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CERAMIC FILTRATION IN THE IN MINERAL PROCESSING OPERATIONS

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Abstract

Ceramic filtration represents one of the most advanced solid-liquid separation technology in the world. It is being increasingly employed across a wide range of industries due to its energy-saving, environmentally friendly, and resource-recycling features. The ceramic filters are capable of removing a significant amount of moisture from the slurries, resulting in a more efficient and cost-effective operation. Additionally, they offer a compact design and low maintenance requirements, making them highly desirable for dewatering of slurry in mineral processing industry. This paper provides a brief overview of the ceramic filtration.

Keywords*: ceramic filtration, solid-liquid separation, mineral processing*

1. INTRODUCTION

The increasing demand for improved solid-liquid separation systems in mineral processing operations is a recent trend. An ideal filtration system should be designed to effectively reduce the moisture content of the final product while maintaining high productivity and minimal energy consumption. One of the most significant breakthroughs in the minerals industry in recent years has been the implementation of ceramic filters [1]. Moreover, ceramic filters exhibit superior availability and productivity, outperforming conventional vacuum filters in every aspect of the filtration process - from cake moisture to filtrate quality [2]. Ceramic filters are particularly effective in filtering feed slurries with a high and consistent solids concentration and contain particles ranging in size from 30 µm to 150 µm [3]. The main difference between a regular disk vacuum filter and the ceramic filter lies in the use of porous ceramic filter disks as the filtering medium. Although they share the same basic principle, the incorporation of these specialized disks enhances its performance and efficiency [3,4]. Ceramic vacuum filter discs, made from sintered alumina sector plates with evenly distributed micro-pores, serve as powerful vacuum-disc filters. Utilizing capillary action, these micro-pores generate suction, ensuring that only liquid passes through during the filtration process. As a result, a filter cake forms on the disc's surface, which can be effortlessly removed using a scraper [5]. The ceramic disc’s micropores also ensure an extremely clear filtrate.

Ceramic material is durable and resistant to wear, providing filter plates with a long lifespan in normal conditions. The outstanding corrosion resistance and exceptional durability of ceramic discs enable the implementation of highly effective cleaning techniques, guaranteeing their consistently remarkable performance [6]. Overall, these properties make ceramic filter plates an ideal choice for industries requiring efficient solid-liquid separation processes. The durability and effectiveness of ceramic discs not only improve operational efficiency but also contribute to cost savings over time.

2. CERAMIC FILTRATION

Several factors have been identified as critical in optimizing the performance of ceramic filtration. These factors include the composition of the ore, the concentration of solids, the particle size distribution, the extent of particle aggregation in the slurry, the temperature, the pH of the slurry, and the duration of the filtration cycle [7]. By carefully considering and managing these factors, it is possible to enhance the efficiency and effectiveness of filtration processes, ultimately leading to improved overall performance and productivity. In ceramic filtration, the performance of the filter depends on the ability of the liquid to flow through the microporous plates. The microporous structure of the plates allows for efficient filtration, but a sufficient flow of liquid is necessary for optimal performance. Therefore, the hydraulic capacity of the liquid flowing through the plate is a key factor in the success of ceramic filtration. The solids concentration has a particularly significant impact on the capacity of the ceramic filter. The filtration cycle is another significant factor to consider in this context. A faster filtration cycle increases filter productivity, but also results in higher moisture content of the cake. The state of particle aggregation in the slurry, influenced by the presence of surfactants and pH control, significantly affects filter performance [7, 8]. The results of the study [7] demonstrate that the solids content is the key factor that significantly affects ceramic filtration. Moreover, the inclusion of a coagulant substantially enhances the filtration system's capability, particularly when dealing with lower solids content.

Benefits related to ceramic filtration include [9, 10]:

high capacity, dry filter cake, stable moisture content, particle-free filtrate, high filtration rates, simple installation, continuous operation, automation features allowing independent cake-forming and drying control, high operational availability; extended plate life; resistant to most chemicals and slurry temperatures and no filter cloth changing.

