DESIGN OF A BEACH SAND MINERAL SEPARATION PLANT

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INTRODUCTION

Beach mineral sand is one of the major source of heavy minerals like Rutile, Ilmenite, Zircon and Monazite. The separation process involves the physical properties of each heavy mineral in comparison to the other. The basic physical properties considered in the design of a separation plant for beach mineral sand are as follows.

1. Specific gravity
2. Magnetic susceptibility
3. Electrical conductivity

The most commonly occurring components found in a beach sand sample in the world are as follows;

1. Quartz
2. Ilmenite
3. Rutile
4. Zircon
5. Monazite
6. Garnet

PHYSICAL PROPERTIES OF EACH MINERAL

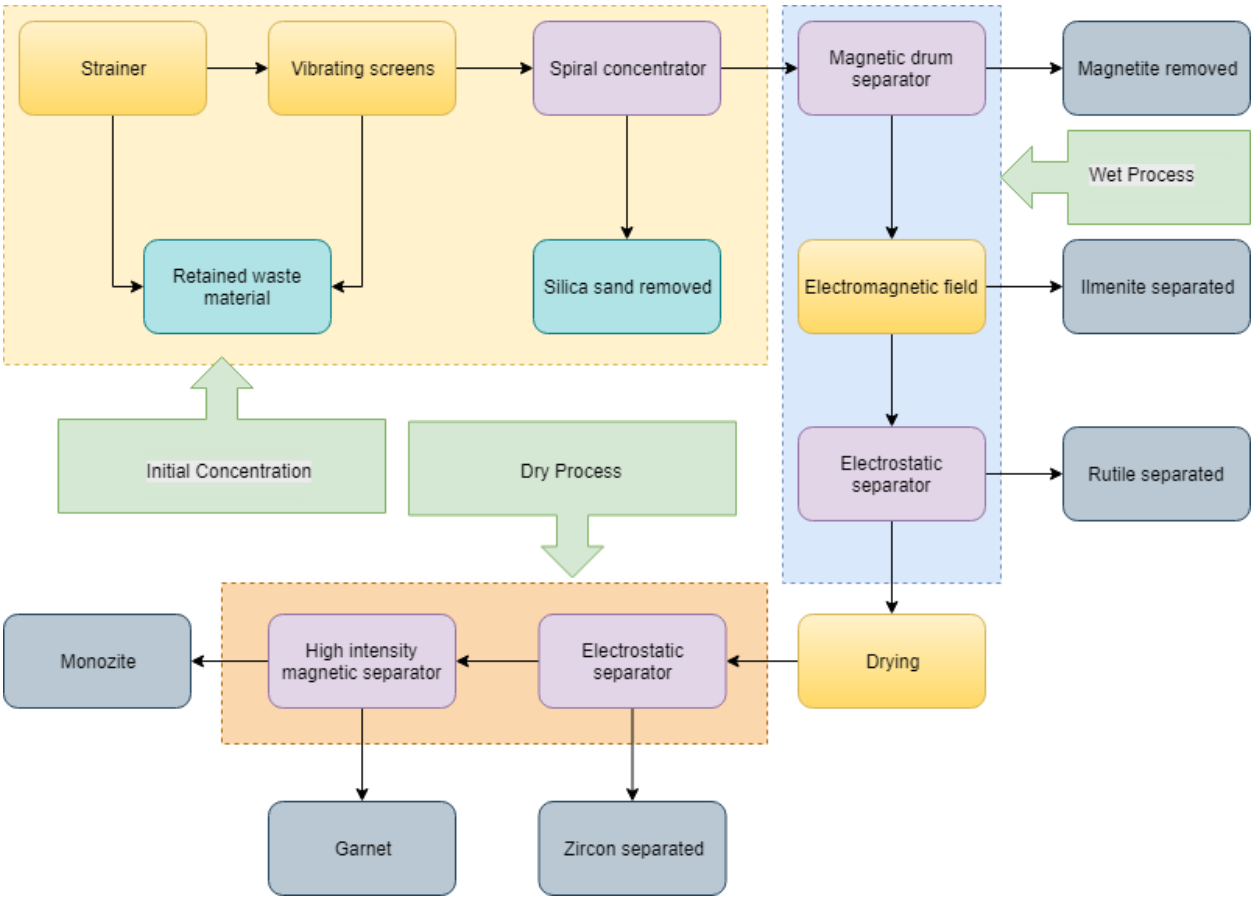
Mineral	Specific gravity range	Magnetic Susceptibility	Electrical Conductivity
Quartz	2.65 - 2.7	No	No
Ilmenite	4.5 - 5.0	Yes - High	Yes
Rutile	4.2 – 4.3	No	Yes
Zircon	4.2 – 4.8	No	No
Monazite	5.15 – 5.3	Yes - Low	No
Garnet	3.5 - 4.1	Yes - Low	No

PRODUCTION PLAN

- The total production of the separation plant is given as 2000 tons per month.
- Assume that the working shift is 8 hours per day for a week of 5 working days.

- Number of working hours per month = 8 × 5 × 4 = 160 hours
- Production rate per hour = 2000 / 160 = 12.5 tons per hour

PROCESSING FLOW CHART



STRAINER

The un-washed beach sand is first put into a strainer to clean the sand and remove unwanted material like large rock pieces, sea shells and plant roots. The strainer picks up waste material and send the remaining material mixture to the vibrating screen.

VIBRATING SCREEN

A gyratory type vibrating screen is selected to match with the production plan. The specifications of the vibrating screen are as follows.

