SESA ENERGY RECOVERY OVENS

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INTRODUCTION

Coke making started with the beehive ovens, which were later enhanced to non-recovery type of coke ovens. The by-product ovens because of the value addition due to the recovery of coal chemicals were preferred over non-recovery ovens as a more viable and profitable investment.

The stringent pollution laws and the high cost involved in the installation of pollution control equipment led to many by-product coke oven plant to face closure in the 80's and 90's.

This led to a revival of interest in the non-recovery coke oven technology as it was realised that it could be used with minimum investment and complied with the pollution control regulations. However sceptics were still not sure about the acceptability of coke produced in these ovens in blast furnaces particularly those with large capacities.

When the coke requirement of Sesa's mini blast furnaces were to be met, the company was attracted by the low capital cost of the non-recovery ovens with its easy compliance with pollution control norms without any major investments.

Sesa Kembla Coke Company was thus formed as a joint venture between Sesa Goa Ltd. and Kembla Goa Holdings Ltd. in 1993 with a set of 84 ovens based on the technology from Kembla Coal & Coke Pty. Ltd., Australia.

Despite the best of intentions the oven design could not withstand the rigours of the 48 hour cycle intended and the entire battery brickwork failed due to various deficiencies. The reasons for failure were systematically analysed and new concepts, designs and materials were introduced successively in prototype ovens.

Based on the new design, the 84 ovens were reconstructed two years back and they have been producing to their rated capacity of 280,000 tons/year. Both the coke yield and energy recovery are high for a given coal blend. The coal charge car, pusher car and hot coke cars were all redesigned and upgraded with the operational and maintenance experience of the last five years and are now performing satisfactorily under an operational regime that has very low emissions, that can meet the norms of legislation in advanced industrialised countries. The capital cost was kept low at about US$ 65 per annual metric ton (construction cost in India). The combination of low capital cost, low operational cost per ton of output and excellent product quality, which is acceptable in large blast furnaces as well, make this technology an attractive investment in today's tightening metallurgical coke market.

The technology has been exclusively licensed worldwide to Enron Engineering and Construction Company Ltd. of the U.S.A. and Toyo Engineering Corporation of Japan in August/September 2000. The licensees, after a series of due diligence tests have expressed satisfaction over the performance of the ovens and the realisation of technological parameters. A separate agreement with Mitsui & Co. and Enron Corporation provides both companies with the opportunity to use their respective capabilities to access coal and coke in the commodity market and provide related risk management and financial products.

CONFIGURATION & CAPACITY AT SESA'S PLANT IN GOA

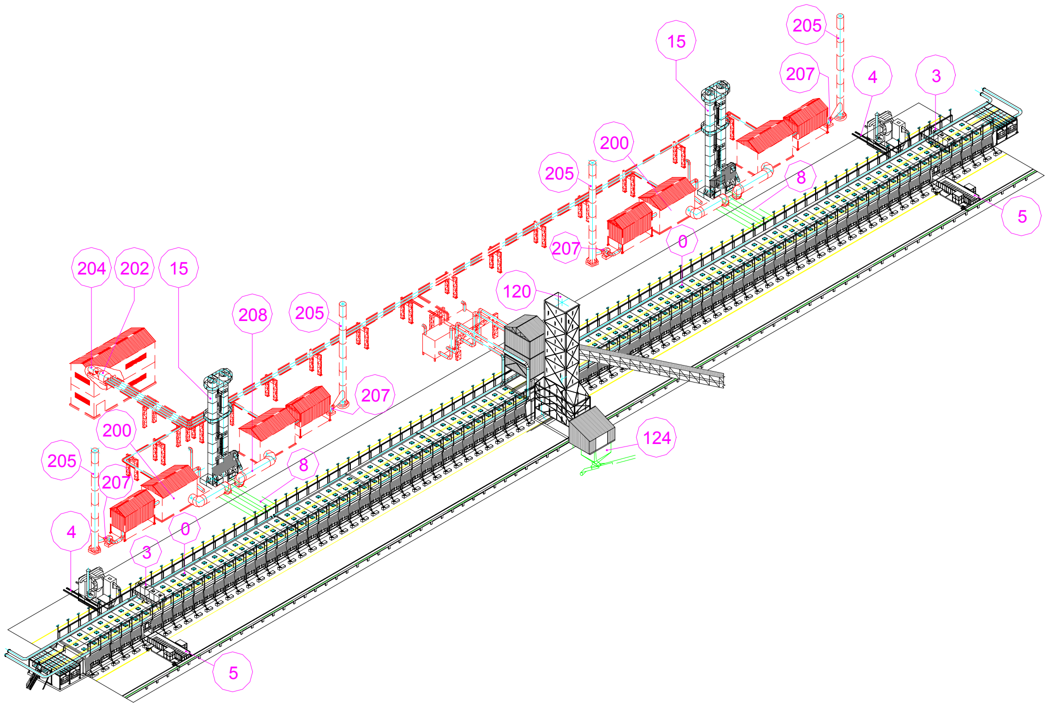
Sesa's plant at Goa consists of 84 ovens in two batteries of 42 0vens each with a level coal charge capacity of 26 tonnes and a coking cycle of 48 hours it has an annual capacity of 280,000 metric tons of coke. Every set of 21 ovens is connected to an independent stack. A comprehensive coal handling and blending plant. A single Quenching tower with wet quenching and a single line coke cutting and screening plant services both the batteries.

