A. Cement manufacturing Process

The whole process of cement manufacturing in Messebo Cement plant which consists of two separate Cement Production lines can be summarized into the following processes; as can be seen in the process and Quality flow diagram below:

1. Quarrying and Crushing
2. Raw material Storage and Transportation
3. Proportioning
4. Raw material Grinding and Transportation
5. Raw meal storage, homogenization and Kiln feeding
6. Pyroprocessing (Raw meal preheating, calcination Clinkerization, clinker cooling, crushing) and Clinker storage
7. Cement grinding and storage
8. Cement packing and Dispatch
Figure 1: Process and Quality Flow Diagram
1 Quarrying and Crushing

The quarry (where the mining activity is performed) is located 0.7 km away from the plant and has the main raw materials such as Limestone and shale, the other raw materials (Iron ore, silica sand, gypsum and pozzolana) are brought from nearby places. Limestone provides calcium oxide and some of the other oxides, while shale and the other materials (silica sand, iron ore) provide most of the silicon, aluminum and iron oxides required for the manufacturing of Portland cement. Gypsum and Pozzolana are going to be used for final cement grinding together with clinker produced from kiln.

In this unit there are three crushers few meters away from the quarry; two Limestone/Shale Crushers (one for Line 1 and One for Line2) and one Additive/Corrective Crushers common for both lines.

Line1 limestone/shale crusher reduces 85% of the size of the quarried raw material from 1000mmx1000mmx1500mm size to <=25mm while Line 2 Limestone/Shale crusher reduces 90% of the quarried raw material from 1000mmx1000mmx1500mm size to <=75mm. Additive/corrective crusher which
serves for both lines reduces 90% of the quarried materials from 800mmx800mmx1000m size to <=75mm.

2 Raw material Storage and Transportation

The plant has three raw material storages; storage 1 which serves for line 1 stores Limestone, Shale, Silica sand, Iron ore, Pozzolana, Gypsum and limestone additive. Storage 2 which serves for line 2 stores Limestone and Shale. Storage 3 which serves for line 2 stores Correctives (Silica sand, Iron ore) and Additives (Pozzolana, Gypsum, Limestone additive).

In both lines stackers are used for making piles which has homogenization effect and are being again pre-homogized and transported by reclaimers + belt conveyors to proportioning bins. Loaders are also used for loading the materials as required (especially in line 1 for correctives and additives).

3 Proportioning

In this unit, Limestone, Shale, Silica sand and Iron ore are proportioned and sent to Raw mill Unit for grinding. The proportioning ratio is done/adjusted every hour.
by the communication of weigh feeders beneath each bins and the QCX software (Blending expert software) based on the chemistry of the raw materials (input to grinding) and the chemistry of the raw meal(output from grinding) analyzed by X-ray every hour.

4 Raw material Grinding and Transportation
In this unit, the proportioned raw materials are being ground to the size of (10% residual on 90 μm sieve) by closed circuit ball mill in line 1 and Vertical Roller Mill (VRM) in Line 2. While grinding; the raw materials are being dried from 4% moisture content to <1% using the excess hot gas emitted from pyrporocessing system.

5 Raw meal storage, homogenization and Kiln feeding
In this unit, the raw meal which is ready for burning process is stored and homogenized in a storage called SILO to make sure that the standard deviation of the raw meal chemistry is within acceptable range suitable for stable operation in burning process and suitable for good quality clinker yield.

6 Pyroprocessing (Raw meal preheating, calcination Clinkerization, clinker cooling, crushing) and Clinker storage
The pyroprocessing unit includes the preheater(whereby the raw meal is preheated for drying the raw material moisture), the calciner(whereby 95% of CaCO3 is decomposed to CaO+CO2), the rotary kiln(where by the remaining 5% of the CaCO3 is decomposed and clinker minerals are formed, the cooler where by the hot clinker is cooled down and crushed by hammer crusher. The energy required for pyroprocessing is satisfied by firing coal at calciner and kiln main burner. The coal is dried and ground to the required moisture content and size before being fired in the process. After this all processes, the clinker is stored at clinker storage. In this unit ,the hot gases exhausted from preheater is used for raw meal drying, coal drying and the remaining is sent to the environment after being treated/cleaned using conditioning tower, cyclones, and bag filters. The hot gases from the cooler
are also sent to the environment after being treated/cleaned using either Electrostatic precipitators in line 1 or heat exchanger+bag filter in line 2.