- Company: Henan Pingyuan Mining Machinery Co. Ltd
- Model: PXZS 1536
- Screen surface: 1500mm × 3600mm

- Feeding size: <50mm
- Power: 5.5 kW
- Capacity: 5 – 120 m^3/h

SPIRAL CONCENTRATOR

The initial concentration process is used to remove the silica sand (quartz) from the mixture. Quartz has a lower specific gravity compared to other heavy minerals and therefore easily separates due to gravity when moving with water. A spiral concentrator with the following specifications are recommended.

- Company: Xinhai Mineral Processing EPC
- Model: BLL-2000
- Feed size: 2 – 0.04mm
- Capacity: 7 – 15 t/h
- Lateral dip angle: 9^0

MAGNETIC DRUM SEPARATOR

At initial stage of separating the heavy mineral mixture without quartz, a single series type drum roll permanent magnet separator is used to separate magnetite which is has a high magnetic susceptibility. At this stage, low magnetic susceptibility minerals like Monazite and Garnet are not separated and furthermore, the process is done in wet conditions. This results in the separation of only magnetite from the heavy mineral mixture which can then be sent to the electromagnetic field separation for the removal of Ilmenite. If incase the magnetite was present in along with Ilmenite in the next stage, there would be a hinderance for the separation of Ilmenite. Therefore this step serves as a preparatory stage for the separation of Ilmenite. A magnetic drum separator with following specs are suggested.

- Company: Hengjie Magnetism
- Model: CTG – 15
- Magnetic roll/drum length: 1500 mm
- Drum magnetic strength: 4000 – 7000 Gs
- Feed size: 83 – 5000 mm
- Capacity: 7-15 t/h
- Motor power (Drum + roll): 5.2 kW

ELECTROMAGNETIC SEPARATOR

Once the Magnetite is removed from the permanent magnet drum roll magnetic separator, and electromagnetic separator with higher magnetic strength will be used for the separation of Ilmenite. Furthermore this step also carried out in wet condition and therefore the selected electromagnetic separator should support feed in pulp form. The following specs are suggested for selecting the electromagnetics separator for this purpose.

- Company: Hengjie Magnetism
- Model: DCSJ Pulp Electromagnetic Separator
- Magnetic strength: 25 000 – 30 000 Gs
- Capacity: 1 – 20 t/h
- Power: 2.0 – 5.0 kW

ELECTROSTATIC SEPARATOR (WET)

Once the Ilmenite in the mixture is separated from its magnetic property, the only remaining electrical conducting mineral in the mixture will be rutile. Therefore an electrostatic separator can be used following the removal of Ilmenite to separate Rutile. However this process will also take place in wet conditions and therefore a machine with such capability should be utilized. Following specifications are suggested for the electrostatic separator. A system of 4 such electrostatic separators should be installed to meet the required production rates.

- Company: JXSC Mining
- Model: BXJ-2A5-60
- Feed size: 0.1 – 3 mm
- High voltage current: 1 -10 MA
- Capacity: 1-5 t/h

DRYING

Up to now, the processing was done in a wet condition. However for further separation of Zircon, Monazite and Garnet, it is suggested to follow dry processes. The drying process can be carried out using a sand rotary dryer. This is much more efficient and beneficial compared to other forms of drying. For this purpose, a sands rotary dryer with the following specs are suggested.

- Company: Henan Zhengzhou Mining Machinery Co. Ltd
- Model: ZQ 850
- Slope (%): 3.5

- Capacity: 12 – 15 t/h
- Power: 45kW

ELECTROSTATIC SEPARATOR (DRY)

Once the mixture is dried up to a moisture content of about 0.5%, again an electrostatic separator can be installed to separate zircon. Zircon has a slightly greater electrical conducting property compared to Garnet and Monazite and therefore this property is used to separate it from the mixture. However for this separation, a dry medium is suitable and also a high energy electrostatic force should be supplied to utilize the minor electric conducting property of Zircon for the separation. The reason for delaying the drying process is due to its high cost compared to other processing steps and to minimize the amount of feed material reaching the drying stage so that the energy consumption is less. An electrostatic separator with the following specs are suggested.

- Company: DESEN
- Model: DME-B-ES-00018
- Feed size – 0 - 2 mm
- Power: 2.5 – 8 kW
- Capacity: 30 t/d

HIGH INTENSITY MAGNETIC SEPARATOR

The final stage of the separation involves the separation of Garnet and Monazite. In this separation, the magnetic susceptibility is again used. Garnet has a relative magnetic susceptibility of 6.68 while Monazite has a magnetic susceptibility value of 4.11. This slight difference is exploited in the separation by using a very high tension electromagnetic separator. An electromagnetic separator with the following specs are suggested.

- Company: Ganzhou Gelin Machinery
- Feed size: 0 – 10 mm
- Power: 1.5kW
- Magnetic strength: 30 000 – 40 000 Gs
- Capacity: 10 – 20 t/h

RAW MATERIAL HANDLING AND ASSAYING.

The beach sand stockpiles will be managed accordingly and assayed using rotary rifle samples. The assay values of the incoming feed and each outlet will be monitored to ensure the standards of the final outcome.

Mixing of different will be carried out to ensure an average assay value acceptable is maintained throughout the mineral processing lifetime.

WASTE MANAGEMENT

The retained waste from the strainer and the vibrating screen should be manually sorted to avoid any naturally decomposing material in the remains. The sorted out waste will be buried at a nearby sight. The production plant will generate no dust due to its lack of crushing and grinding stages. Water used for straining and the pulp production will be recycled separately from a recycling plant and used again for the process. No fuel oil used in any stage resulting in zero carbon gas emissions.