

# TECHNICAL WRITE-UP ON NON RECOVERY COKE OVEN

## 1.0 Design Basis

### 1.1 Plant Capacity

Typical Coke-Oven would consist of 1 (One) module consisting of two batteries having a guaranteed monthly capacity of 4250 M.T. of LAM gross Coke of Standard specification using 100% imported Coal. However, capacity can be increased or decreased as per requirement.

### 1.2 Typical capacity of Individual Battery

No of modules in the Plant:	1
No. of battery per module	2
No of Ovens per Battery:	12
Qty of Coal Charge per Oven:	14.4 M.T.

1.3 **Cycle Time per Oven :** 42 to 48 Hours depending on type of coal used.

1.4 **Oven Availability:** 360 Days per year

1.5 **Coal Consumption (NET ON DRY BASIS):** 1.35 M.T. PER 1.00 M.T. OF LAM Coke at 22% VM of coal.

1.6 **Oven Temperature :** 1250<sup>0</sup> C – 1300<sup>0</sup> C

### 1.7 Typical LAM Coke Specification

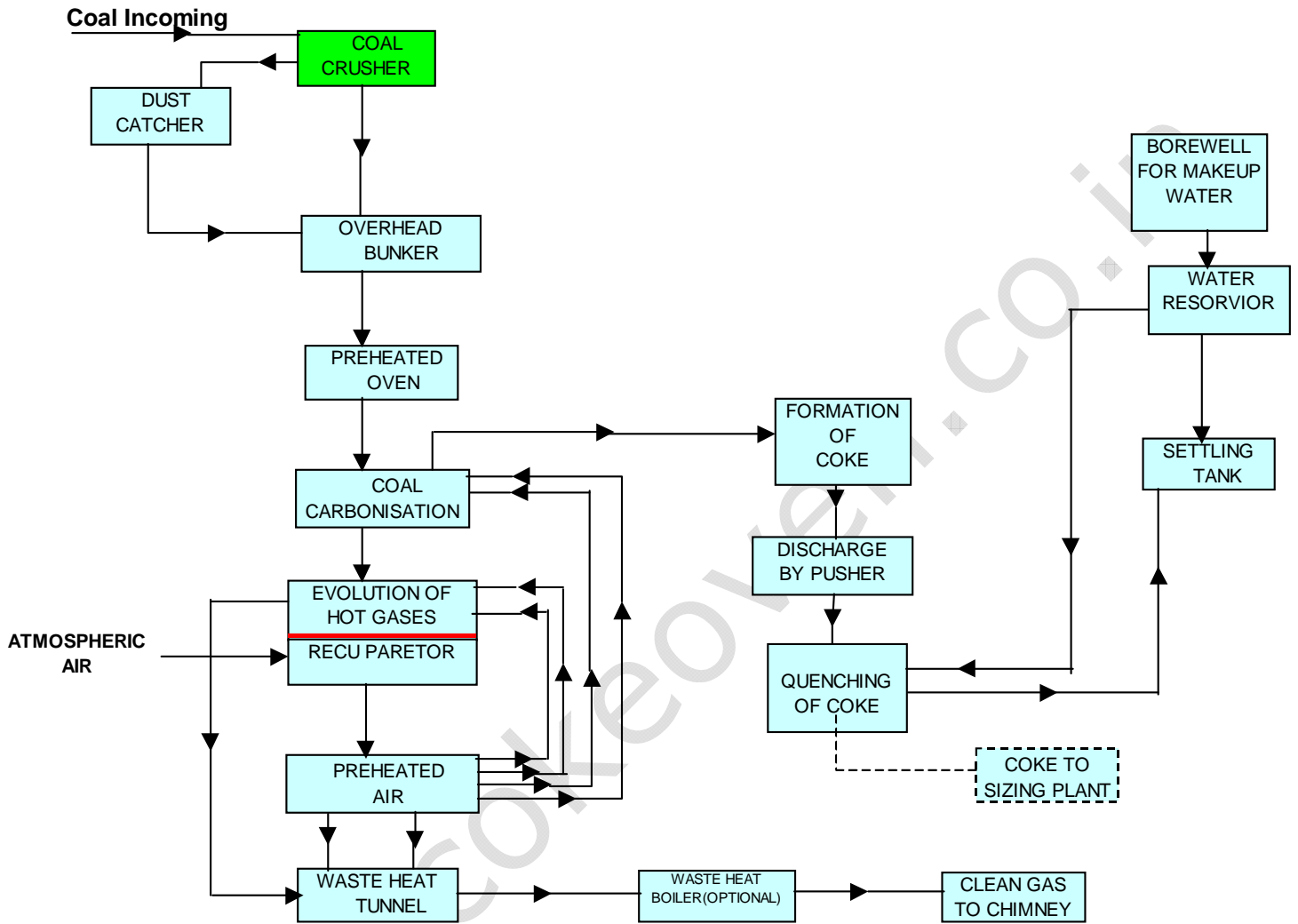
Ash:	12%
VM:	1.0% Max

Moisture:	7%
Fixed Carbon	86%
Phosphorous:	0.03% Max
Sulfur:	0.60% Max
CSR:	65 - 68
CRI:	22 - 26
M10	7 to 10%
M40	75 to 80%

