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PROCESS DEVELOPMENT FOR MANUFACTURING OF DIATOMACEOUS EARTH FILTER AIDS

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Abstract— A pilot plant, capable of treating three tons of diatomaceous earth per day, has been operated to obtain optimum design criteria for scale-up to the commercial plant [1]. High quality filter aids, such as DICALITE [2] have been produced. A commercial plant has been completed in Kyongju city by scale up of this pilot plant test. Selective diatom-earth preparation, homogeneous calcination of diatom-cells-mixture, proper delumping and pneumatic concentration of diatom-cells are main process schemes [3]. The most efficient grinding effect has been obtained using a milling blower, as of two-cage disintegrator [4]. Variable-speed rotary kiln has been operated to convert the diatom-cells into more porous and pure products. Diatom-filter-aids, in the size range of 10-40 microns, are completely separated pneumatically by back wash cyclones.

INTRODUCTION

Recently, the demand for chemically pure and inert filter aids which improve clarity in filtration is increasing in various industries [5]. Two grades of products are produced. The general grade, named as DIALITE 200 and sized in 20-40 micron range, is largely used in sugar industry. The fine grade, named as DIALITE 300 and sized in 10-20 micron range, is used for special polish filtration. Their difference in pore size is very small, but the pore size greatly influences the rate of flow and the degree of clarity. The property of diatom-filter-aid is largely influenced by the degree of calcination.

The initial light rock mixture of diatom-cells, which has a bulk density of 0.5 gr./cm^3 is treated and converted into a more lighter material of 0.35 gr./cm^3 [6, 7, 8]. The calcination in rotary kiln affects the surface of the diatom-cells, increasing the particle size diameter and reducing the surface area of the feed. This also increases markedly the filtration rate and efficiency [9].

The most efficient diatom-filter-aids could be produced by application of proper separation processes and by proper conversion of the fossil skeleton of diatom-cells.

PROPERTIES

The wide use of diatomaceous earth filter aid is attributed to its unique physical and chemical properties [10]. The following is a brief description of its important properties.

The microphotograph measurements clearly illustrate diversity of the particle size, particle shape, and porous nature of diatom-cells. According to the microscopic observations, the minute diatoms are in many unique and beautiful shapes, such as of pill boxes and honey-combs. The photos are shown in Fig. 1. The dominant species are reported to be synedora and cyclotella. The Coscinodiscus, Cymbelland, and Epithemia are also observed.

Particle size distributions may be analysed by sedimentation principles. Chemical compositions are analysed by general standard methods. Diatomaceous earth, fossil skeleton of unicellular aquatic plant called diatom deposited in far-off geological ages, are composed of nearly pure amorphous silica. Minor ingredients are aluminum, calcium, iron, and magnesium. They are usually combined as silicates and not readily soluble in water.

MANUFACTURING PROCESS

Process flow diagram for manufacturing of the diatomaceous earth filter aids is shown in Fig. 2.

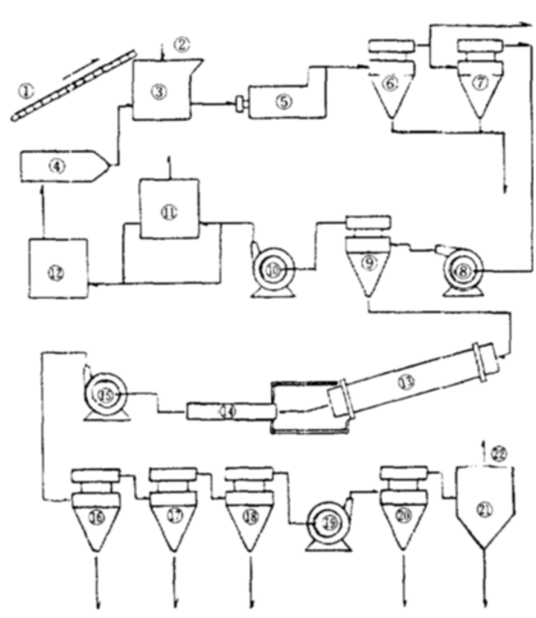
Feed, amorphous light rock or powder mixture, is subjected to a feed preparation process which comprises a sequence of ore crushing, fine grinding, finish milling and separation, and fine dust collecting. Pneumatic concentration method is applied. Air wash classifier is used to remove solid-sands before entering into finish milling. High speed milling blowers are used to delaminate

Fig. 1. Microscopic observations(Yang Buk Ore).

and finish milling. Ball mill is not allowed for this purpose because it grinds the diatom-cells and sands together, and therefore a rapid removal of the product is not easy.

