

# **SESA ENERGY RECOVERY COKEMAKING TECHNOLOGY TEN YEARS OF OPERATION AND OUTLOOK FOR FUTURE DEVELOPMENT**

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The Sesa Kembla Coke Company started operating its ovens in 1994 with technology from Kembla Coal and Coke Pty. Ltd., Australia, and has been continuously producing coke since then. Consequent to some shortcomings experienced in the initial installation, the alumina based fireclay bricks were redesigned in shapes and quality of refractory and arranged in a unique mosaic to suit the studied temperature profile and to ensure effective temperature resistance at a reduced cost. The new Sesa design was used to reconstruct the ovens in 1998 and the ovens have been operating satisfactorily since then with superior coke quality from a wide range of blended coals, a level of environmental pollution that is acceptable to the most stringent international standards, and with a high level of energy recovery from the exhaust gasses.

In a further development experienced engineers from VeCon GmbH of Germany designed a compacted charging system to specifically adapt to the operation of these ovens, which could then use up to 70% semi soft coals in manufactured in India to the German basic design.

The design is now currently being offered internationally in standard cost effective modules of 300,000 T/A each and can be expanded in multiples of this to achieve higher capacities at better economies of scale.

Keywords: energy recovery ovens; compacted coal charge; Sesa Kembla

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## **1. HISTORICAL BACKGROUND: EXPERIENCE TO DATE WITH TOP CHARGING OF THE COAL BLEND**

The Sesa Kembla Coke Company Ltd. was formed in 1993 as a joint venture between Sesa Goa Ltd. and Kembla Goa holdings Ltd., and a coke plant of a nominal capacity of 280,000 T/A commissioned in Goa in 1994 with technology sourced from Kembla Coal & Coke Pty., Ltd., of Australia. The initial installation experienced some shortcomings. In order to resolve these 5 pilot ovens were reconstructed, their temperature profile studied and their component brick shapes and quality specs modified to suit the variations in the temperature profile of the oven. The temperatures within the coal cake were found to be even. Cold spots were designed out by modifying the flue passage, especially the down comers, and bricks that experienced repeated failures in different ovens were redesigned so that by a diligent process of trial and error all the known defects were designed out.

The modified ovens now operate almost maintenance free as can be seen from the output of the ovens which is higher than its rated capacity consistently over the last five to six years.

The quality of coke is excellent. Pollution levels are minimal and meet the latest US EPA Regulations. The energy recovery is superior due to the cooling of the oven foundation by ambient air and the reuse of that air in the ovens and its underflues as primary and secondary air. The hot air is also injected into the common flue in a controlled manner based on the oxygen content at the base of the stack or the entry into the boiler in a manner that ensures a 6% level of oxygen in the flue gasses as they enter the boiler. The temperature of the gasses is maintained at a consistent level of 1200°C because of the high coking temperatures in the region of 1300°C and the exothermic nature of the reaction, when the hot oven foundation cooling air enters the common flue and converts CO to CO<sub>2</sub> burning all the combustible particulates there.

The SPM of the air entering the boiler is below 50mg/NM<sup>3</sup> since all suspended particulate matter of a combustible nature is combusted in the long common flue thus eliminating a critical source of pollution.

The coal charge in the top charged ovens is 26 tonnes per charge. The charge is then leveled in the oven by a leveler with hydraulically operated wings that are profiled in a shape that is the outcome of several trials, and this ensures a minimum burning loss on the surface of the coal cake.

The well leveled coal cake to a height of approx 1.18 meters (depending on the constituents of the coal charge) cokes in a cycle of 48 hrs. The even coking of the coal cake is demonstrated by the good and uniform coke quality, its very low burning loss of the order of 2 to 3% max and the absence of emissions while pushing the coke block into the hot coke / quench car.

