

Carbon and graphite in the service of steel and ferro alloy industries

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There is hardly any industry where carbon is not used in one form or other, but it enjoys a special importance where its property as a carrier of electricity plays a vital role in addition to other properties specifically its inertness to attack by molten metal at elevated temperatures. Hence, in electric energy intensive metallurgical industries like, aluminium smelter, pig iron by electro smelting, calcium carbide, ferro-alloy industries etc., electrodes of various designs & sizes are used either in amorphous or graphitised form.

The ferro-alloy, calcium carbide, pig iron industries utilize carbon paste in the cylindrical form with sizes varying from 50 to 500 mm dia depending on the size of the furnaces. In the aluminium industry mainly rectangular shape electrodes are used which may be either continuous soderberg type or continuous prebaked type or multiple prebaked type. In the electric steel making process, multiple graphite electrodes using nipple-joints need to interrupt production process.

Soderberg electrodes are the vital part of the electric smelting furnaces of pig iron, calcium carbide, ferro-alloys etc. These are generally of large in diameter upto 2 meters, cheaper in cost, easy for operation and baking since manufactured on the spot by additional joints without interrupting the furnace operation and are quite suitable for electro-thermal smelting process where the contamination of metallic casing is tolerated

Carbon paste is the basic raw material for

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the Soderberg Electrodes. The properties of carbon paste to be controlled are its bulk density, flowability and chemical composition which are critical to form a uniform baked electrode with good electrical conductivity, mechanical strength and thermal elasticity.

Basically the process of electrode manufacture starts from the base material-carbon in a suitable granulated form with the use of a binder material. The choice of base carbon material, its characteristics, granulometric composition of the aggregate, quality and quantity of binder and the manufacturing process have developed to such a level of expertise that each of them have become, of paramount importance and part of a specialised field of technology. The end use of the electrode governs the selection of raw materials and manufacturing process.

Though the quality is of prime importance in the selection of raw materials, there are other restraining factors like availability, suitability, price etc. Though regular grade cokes available in India are suitable for making products suitable for the aluminium and ferro-alloy industries, they are not quite suitable for making high quality regular grade graphite electrodes of bigger sizes (> 400mm dia) and high current carrying UHP electrodes. Production of these electrodes require the use of the highest grade needle coke. But the world production of needle cokes is limited by the fact that petroleum crudes which can produce needle cokes are themselves in limited quantities. Generally, Indian crudes are found to be capable of producing only regular grade cokes with relatively high coefficient of

thermal expansion. Availability of quality binder pitches with high beta-resin content is also limited in the country and large quantities of this material are being imported from Japan and West Europe.

In the electric furnace process, electrode performance is important from the view-point of cost control not only because of actual consumption but also with respect to service reliability to avoid process delays. In the production of carbon and alloy steels, utilising high and ultra-high power furnaces, electrode cost accounts for about 10-15% of total conversion cost.

Generally, a distinction is made between net and total electrode consumption. Net consumption is the result of the various modes of wear, electrodes are subjected to in the electric furnace environment. It can be subdivided further into longitudinal consumption, consisting of such variables as are vaporization, butt losses, mechanical erosion between the steel bath and the electrode etc., and transverse consumption which is mainly caused by the oxidation of the electrode in the furnace. Total electrode consumption is net consumption plus breakage.

Breakages can be due to either poor quality or bad handling of electrodes. Constant efforts are being made by the graphite industry to upgrade the quality of their electrodes by careful selection of raw materials, improved manufacturing processes, strict quality control at every stage of the process, as well as machining of the finished product etc.

To reduce electrode consumption due to oxidation, various oxidation retardants, ceramic/metallic type coatings have been developed. Impregnating with some inorganic substances (phosphoric acid, zinc oxide, aluminium hydroxide, copper sulphate, copper nitrate etc.) can decrease electrode consumption by 20%.

To improve the overall performance of graphite electrodes, various modifications have been attempted with varying degrees of success. They include oxidation retardants, pitch plugged nip-

ples to reduce joint loosening and butt loss caused by furnace vibration, hollow electrodes for arc stabilisation, nipples of different sizes and configurations to reduce thermal stresses etc. Each of these modifications have demonstrated benefits to the consumer but the degree of benefit has been quite variable depending on the operating parameters and practices of given industrial shops.

UHP electrodes, another recent development in the electrode technology, are capable of carrying very high currents, thus rendering possible the use of larger capacity (upto 400 MT) steel melting furnaces. But production of these high quality UHP electrodes is energy intensive and requires quality raw materials, both of which are in short supply in the country, at the moment. Also the graphite industry does not feel it worthwhile to go into the production of these electrodes, as the steel industry is not yet ready to use these electrodes because of prohibitively high cost.

Another achievement in the line of reducing electrode consumption has been reported in Canada where an innovative composite electrode system has been developed. This system combines a non-consumable metallic, water-cooled top section with graphite electrode in lower sections. The top section won't overheat or distort, it is hollow for decreased weight and cooling. No oxidation takes place in this region. Savings of about 20% have been achieved in extended trials. The total operating costs of a composite electrode system are significantly less than an all-graphite system.

The technology of electrode manufacturing is extremely vast and complicated. There are stringent demands on the raw material quality and severe restrictions imposed on the process parameters. Therefore, there is an obvious need for an intensive exchange of data and experience by those who are connected with this field—the scientists, technologists, engineers, producers and consumers. We hope some of these objectives will be achieved by conducting seminars like this.

Discussion

M. Subramanian, FACOR, Shreeramnagar.

Q. Can you supply the electrode materials with additives to resist oxidation losses ?

A. No, not yet. Developments which are taking place abroad are all patented. Our R&D is working in this area and we are likely to come out with some results in the near future and we shall get in touch with customers as and when we come up with this material.

S. K. Srivastava, R&D (SAIL), Ranchi

Q. Can you give some specific types of coating materials used for prevention of oxidation. What are the methods of making such coatings ?

A. As in one above.

S. K. Patnaik, IMFA, Bhubaneswar

Q. What is the largest size of electrode available in your organisation ?

A. 500 mm dia

Q. Is there any plant to produce the items in diameters of 950 mm size which is to be used for the production of metallic iron ?

A. No, not in the near future.

Q. Do you have plans to manufacture carbon blocks for Ferro Alloy industry ?

A. Yes, if the CPC base material is acceptable, we are already manufacturing these blocks in a maximum of size of 16" x 16" and length can be as 1.8 mtrs. but the only question is whether CPC base material is acceptable because we had discussions with certain ferro alloy manufacturers and we were informed that they are more interested in anthracite base material.