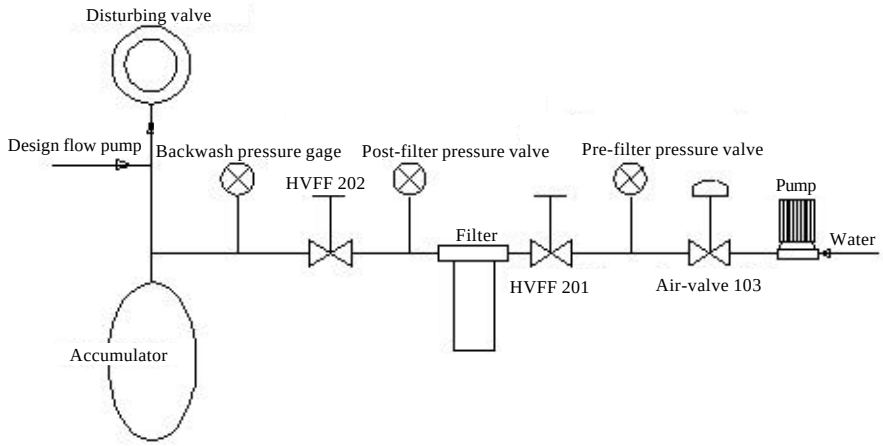

Fig. 2: A schematic diagram showing the backwashing pipeline with the use of an accumulator

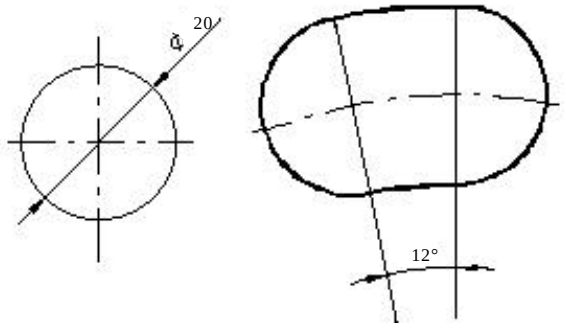

Fig. 3: A distribution valve backwash orifice improvement diagram

Table 1: Backwash pressure fluctuations at exit port at different N_2 filling pressure of the accumulator

Pressure of nitrogen filling at dint device (MPa)	Backwash outlet pressure (MPa)	Pressure fluctuation at backwash outlet (MPa)
0.27	0.10~0.30	0.20
0.2	0.11~0.23	0.12
0.14	0.12~0.18	0.06
0.1	0.14~0.16	0.02
0.09	0.1~0.13	0.03

As revealed in Table 1 for the TT-12 type of ceramic filter machine, the best reduction in backwash pressure fluctuation was observed when the backwash outlet pressure was reduced to 0.14~0.16 MPa and when the nitrogen filling pressure was adjusted to 0.1 MPa.

Figure 3 is the diagram for the distribution valve backwash orifice improvement. We design the inside round backwash orifice to waist, that is, extend original circular to waist on both sides andexpand the two waist holes for original vacuum orifice and suck orifice to large waist along two sides of circumference while the other sizes don't change.

By using TT-45 (3 m^2) type ceramic filter as an example, experimental results showed that, by improving the structure of distribution valve, the pressure fluctuation range was reduced from 0.02~0.1 to 0.09~0.1 MPa which controls the backwash pressure fluctuation effectively.

Whole machine integration technology: For the machine becomes more compact and rational layout, TT series ceramic filter integrated the host, dehydration equipment, ultrasonic cleaning equipment and electrical control system as a body which forms the main rack system. And the liquid-gas distribution valve, electric control system were set above the platen of machine, dehydration equipment was hung below the liquid-gas distribution valve and seated in rack, the mixing acid system, ultrasonic equipment were set under the platen which together make up the rack systems. The integrated host has the advantages of compacting equipment, convenient in installation andwithout much disassembly and assembly on the scene which pledges the quality of product.

Automatic drainage device: The working of the dehydration system is to accomplish solid-liquid separation (filter) and drainage in ceramic filter. 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 (Zhang, 2001). The filter pump drainage device is used mostly but its failure rate and cost are also high while the height drainage device and the automatic drainage device have simple structure but the former has installed restrictions andthe latter has dewatering restrictions which make their application limited (Gong *et al*., 2011).