**CHARGE CAR IN ACTION – NO CHARGING EMISSIONS**



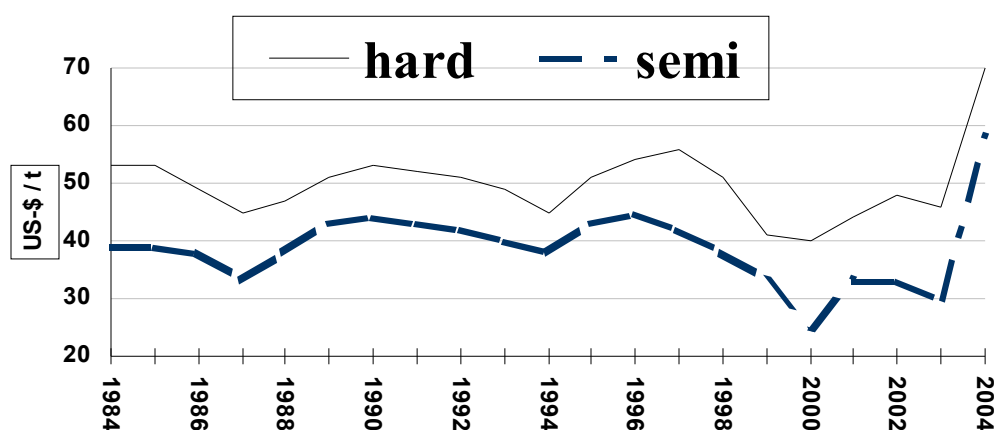
**COKE BEING PUSHED INTO THE QUENCH CAR – NO PUSHING EMISSIONS**



## **2. CURRENT UPGRADATION DEVELOPMENT ON COMPACTED CHARGING**

During the last two to three years we have carried out several trials with the compacting of the coal cake charged into the oven. The trials were carried out in collaboration with Mr. Gerd Veit from Germany. The initial trials were very successful. A density of 1.14 Tonnes/M<sup>3</sup> was achieved by manual compaction using a pneumatic machine and there was found to be no need for moisture addition. The results of these trials have been presented at the 2001 Iron and Steel Exposition and AISE Annual Convention in Sept 2001 in Cleveland Ohio and are available at [WWW.STEEL TECHNOLOGY.ORG](http://WWW.STEEL TECHNOLOGY.ORG) under COMBINING STAMP CHARGING WITH THE HEAT RECOVERY PROCESS.

Some independent trials were also carried out by our shareholders at the pilot oven of Nippon Steel during the last year and these confirmed the validity of the proposed project investment.



With the recent sharp rise in coal prices the need to lower input coal costs through compacted charging and adoption of up to 70% Semisoft coals into the coal input blend became more pressing. By 2005 the whole of the oven installation will be upgraded from a 280,000 T facility to one with an output of 340,000 T/A with the introduction of compacted charging. The compaction of the coal charge is proposed to be carried out in a stationary compacting station with the use of electromechanical vibrators and the compacted cake is expected to be transferred on to a charge car which will charge the compacted coal cake mounted on a steel plate into the oven where it will be held in position by a trestle while the steel plate is withdrawn and the oven door closed. A compacted coal cake of a height of 0.95 meters can be fully coked evenly in our ovens at Goa within 48 hrs. The coal input into the blend for the cake is proposed to use up to a 70% semisoft coals component without adversely affecting the final coke product quality, which is expected to be more than adequate for blast furnace operations.

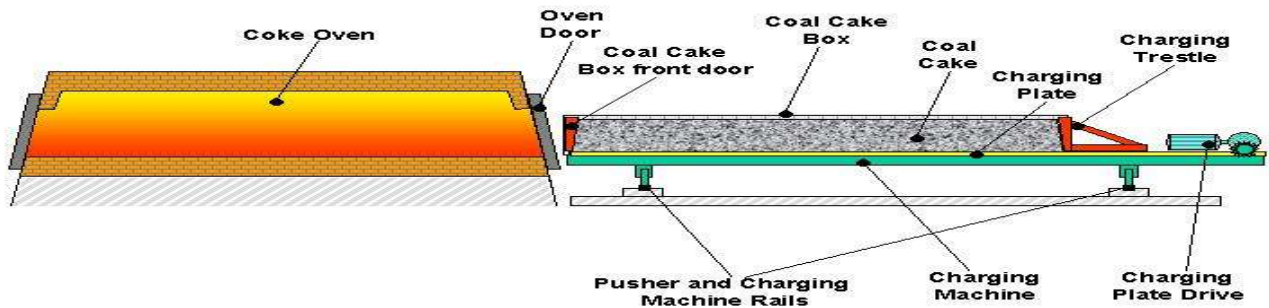
The current costs of semisoft coals are approx US\$ 16 per tonne coal cheaper than the hard coking coal component and hence the project payback is very short indeed - in a matter of months. More importantly, the semisoft coals are much more easily available than

the prime hard coking coals that are critically required in a larger proportion for the top charging options.