Up to 4 components of coal can be incorporated in the coal blend. The plant has a covered storage yard to store up to 6 month's coal consumption since it is difficult to import coal during the monsoon season when it rains heavily.

Due to the low sulphur in the coal blend SOx emissions are low and a system of tertiary air feed into the common flues ensures against the exhaust of carbon monoxide and the presence of over 6% oxygen in the flue gases. Particulate emission is very low as all combustible particulates are completely burnt in the common flue.

The original batteries designed by Kembla Coal & Coke Pty. Ltd. of Australia was set up in 1994 but after their failure, several prototypes were developed and the ovens were reconstructed in 1999/2000 to its present configuration.

A 30MW power plant is being installed on a BOO basis. Plant capacity is also expected to increase by 50% with the proposed installation of 42 additional ovens, which will incorporate the most recent developmental experiments by way of optimisation of energy recovery and improvements in process controls.



ISOMETRIC VIEW OF THE PLANT

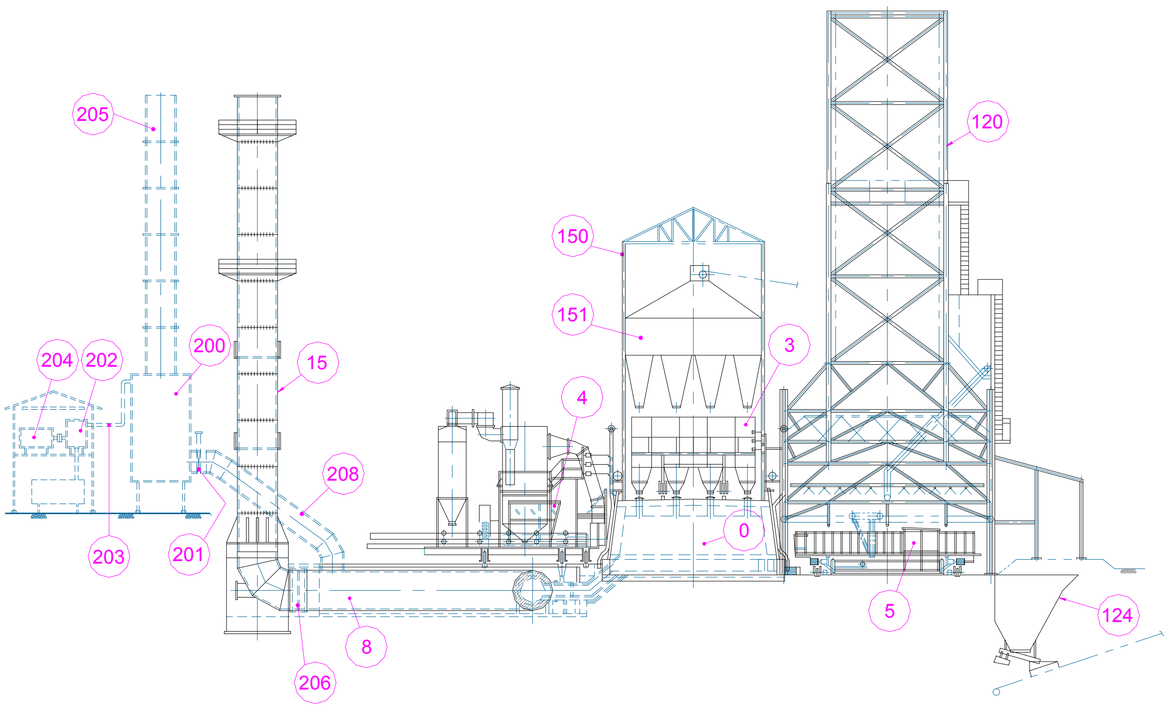
0	Oven	124	Hopper
3	Charge Car	200	Boiler
4	Ram Car	202	Turbine House
5	Hot Coke Car	204	Generator
8	Common Flue	205	Stack (Power Plant)
15	Stack	207	I D Fan
120	Quench Tower	208	Duct

