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Ceramic polishing powder and AAC production

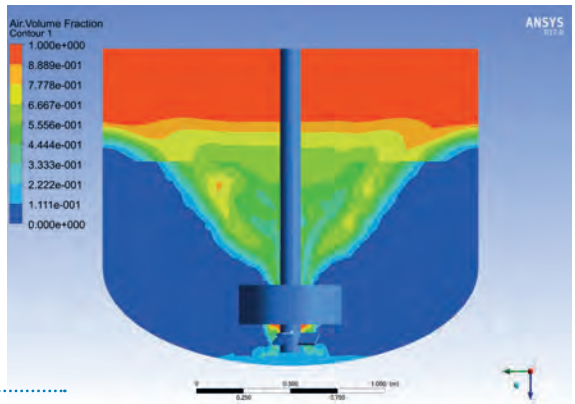
China's ceramic manufacturing industry has experienced a period of stable development. Output figures of ceramic products and the number of enterprises doing their business in the ceramic industry have grown tremendously. Today, China is the largest worldwide producer and exporter of ceramics boasting a rapid development in this industry. The result is a vast amount of ceramic powder wastes on account of trimming and polishing processes during the production of ceramic walls. According to some statistics, more than 20 million tons of ceramic waste is annually produced by ceramic production facilities. In the past, there have not been any relevant recycling technologies; ceramic waste was regarded by companies as "garbage" used for landfills or to fill gullies, roadbeds and the like. Environmental problems of this nature were an extremely unpleasant phenomenon in the Shangdong Province as well. Challenged by the Chinese government, the ceramic industry of this province attempted to find ways in solving this environmental pollution problem especially caused by the long-term storage of ceramic polishing powder wastes. It was therefore in 2014 that a company located in the Shandong Province, Heyue Technology, started to cooperate with Keda Suremaker to install an AAC plant with an annual capacity of 300,000 m³. This facility has since been using ceramic polishing powder waste as the main raw material for the production of AAC panels and blocks.

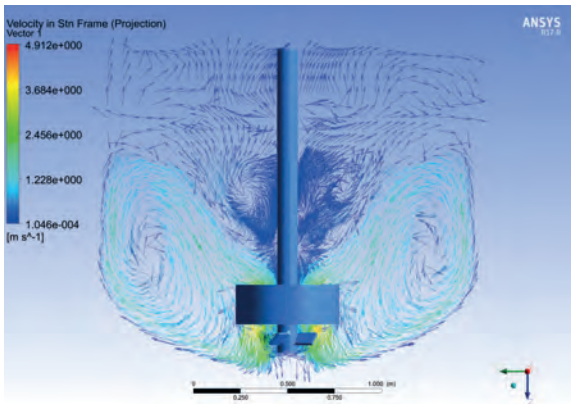
Mixing technology provided by Keda Suremaker

The main minerals in ceramic powder waste are feldspar, quartz, talc, mullite, and montmorillonite. Research has shown that ceramic powder waste strongly reacts chemically when the content of SiO_2 exceeds 65 % and the content of Al_2O_3 is about 16 %. Findings also seem to indicate that ceramic powder waste, owing to its advantages compared to fine grain size and high SiO_2 content, can very well be used as a main raw material together with cement, lime, gypsum and aluminium powder to constitute a foaming agent for the production of autoclaved aerated concrete blocks and panels. Based on these findings, it can be concluded that the proportion of ceramic powder waste can readily exceed 73 % of total raw materials in this context.

The Heyue project uses a special pouring mixer based on the mixing structure of the "double cross paddle & modular draft tube" philosophy as maintained by Keda Suremaker. The analysis of design parameters by means of a finite element analysis tool has proven that this mixing structure can ensure high efficiency mixing of ceramic powder waste and other raw materials. Compared to other pouring mixers, this mixer is capable of reducing power consumption by as much as 45 KW by optimizing fluid movement circuit during the mixing process and thus addressing the demand for energy savings and at the same time ensuring a top-quality mixing effect. With this process, the curing time in the precuring chamber is around 2 to 3 hours at temperatures between 40 and 50° C and a steam pressure around 1.2 to 1.4 Mpa during the constant temperature stage.