Kiln feed, fine concentration of diatom-cells, is stored in inter-bins attached with feeding device. Calcination line comprises a sequence of feeding, drying and calcination, soaking, and cooling. Variable speed rotary kiln is essential. Calcination is completed in the presence of fluxing agents, such as soda ash (Na_2CO_3) and other chemicals. Calcination temperature ranges between 900°C and 1300°C. The optimum calcination temperature and proper fluxing agent for particular feed must be determined by careful investigations. Process line is operated and controlled by instruments that are basically similar to those in portland cement manufacturing plant. As the calcination proceeds, the surface characteristics change, and surface bridge is formed by the cristobalite crystallization on the amorphous silica particle.

Final feed, white and lumped powder, is supplied to the final product separating line. The whole line comprises a series of delumping, pneumatic concentration and separation, and fine dust collection. Two types of filter aid are produced in this line. Special delumping-machine, which is a two-cage disintegrator with bars of special alloy steel revolving in opposite directions, pulverizes the lump of calcined-diatom-cells. Discharges are processed immediately by the pneumatic concentra-



No.	Eq. Symbol	Equipment Name & Description
1	L-1-1	Belt conveyor for ore rocks & powder
2	C-1-1	Chemicals, additives for fine grinding
3	H-1-1	Hammer crusher with devices for driving
4	F-1-1	Hot furance for ore drying
5	MB-1-1	Crushing & milling blower with motor
6	S-1-1	Pneumatic air separator & classifier
7	S-1-2	Pneumatic air separator & classifier
8	B-1-1	Milling blower with motor
9	Cr-1-1	Cyclone separator with adjustments
10	IB-1-1	Induced blower with motor
11	D-1-1	Dust collector with removing units
12	D-1-2	Dust collector with removing units
13	R-1-1	Rotary kiln with furnace
14	O-1-1	Air quenching cooler
15	B-3-1	Milling blower with motor
16	S-3-1	Pneumatic air separator & classifier
17	Cr-3-1	Cyclone separator with adjustments
18	Cr-3-2	Cyclone separator with adjustments
19	IB-3-1	Induced blower with motor
20	Cr-3-3	Cyclone separator with adjustments
21	D-3-1	Dust collector with removing units
22	T-3-1	Stack to vent gas removing

Fig. 2. Process flow diagram.

tion equipments, back wash classifier, and cyclones. Fusion-solids, that are formed in rotary kiln as it fuses, are separated completely by back wash air classifier. Two types of filter aids, the coarser and the finer, are obtained by proper control of cyclone operation. The products are packed in paperbags of 20 kg. wt. The very fine dust, less than 5 micron size, is collected in two stages. The bag filter system is applied. Change of pressure drop, as well as air leak into process pipeline, is minimized. The very fine dust collected is packed in paper bags to be shipped for many industrial uses as fillers.

GENERAL DISCUSSION

Pneumatic concentration technology is applied to separate diatom-cells from associated materials. Proper use of milling blower, air classifier, and cyclone is the most important process unit arrangement.

Delamination of diatom-cells by high speed milling blower is most effective. Back-wash air-classifier separates fusion slags completely.

The optimum calcination conditions are as follows:
Calcination temperature—1000°C to 1300°C
Fluxing agent—Soda Ash (Na_2Co_3)
Amount of Fluxing agent—3 to 5 percent wt. of feed.
Pilot plant test was completed using the sample obtained from Yangbuk Area, near Kyongju City.

COMMERCIALIZATION

The first commercial plant based on the pilot plant tests was constructed in Kyongju City in Korea. The capacity is designed to produce 400 M/T per month of diatom-filter aids. A second commercial plant, which will produce 1000 M/T per month of diatom filter aids, is recommended to meet the local demands and the foreign export in the near future.

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