DESIGN CONSTRUCTION AND CAPITAL COST

Simplicity and robustness are the hallmarks of the design of plant. Ease of construction, operation and maintenance follow from this. Most importantly the capital cost is quite low. For the installation of the 280,000 metric tons/year plant at Goa with coal unloading, storage and blending facilities as well as coke cutting and screening facilities a capital cost of approx. Rs.3000 or US$ 65 per annual metric ton installed capacity was incurred.

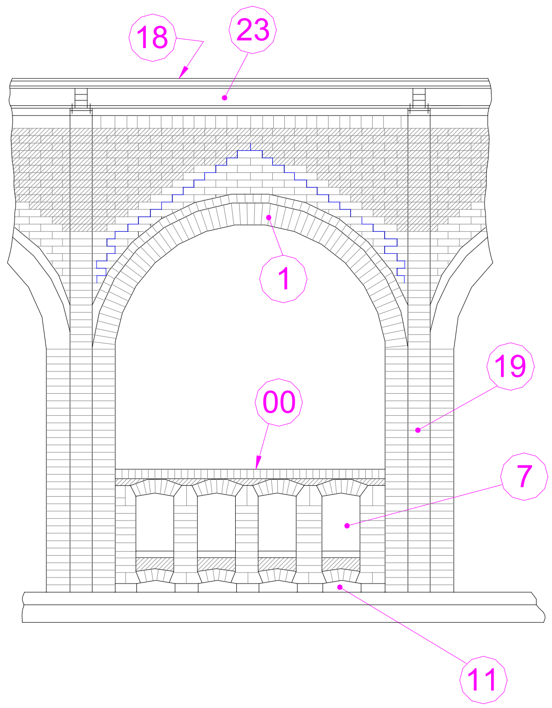
The ovens are constructed of alumina bricks of different specifications, evolved over the last 4 years after experimenting with a series of prototypes. The mosaic of bricks of different specs ensures that high alumina bricks are used in the areas of the oven that call for the higher (and more expensive) specifications while the areas subjected to less stringent thermal requirements have lower (and less expensive) specifications. The design makes supervision during construction a more stringent requirement to ensure that refractory bricks that might look alike are not incorrectly installed. However, the number of “shapes” used is limited to 100, thus reducing the brick layers efforts and enabling the achievement of a high productivity level during construction.

The above logic of simplicity is followed through in the design of the doors, the coal charge car, the pusher car with levelling mechanism and the hot coke car, all of which contribute to the lower capital cost of the installation.



CROSS SECTION OF THE PLANT

0	Oven	151	Coal Bin
3	Charge Car	200	Boiler
4	Ram Car	201	Valve
5	Hot Coke Car	202	Turbine
8	Common Flue	203	Steam Pipe
15	Stack	204	Generator
120	Quench Tower	205	Power Plant Stack
124	Hopper	206	Damper
150	Coal Bin Tower	208	Duct



CROSS SECTION OF THE OVEN

00	Oven Floor	19	Dividing Wall
1	Oven Roof	18	Charge Car Rail
7	Under Flue	23	Rail Beam
11	Cooling Air Duct		

PROCESS OPERATION, MANNING AND COKE QUALITY

Process Operation and Control

Coal is charged by gravity as is done in the conventional by-product ovens into the hot coke oven (after the previous coke charge has been pushed out) from the top of the oven with the help of a coal charge car that discharges predetermined quantities of coal from its 4 canisters in a sequence so as to minimise emissions and achieve a uniform and optimum bulk density.

The coal is then levelled to a flat profile that ensures optimal coking of all portions of the coal charge within the operating cycle of 48 hrs and distributed coal to the sides of the oven. This hydraulically operated leveller has been specially designed by Sesa's engineers after many studies of the coking pattern in the design of the oven. The significant advantage of this design of leveller is the achievement of a very uniform levelling as a result of which well coked charge can be pushed out of the oven in 48 hours with a minimal burning loss of the order of below 2%.

The process control is achieved by controlling the ingress of primary air into the oven chamber and secondary air into the underflues. While these operations are largely time dependant there is a certain element of control consequent to visual input and more importantly a feed back of the temperatures achieved in the oven crown and in various portions of the sole flues.