Heyue's AAC products show very good performance. The thermal conductivity of Heyue blocks with a dry density of 500 kg/m³ is only 0.09 W/(m·K), which is lower than that of fly ash based AAC blocks of the same dry density grade. Heyue panels with a thick-





Phase distribution (left) and fluid velocity distribution (right)

Tab. 1: Performance of Heyue AAC products

Dry density	Compressive strength	Thermal conductivity	Frost resistance quality loss	Post-freezing strength	Drying shrinkage
400 kg/m³	3.5 MPa	0.08 W/ (m·K)	1.46 %	2.3 MPa	0.29mm/m
500 kg/m³	5.3 MPa	0.09 W/ (m·K)	2.05 %	4.3 MPa	

Heyue AAC block incorporating ceramic polishing powder

ness of 20 cm perform better than solid brick walls with a thickness of 50 cm ensuring external wall heat insulation. The compressive strength of Heyue blocks with the above described dry density of 500 kg/m³ is at 5.3 MPa, a figure that greatly enhances seismic performance and toughness of the material. The material is inorganic and non-combustible and does not lose its strength even at temperature levels of 700° C. After 15 freeze-thaw cycles at a temperature level of -20° C / 6 h ~ +23° C / 5 h, the mass loss percentage rate of the saturated absorbent product is only 2.05 %. After 90 days of natural carbonation, the carbonation coefficient is at 0.91. Frost resistance and carbonation tests have shown that Heyue products boast excellent durability features. In particular, the drying shrinkage of these products is only 0.29 mm/m, reducing the occurrence and severity of shrinkage cracks caused by carbonation.

One important type of Heyue products are thin panels with thicknesses of 5 and 7 cm. These panels exhibit extremely good thermal insulation features reducing the occurrence of cold bridges in columns in huge demands in local markets. In order to arrive at mass production rates for thin panels, requirements on technologies and equipment are very demanding. Traditional horizontal cutting machines existing in the market are equipped with 5 - 8 pairs of steel columns for hanging steel wires and normally there are at least three steel wires hanging on each pair for producing panels with a thickness of 5 cm. With this kind of arrangement, cutting gaps during simultaneous cutting operations are inevitable. Thereafter, gravity will make the cake settle, and the greater the number of cutting kerfs on the same vertical plane, the greater the differences in height that will occur on account of cumulatively increasing numbers of kerfs. All this will result in quality problems, such as the above described gravity settlement cracks. In addition, when cutting wires discontinue their operation and leave the cake, there is a strong likelihood that cake ends will be damaged on account of the substantial friction resulting from the numerous steel wires pulling on the same vertical plane.

Cable-stayed beam horizontal cutting machine

Examples of thin panels

Keda Suremaker has developed a cable-stayed beam horizontal cutting machine which is equipped with two main cable-stayed beams and a certain number of small columns distributed evenly along the two beams for hanging the steel wires. Each pair of these rather small-sized columns on the two beams is used to hang only one steel wire and hence just one cutting kerf (0.6~0.8mm) on one vertical plane during the cutting process, reducing the gravity settlement crack impact. In addition, there will be a lower degree of friction when the cutting steel wire completes its job and leaves the cake. So this is an innovative concept of a horizontal cutting machine to improve the adaptability of an AAC production line for the mass production of thin panels, a direct and immediate benefit for clients or users.

With the advantages of low raw material cost, stable equipment operation and strong governmental support, Heyue Technology soon accomplished a huge return on investment. In 2018, the company set up two new AAC plants, the second cooperation with Keda Suremaker. This year, Heyue Technology will be setting up yet another two AAC plants featuring equipment supplied by Keda Suremaker as well.

By operating these five ceramic powder AAC facilities in the Shandong province, Heyue Technology is planning to produce a total of 1.5 million square metres of ceramic powder based, autoclaved aerated concrete blocks or 800,000 square meters of ceramic powder based, autoclaved aerated concrete panels annually. That is to say that more than 600,000 tons of ceramic tile polish wastes can be turned into a valuable material each year to contribute its share to the reduction of environmental pollution problems by replacing with this material more than 500,000 tons of fly ash or sand that would otherwise be needed.

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