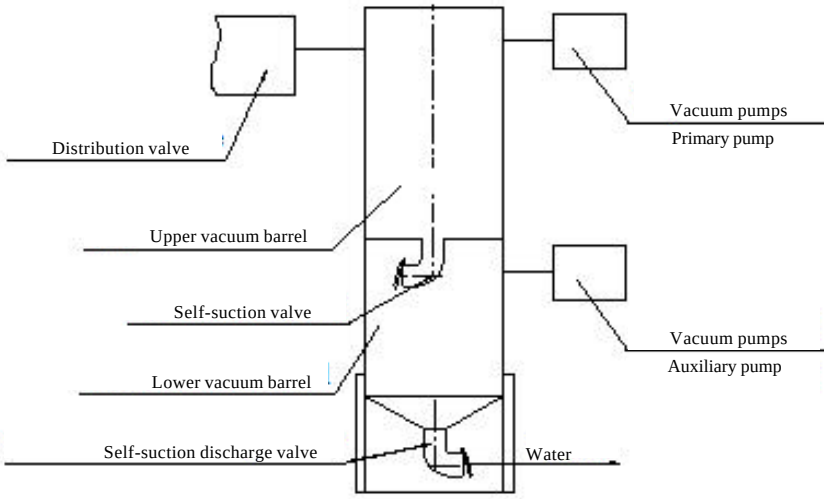

Fig. 4: A schematic diagram for the improved automatic drainage device

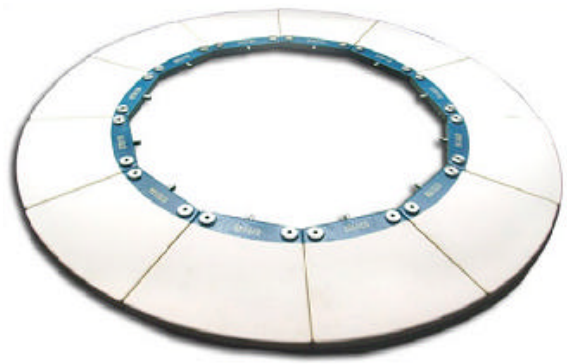

Fig. 5: Structure diagram of polymer filter plate

TT series ceramic filter improved the design on basis of existing automatic drainage device which take the following measures such as adopting upper and lower structure of 2-barrel drainage box, increasing the auxiliary vacuum pump and using fission style structure to large capacity filter etc. to avoid the drawbacks of the former. The improved automatic drainage device has the advantages of simple structure, easy installation, application range, low failure rate andalso its operation cost is low. 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 andby-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 andself-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 andself-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 andthe liquid flow from the upper barrel to the lower barrel by self-suction valve. Circulate repeatedly so, realize automatic discharge (Gong *et al*., 2011).

Polymer board applied successfully: Traditional filter media is ceramic plate which has the advantages of adjustable micropore, mature technology, rich temperature-stable ability andeasy to clean but it has many disadvantages, such as no acid and alkali resistance, poor corrosion resistance, low flexural strength, few filtering effect to very fine material.

In view of the insufficiency of the ceramic plate, TT series ceramic filter developed the new filter medium-high polymer filter plate which is made of ultra-high molecular weight PE material. It has the advantages of corrosion resistance, high compressive and flexural strengths, good filtering effect, wide application range, light weight, recyclable, etc andbe widely used in the filtering field of mining, chemical, smelting, titanium dioxide etc. Figure 5 is the structure diagram of polymer filter plate. Successful

development of the polymer filter plate will further expand the application field of ceramic filter, to satisfy the needs of various clients in the market.

DEVELOPMENT OF TT SERIES 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 andobtained 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 TT series ceramic filter can be supported mainly in the following several ways (Zhang *et al*., 2013).

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.

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 andself-cleaning to filter boards, etc.

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 andgetting the best match between the economic benefit and social benefit to enterprise. So, it is more and more valued by the designers andhas 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 andachieved good economic benefit, will be an important research direction in the future.

CONCLUSION

With the improvement of performance and cost-effective, the ceramic filter will just have to get an unprecedented development and application. In this study, several key technology of TT series ceramic filter was analyzed. The further research of TT series ceramic filter was also discussed which provides reference for the development of Chinese ceramic filter.

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