The extent of automation possible on these ovens is constrained by the large quantum of heat in the brick mass delaying the result of any action on automation. Furthermore, the cost incurred in such automation appears to be disproportionate to the savings. However, this does not preclude introduction of automation in identified areas and developmental work on this is continuing at Sesa plant. We believe a cost-effective automation could be achieved in the future.

Coal Blend Used

Admittedly, the coke quality is primarily dependent on the coal blend used. At Goa we have experimented with various blend combinations using Australian and Chinese coals. A typical blend would be as under:

Moisture	-	6%
V.M.	-	22%
Ash	-	8.6%
FC	-	69.2%
P	-	0.026
S	-	0.5
CSN	-	6.5
B.D.	-	0.78
Size (below 3mm)	-	83%

Coke Quality

The coking cycle times and the high temperatures used in this process contribute to the achievement of very good coke quality. The coke CRI and CSR are 2 to 3% better than those achieved in a corresponding by product oven using the same coal blend. This coke which is used in Sesa's mini blast furnaces has resulted in lower coke rates and higher productivity levels than those achieved in the same mini blast furnaces using a variety of good quality Japanese and Chinese cokes.

The typical specifications of BF grade coke are as under:

Moisture	-	3 – 4%
V.M.	-	1.0 – 1.25%
Ash	-	11.5% max
FC	-	87.3 – 87.9%
P	-	0.03%
S	-	0.5%
M20	-	90% (M20 is used instead of M40 since grade size is 20 – 50mm)
M10	-	6%
CRI	-	16%
CSR	-	74.5%

Emissions

The emissions from this installation are low and can meet the emission norms of most advanced countries and the EPA norms of the USA.

Leakage from oven doors and lids: Since the ovens are under negative pressure air leaks in rather than gases leaking out. There are moments particularly during and soon after charging when the oven pressure could turn positive momentarily but even these are taken care of in the design of doors and lids and more importantly in the oven operating regime.

Particulate emission: Particulate emissions out of the stack or into the boiler are normally below 50mg per Nm^3. This is achieved by the trapping of initial dust during charging by the operation of a bag filter on the Pusher Car during charging on the one hand and due to a system of tertiary air inlet for combustion of the combustible particles in the common flue on the other.

Exit gas composition: Due to higher coking temperatures (1200-1250 deg. C) the hydrocarbons in the coke oven gas are broken into combustible compounds and burnt. Controlled introduction of tertiary air in the common flues ensure that there are no remnant combustible matter in the waste gases going to the stack.

A typical gas composition at the base of the stack would be :

Temp	-	1200 – 1250 Deg C (substantially reduced at the top of the stack)
CO	-	25 ppm
SO_2	-	75 ppm
O_2	-	6 – 7%
C_xH_x	-	0.1%
CO_2	-	7.5%
NO_x	-	90 – 150 ppm

ENERGY CONSIDERATIONS

With the high exhaust gas temperatures and the inert composition mentioned above it is very convenient to utilise the high sensible heat content in unfired heat exchangers (waste heat recovery boilers) to produce high pressure steam that can operate a turbine.

The Sesa design circulates air in the foundation below the battery to keep it cool and this cooling air which absorbs certain amount of heat is reintroduced in the oven as primary and secondary air with a view to enhance the heat recovery. This puts a significant amount of energy back into the ovens and makes it possible to use lower VM in the coal blend resulting in a higher coal to coke yield. Alternatively with the same VM, more power could be generated from the flue gases.

MANNING

The operational manning at the plant in Goa is 70. Further reduction is possible with some automation of the cars and the plant capacity can be increased by 50% without increase in operational staff.

SUMMARY

1. Non-recovery coke ovens have staged a come back with the intrinsic capacity to meet emission control norms and recover waste heat energy to generate power.

2. Low capital costs and simple design are the hall marks of Sesa Coke Ovens, which have high energy recovery and can comply satisfactorily with US emission norms.

3. Sesa Coke ovens employ the latest developed technology with optimum automation. Further automation is being developed to meet the requirements of customers needing higher levels of automation.

4. The quality of coke produced is superior to that from by-product ovens using the same blend and has to be successfully used in large blast furnaces.

5. Successful energy recovery provides valuable gains where power costs are relatively high.

6. Operating costs are low with low manpower deployment.

7. This technology provides a satisfactory answer to coke production problems currently faced by the industry.

8. The technology is licensed exclusively by Sesa Kembla Company to Enron Engineering and Construction Co. of the USA and Toyo Engineering Co. of Japan.