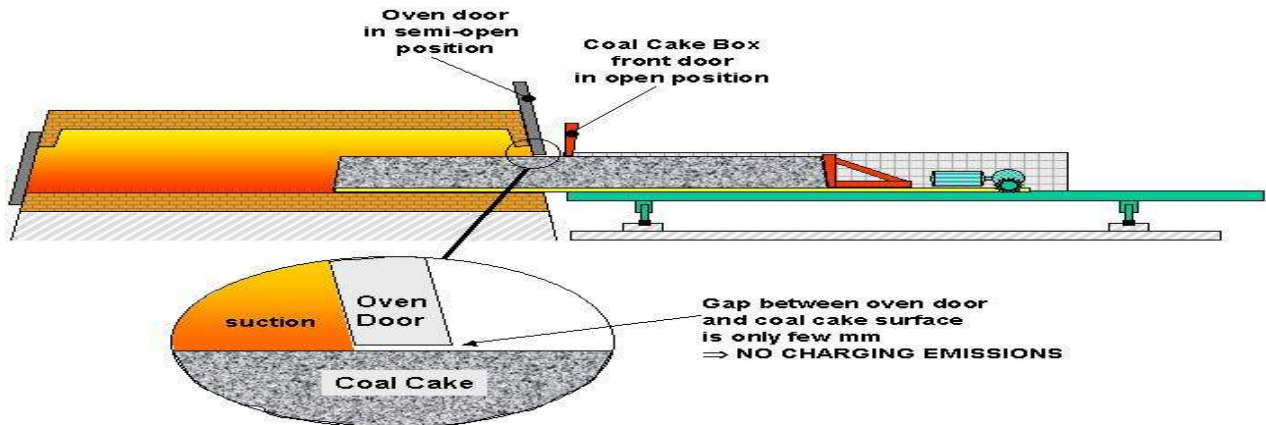
In a new installation the oven size with the Sesa technology has been redesigned to take a compacted coal charge of up to 36 Tonnes / Charge. The flue passages have been appropriately designed to take on the higher gas load from the larger quantum of volatile matter.

In a 600,000 T/A installation the cost savings due to the reduction in the no. of ovens and the refractories required for the installation, offsets the cost of the additional compacting machinery. The basic design of the machines is being done by VeCon GmbH in Germany while the detailing and the fabrication work for the machines is being made in India by FFE Minerals Ltd., under the supervision of VeCon GmbH in order to minimize capital costs.

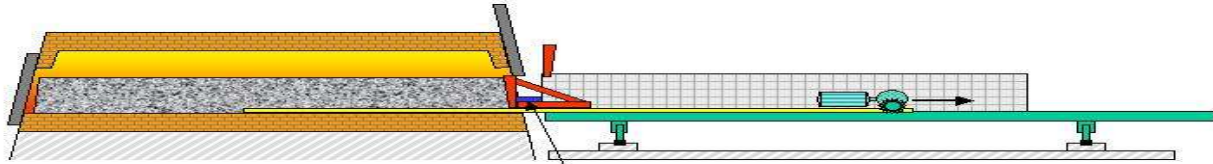
### THE ESSENTIAL PARTS OF A COMPACTED CHARGING MACHINE



### SITUATION DURING CHARGING OF THE COAL CAKE



## SITUATION DURING REMOVAL OF THE CHARGING PLATE



Charging Trestle holds back the Coal Cake  
Charging Trestle is locked to the Charging Machine by a stopper  
before pulling back the Charging Plate

### 3. CURRENT DEVELOPMENTS – FACILITIES FOR FEEDING GROUND COKE BREEZE OR OTHER INERTS INTO THE COAL CHARGE

In an oven installation located at an integrated steel plant the fines generated at the coke ovens and in the handling of the coke are easily economically utilized in the sinter feed plant if available. However if no use for the fines can be found locally then the most economical option is to install a coke grinding facility which heats the fines, grinds it to a size of below 90 microns in a ball mill, and blends this feed economically into the coal feed depending on the economy of doing this versus the option of selling the fines.

The coke breeze is an inert. When introduced without grinding it causes the product coke to have an increased quantum of fissures. When finely ground and fed it results in larger size of coke lumps. In coke ovens that are dedicated for the production of foundry coke, an appropriately ground feed of inert ground coke breeze has been found to be very useful in increasing the average size of coke lumps from the ovens. In such installations there is also the practice of adding petroleum coke to lower the ash level in the product coke. Coking at lower temperatures increases the cycle time but improves the shatter index of the foundry coke. However lower temperatures (below 1280°C) do not break up all the hydrocarbons in the volatiles and cause them to escape in the exhaust. These hydrocarbons precipitate in fine particles at ambient temperatures causing a serious pollution hazard and needs to be separately treated to ensure that this pollution is taken care of and that the exhausts meet the stipulated EPA norms.

### 4. MINIMUM ECONOMICAL SIZE OF INSTALLATION - MODULAR SIZES STANDARDISED FOR THE SESA DESIGN

The minimum economical size of installation is, of course, dependent on the costs of coal input and the market price of coke as also on the capital cost of the oven, the type of refractories used and the cost of oven machinery in the design and installation. At current prices almost any small capacity can be found to be economically viable. However under more stable conditions of coke pricing and coal availability and pricing SESA has designed a standard module of 300,00 T/A that is expected to always stay economical in the long run.

This module consists of two sets of 16 ovens each connected to its common flue and both common flues connected to a single stack, which is refractory lined. The off take to the boiler installation is so arranged from the stack in a manner that retains the high sensible heat in the gas when it enters the boilers which need to be specially designed with a larger radiant section and a larger water drum that will absorb the variations in heat due to the lower number of ovens being pushed (since each oven charge initially results in a temporary peak in heat output).

