PRODUCTION OF SPONGE IRON AND CHARACTERIZATION OF IRON ORE FROM FUNYULA DIVISION, BUSIA DISTRICT, KENYA

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B.Tech (Production Engineering)

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PHILOSOPHY IN PRODUCTION ENGINEERING.

DEPARTMENT OF PRODUCTION ENGINEERING

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P.0. BOX 3900,

ELDORET,

KENYA.

JULY, 2002

ABSTRACT

Sponge Iron containing 60-95% Fe is an alternative raw material from the use of pig iron in the production of iron and steel. Cast iron and steel are virtually important in various fields like building industry, motor vehicle industry and in machine industry. Pig iron and sponge iron production requires an iron ore and a reducing agent like coke or coal. In rare cases, charcoal may also be used.

A survey done by the Ministry of Industry in 1987 revealed that iron ore reserves at Wanjala in Taita Taveta, Ikutha in Kitui and Marimanti in Meru district with a quantity of about half a million tons was not sufficient for economic exploitation.
The iron ore deposits found in Njalagobe hill, known to the locals as Ageng'a hill, (one of the hills constituting the Samia hills) at Funyula, Busia District, Western Kenya are mainly haematic in composition. During the time of this research, some Jua Kali artisans were smelting this iron ore source. Following a mathematical approximation from a geological map at a scale of 1:125,000, approximately 300 million tonnes of ore exist in Ageng'a hill.

The aim of this project was to characterize the iron ores in Samia hills and use the ores to produce sponge iron in a charcoal fired rotary kiln that was manufactured at Moi University. The kiln was utilizing charcoal as a fuel and as a reducing agent.

During the production of sponge iron in the rotary kiln temperatures were measured by the use of a thermocouple connected to an oscilloscope that was calibrated against an electric furnace type GLM 11/3. This furnace was also used for carrying out several characterization experiments. The separation of the magnetic material was done by the use of an axially magnetised ring magnet. An Atomic Absorption Spectrometer and titrimetric analysis were utilized in the chemical analysis of the raw ore and the products of production. These were done after crushing the samples by a jaw crusher followed by fine grinding to less than 200 mesh at Mines and Geological Department, Ministry of Environment and Natural Resources in Nairobi. The actual production of sponge iron was undertaken in a two -stage process.

Characterization experiments revealed that the iron ore in Samia Hills with a specific

gravity of 3.825 and ≈ 37% total iron is a concentrating grade comprising of rich and lean iron layers. The ore contains about 45.47 % Fe_2O_3, 8.72% Fe_3O_4 and the main impurity material being silica (35.0%).

Reduction of the ore in an electric furnace in the presence of charcoal for 4 hours at 800°C yields a magnetic material with 29.50% Fe, 65.52%Fe_3O_4 and 0.6 % Fe_2O_3. This material is called magnetite. Further reduction of the magnetite in the electric furnace for 1 hour at 1050 °C gives sponge iron with 76.18 % Fe, 21.99% Fe_3O_4, total iron content of 92.02% and a degree of metallisation of 82.8%.

Reduction of the raw ore for 6 hours at 839 °C in the presence of charcoal in the rotary kiln produced magnetite with 15.66% Fe, 67.37 % Fe_3O_4 and 1.20 % Fe_2O_3. Further reduction of the magnetite in the electric furnace for 2 hours at 950°C produced magnetite with 54.14% Fe, 44.45 % Fe_3O_4 and 0.45%Fe_2O_3. The reduction of this magnetite for 2 hours at 1000 °C in the rotary kiln produced sponge iron with 67.5% Fe, 31.72 % Fe_3O_4, 0.20 % Fe_2O_3 and a degree of metallisation of 75 %. This iron content (67.5% Fe) is however low.

In conclusion, for sponge iron production in a rotary kiln, a two-stage process should be used with well-insulated furnaces and with raw ore sizes of 4-5 cm. The first stage is the reduction of these ores for 4 hours at 800 °C then reducing the magnetite to sponge iron for about 2 hours at 1050°C.

It is recommended that a geological survey be undertaken to quantify the amount of iron ore present in Samia hills more accurately.