On the other hand, high capital investment, costly acids for cleaning and regeneration, and expensive ceramic plate replacements are significant challenges that need to be addressed.

2.1 Ceramic filtration operating principles

The ceramic filtration operating principles are thoroughly explained by the ceramic unit suppliers. According to the supplier, the process generally consists of five distinct steps: cake forming, cake drying, cake discharge, backflow washing, and disc regeneration [10]. The illustration in Figure 1 depicts the key stages of the filtration cycle in ceramics vacuum disc filters, providing a visual representation of the process.

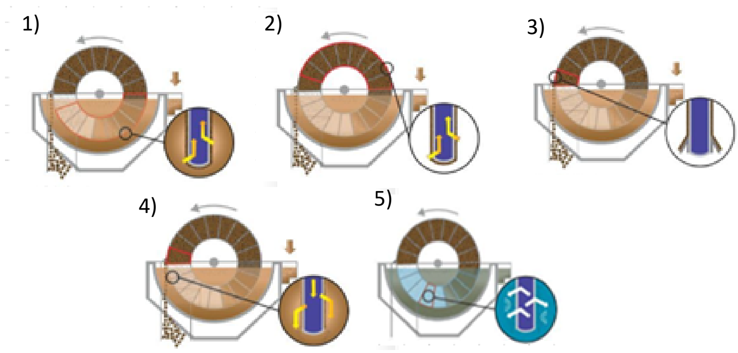

Figure 1. *Stages of the filtration cycle in the ceramic disc filters: (1) cake-forming, (2) cake drying, (3) cake discharge, (4) backflow washing, (5) disc regeneration [10]*

- Cake forming - In the cake formation process, the rotating discs draw the liquid through the ceramic filter discs, creating a strong vacuum through capillary action. The microporous structure of the discs prevents solids from entering the disc surface, allowing them to accumulate on the external surface. To remove the filtrate, only a small vacuum is necessary to extract it from the micro-porous filtrate lines.
- Cake drying - As the discs rotate, capillary action removes all the liquid from the solids. The microporous medium only allows liquid to pass through, preventing air from entering the disc surface. This creates a very dry cake using much less energy compared to traditional filtration techniques.
- Cake washing (optional)
- Cake discharge - The scrapers play an important role in removing the cake from the disc, leaving a protective residue to reduce mechanical abrasion and extend disc life. Unlike rotary vacuum filters, continuous cake discharge doesn't require a snap-and-blow-off system.
- Backflow washing - Filtrate is essential to clean the microporous structure and maintain the filtration efficiency of the discs. It is used to flush the discs after cake discharge, removing any leftover residue.
- Disc regeneration - The discs need regular cleaning to keep them fully permeable. Chemical and/or ultrasonic systems are used for this purpose. The cleaning frequency varies depending on the application, ranging from weekly to daily. More frequent cleaning is needed when there are higher amounts of submicron fractions. The cleaning process is fully automated and controlled by the PLC system. It includes the filling of the tank with wash liquid or water to ensure thorough cleaning.

The selection of a ceramic filter depends on meeting several operational requirements, such as cost considerations, filtration efficiency, and the ease of discharging filter cake and achieving desired cake moisture levels. For example, one of the leading manufacturers in this field, Metso Outotec, has developed a new generation of CC filters (Figure 2) that stand out for their innovative design. It replaces the traditional filter cloth with microporous ceramic sectors and filter media. Additionally, it features a durable plastic frame, providing enhanced performance. This innovative construction allows for more efficient and reliable solid-liquid separation, making it an ideal choice for a wide range of industrial applications. Its robust design also ensures long-lasting performance and minimal maintenance requirements [10].

Figure 2. *Metso Outotec Ceramic Disc Filter [10]*

3. CONCLUSION

The innovative design of ceramic filters not only reduces energy consumption but also improves the clarity of the filtrate, making it a highly efficient and low-maintenance filtration solution for various industrial applications. The ceramic filters not only offer excellent process performance but also enable factories to achieve maximum automation and precise control over processes. This is particularly crucial in factories that require consistent residual moisture control.

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