Line 1 and Line 2 pypoprocessing units are designed to produce 2000 ton/day and 3000ton/day clinker and now producing 2100ton/day and 3500ton/day respectively.

7 Cement grinding and storage

In this unit, the input materials (Clinker, Gypsum, Pozzolana, and Limestone additive) are proportioned and ground in Cement mill (one Closed circuit ball mill in line 1 and two Roller press+closed circuit ball mill in line 2) based on the type of cement to be produced keeping the quality of cement equal or above the required standard. For instance (Clinker+Pozzolana+Gypsum) are proportioned and milled to produce PPC type of cement, (Clinker+Gypsum) to Produce OPC type of Cement, (Clinker+Gypsum+Limestone) to produce PLC type of cement, (Special clinker + Gypsum) to produce LHHS type of cement. After grinding, the finished product (cement) is stored in cement silos ready for dispatch.

8 Cement packing and Dispatch
In this unit the finished product (cement) from the storage silo is transported and packed by 50kg polypropylene bags using modern Ventomatic GEV/8 packers (two packers + 4 loading bays in line 1, four packers and 8 loading bays in line 2) each packers having the capacity of packing 2000-2500 bags/hour. This unit also has bulk cement loading system in powder form and in big bags (2ton).

N.B in each of the above units (1-8), cyclones, bag filters, are used to control dust emission to the environment to keep the emission level below 30mg/Nm3.

**B. Process Control**

The above unit operations and processes are controlled in a central control room (CCR) by well experienced cement technologists and Engineers with the help of computers (DCS, PLC software installed), PIDs, display mimics, monitoring cameras and etc as can be shown in the CCR photo gallery below.
C. Quality Control

As can be seen in Fig 1 (Process and Quality flow diagram) above, there are around 8 quality check points where by different samples are taken at some time interval (every hour most of the time) to check whether the raw materials/intermediate products/finished products fulfill the quality requirements or not so as to take countermeasure to correct any deviations on time.

1. Messebo Quality control testing Methods

1.1. Dry method testing

This procedure is used for testing of raw materials, finished, and semi-finished products using X-ray in combination with QCX and QCS blending expert software and this method is short and precise.

In addition, the plant has two types of XRF machines namely panalytical and thermofisher (XRD XRF compacted) which are able to give accurate measurement, detect and control any instrument deviation.

1.2. Wet method / Chemical method testing

This procedure is used in the chemical analysis of cement, clinker, free-lime, and the remaining raw materials using chemicals and it is also categorized as volumetric (titration) and gravimetric (weight).
2. Names of available equipment and devices to test & control chemical and physical properties of cement, clinker, raw mix, Coal, and raw materials

- **XRF machine**: to measure elemental chemical analysis within the raw material.

- **Bending and comprehensive machine**: to test and control the physical property of cement strength so as to meet the standard stipulated in ES EN 197-1.

- **Le-chatlier apparatus**: To test and control the physical property of cement soundness which is potential danger of concrete expansion and crack.

- **Blain apparatus**: to test and control the physical properties of cement fineness during finish milling.

- **Vicat apparatus**: to test and control the physical properties of cement setting time which plays vital role for workability.

- **Bomb calorimeter**: to measure the gross calorific value /heat value of coal or any other type of fuel.

- **Differential calorimeter**: to measure the exothermic heat value of cement liberated up on hydration in of cement.

Please refer Quality Control Photo gallery below for further understanding;