The exhaust from the boiler may or may not need a de-sulphurisation facility depending on the quantum of sulphur emissions in the area and the local pollution control norms but more importantly on the sulphur in the input coal charge and whether that sulphur is in organic or inorganic form.

If the installation is used for low temperature (below 1250°C) coking a special facility to raise the temperatures of the exhaust and to break up the hydrocarbons is most essential to ensure against polluting emissions.

Anyway the SESA design is flexible and the standard design can be adapted with small modifications to the individual small customer, and this is particularly applicable to Brazil as it is to India, which must cater to this special requirement.

## 5. PERFORMANCE OF BF COKE IN THE BLAST FURNACE

Over 90% of the metallurgical coke consumed in the world is used in blast furnaces and this coke needs to have certain critical properties that we are all aware of. With the advancement of PCI practices and the more stringent need to conserve coke and improve blast furnace productivity the coke properties have become more critical. In our experience the quality of coke produced in the Sesa ovens performs extremely well in the large blast furnaces which used the higher size range of 30mm – 80mm as well as in the mini blast furnaces which use the smaller size range of 20mm – 60mm. In the Sesa MBFs which use the KTS Brazilian MBF technology with Glendons / Metallic Blast Preheaters which produce comparatively lower blast temperatures the performance is as under:

Performance in 173M <sup>3</sup> MBF with 100% Lump ore			
Hot Metal	Foundry GR	Basic GR	Blast Temp. °C
Productivity	2	2.3	
Coke rate	640 Kg	600 Kg	850
Coke rate	655 Kg	615 Kg	

We submit that this is a high level of productivity and coke rate, given the constraints of the lumpy ore feed (no sinter) and the low blast temperature.



The quality parameters for coke used for other applications than the blast furnace e.g., for foundries, for ferroalloys etc are different from the BF parameters and we have been able to develop oven design that can cater to these parameters, always holding the imperative requirements on pollution and energy conservation. If there are customers who are interested in these specialized applications we can discuss their requirements separately.

## **6. LICENSING ARRANGEMENTS FOR BRAZIL:**

Sesa has a corporate policy that whereas we are successfully engaged in production and development operations, we do not have adequate expertise in the engineering activity of erecting the oven facility and the transfer of technology. We need to partner an experience licensee for this purpose.

In 2001 we had signed licensee agreement with Enron Engineering and Construction Co. Ltd., of the USA and with Toyo Engineering Corporation of Japan and these parties had separate exclusive geographical areas of operation. There was also collaboration for mutual technical assistance between our licensees. However with the unfortunate collapse of Enron we have regained the technology rights from both our licensees. The territory of India, Sri Lanka and Bangladesh has been assigned to Mesrs. FFE Minerals, India and they have booked orders or LOIs for three plants in India so far. Additional orders are expected for more plants and we hope by end 2005 to have orders completed or work in process for plants with a total capacity of 3 million tonnes per year of product coke.

The licensing arrangements for Brazil are currently under final discussion and our proposed licensee will be presented at the ABM Seminar.

## **7. CLEAN DEVELOPMENT MECHANISM – ENTITLEMENT FOR CARBON CREDITS AS PER KYOTO PROTOCOL AND CONCLUSION:**

The Sesa Energy Recovery Technology Power Plant Facilities are entitled to carbon credits as per the Clean Development Mechanism as agreed at the Kyoto Protocol. Both Brazil and India are signatories to this protocol.

The NPV value of the carbon credits for a module of 300,000 TPA of coke complete with a power plant of around 28MW of electrical generation is of the order of US\$ 8 million - the exact details can be determined and ascertained for individual projects as desired.

In one particular project currently under execution in the Western Coast of Indian the introduction of the coke plant together with its ancillary power plant facilities actually leads to the reduction in polluting emissions in a local fertilizers plant.

In conclusion, I wish to state that the Sesa Energy Recovery Technology is most suited for most Brazilian applications whether they are small miniblast furnace applications or large Blast Furnace usage, foundry applications of a min of 300,000 T/A consumption or even ferroalloy applications. The provision of compacted charging reduces input coal costs and improves coke quality without increase in plant capital costs. The German designed machines can also upgrade the operation to suit individual needs and requirements of automation and instrumentation.

The cost of conversion of coal to coke in India, inclusive of cost of power, water, labour and third party costs of operation and maintenance is below US\$ 4 per tonne. This may be higher in Brazil where labour costs are higher but again can be reduced with a higher degree of automation. The capital cost of the plant is most certainly lower than the competition because of the optimization of the quality of refractories used and higher levels of automation and instrumentation in VeCon's machines, which are economical because they are manufactured in India, where costs are cheaper, although they have the backing of high quality German design engineering concepts backed by extensive experience.

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