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Studies on the production of calcium carbide in a 400 kVA Soderberg electrode furnace

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A prototype 400 kVA Arc furnace using graphite electrodes has been retrofitted with Soderberg self-baking electrodes, and the present paper describes the features of the retrofitted arc furnace facility and the results of the experiments which establish the advantages of self-baking electrodes.

Key words: Calcium carbide, 400 kVA arc furnace, Soderberg electrode

INTRODUCTION

Studies on the production of calcium carbide have been carried out at CECRI employing prebaked electrodes [1]. However, all modern carbide plants are equipped with self baking electrodes, more commonly known as Soderberg electrodes as they are much cheaper to operate than the prebaked type. In addition, the high cost of prebaked electrodes affect the economics of production. Hence the Soderberg system of electrodes was incorporated in the 400 kVA arc furnace and the results of the experiments confirmed the economic viability of small scale plants.

DESIGN AND STRUCTURAL ASPECTS

The furnace transformer available in the laboratory is provided with four voltage taps of which 80 volts tap corresponding to a current of 3100 Amps has been chosen for the present studies. Electrode diameter and other furnace dimensions are then fixed by applying standard design calculations [2,3].

The furnace of 1.75M height, lined along the side and at the bottom with carbon, fire clay and insulation bricks, rests on a steel foundation with a tap hole located in the front at 0.5M height from the bottom. A swing type tapping electrode supported in the furnace shell serves to tap the molten carbide. Two platforms for charging the raw materials, for welding the steel casing shells and for adding the Soderberg paste have also been provided.

Slipping of the electrode is accomplished by a simple arrangement. The contact pads, which also serve as the cooling rings, are connected to the electrode holders by chains, the electrode holder being supported by steel ropes passing through pulleys with counter weights on the other end. During slipping, the contact points are loosened and refixed at a fresh point corresponding to the slipping distance. In a similar way the electrode holders are also fixed at new points.

Electrode movement is done by gear motors and controlled by observation of current readings in a panel board.

EXPERIMENTAL

Limestone and sea shells employed as the source of lime along with charcoal were of 97-98% purity. Experiments were conducted for 24 hours duration. Four steel casing shells (1M length) each, placed and welded one over the other were used to make the electrode column. In large scale furnaces a reduction of manpower is reported [4] by inserting the solid carbon paste blocks into the space between the fins of the electrode casing with the help of cranes. In addition, this arrangement provides more weight per cubic foot of the paste than other methods of filling the electrode column. However in the present studies, carbon paste in a granular form was fed from the top. Slipping was done once in a day. First tapping of the molten carbide was done four hours after the start of the experiment and thereafter once in two hours.

RESULTS AND DISCUSSION

The results of the typical experiments are given in Table I. From the Table, it is evident that with 1: 0.5 limestone and charcoal ratio, commercial grade calcium carbide is formed and the gas yield, power, electrode and casing shell consumption are all comparable to the commercial data. The greater consumption figures in other experiments can be explained from the CaC_2 - CaO phase diagram [5], which shows greater melting points for pure as well as CaC_2 with more CaO inclusion. There is scope for further lower consumption pattern of power and other parameters for 1: 0.5 ratio experiment, when the production is carried out for longer duration.

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TABLE–I: Production of calcium carbide in a 400 kVA Soderberg electrode furnace

No.	Limestone and charcoal charge ratio	Gas yield (l/kg)	Power consumption (kWh/T)	Electrode consumption (kg/T)	Electrode shell consumption (kg/T)
1	1: 0.3	175	5.6	55	21
2	1: 0.4	244	5.1	47	18
3	1: 0.5	305	4.5	42	15.5
4	1: 0.6	337	5.25	46	17.5

CONCLUSION

Soderberg electrode system for calcium carbide production has been proven workable even in the smallest size plant.

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