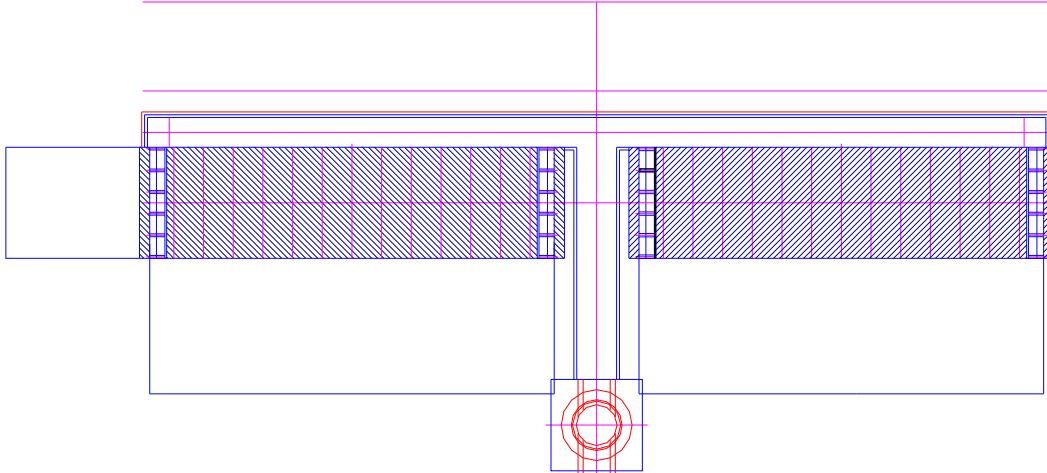
### 1.8 Typical Raw Material Specification (Imported Coking Coal)

Ash:	9.7%
VM:	22.0%
Total moisture:	10%
Moisture (IM):	1%
Phosphorous:	0.04%
Sulfur:	0.58%
MMR:	1.15 – 1.3
Fluidity	400 – 1600 ddpm.

# FLOW CHART OF PROCESS



## Typical Layout of the Plant



### 1.9 Major Plant and Facilities

The major plant facilities will include the following:

- Raw material handling system consisting of Ground Hopper, Coal Crushing System, Conveyor handling system and Overhead Coal Storage Bunker
- Coal Storage Shed (Optional)
- Coke Oven Battery Consisting of
  - Refractories
  - Structural Steel and cast iron castings
  - Buck Stay
  - Coke Oven Door
  - Coke Platform (if quenching car is not installed)
- Waste Heat Tunnels
- Main Tunnel
- Chimney
- Rail Tracks for pusher car, quenching car and charging car.
- Coke Oven Machinery
  - Coal Charging Car
  - Pusher and Leveler Car
  - Door Lifting System

- Coke Quench Car (Optional)

- Quenching Tower (Optional)
- Stationery Pusher (Optional for quenching system)
- Coke Sizing Plant
- Payloaders and Excavators
- Plant electrical (Pertaining to above equipments only)
- Instrumentation and Control (Optional)
- Weigh Bridge
- Quench Water Circulation System
- Laboratory (Optional)

## 2.0 Description of Plant Facilities:

### 2.1 Receipt and storage of raw material at coal crusher area.

The coal will be brought from coal stockyard by tippers / tractor trolleys and stacked near the coal crusher feed conveyor.

Raw material handling system:

The coal from the crusher stockyard would be fed into the ground hopper using Front end loaders and Tractor / Tippers. The coal would be conveyed from the ground hopper into the crusher to get the desired feed size of -3 mm. The crushed coal is conveyed into the over head bunker which will have capacity to store coal for 8 hours requirement.

### 2.2 The Coke Oven

The coke oven to be installed is designed for high temperature carbonization of imported coal and will produce coke suitable for use in blast furnace.

The coke oven under normal operating conditions

- Receives the sized coal from the overhead bunker into the charging car and top charged directly into the ovens. The charging car would be electrically controlled.
- Will use the heat generated by combustion of the volatiles in the oven and the sole for carbonization.

- The ovens will utilize pre-heated air instead of cold atmospheric air for combustion.
- Discharge coke after carbonization by pusher car.
- Deliver heat to maintain the oven and sole temperature to make the process self sufficient.

The coke oven will stand on foundation made of combination of RCC and refractory work. Arrangement for foundation cooling will be provided. The coke oven will be built mainly of refractory. Special high alumina refractory will be used in heat zones and abrasive zones.

Buck stay made of steel structural will support individual ovens and also hold the door lifting arrangement. The oven will have three charging holes at the top where the charging car would travel on rail tracks.

The pusher car traveling on rail tracks will push the coke from one side of the oven door and Coke will come out from the other side door of the oven. The finished coke can be discharged directly into a quenching car which will take the hot coke for water quenching below a quenching tower, or the coke can be discharged on the coke platform for manual quenching.

### **2.3 Coke Oven Control (Optional)**

A control room will be installed near the coke oven for safe operation. Discrete control system is envisaged for trend recording, and control of process parameters. From Coke oven control room the following controls are performed:

- Oven Temp
- Draught recording for damper control

The following parameters are trend recorded:

- Sole Flue temperature of individual ovens
- Oven Temp
- Draught

## **2.4 Charging System**

From the overhead storage bunker coal is discharged into the calibrated charging car. As per the charging sequence, the charging car would travel on rail and charge the coal in the desired oven through 3 nos charging hole provided on top of each oven. A single lever mechanism would charge the coal in the oven from the charging car. The leveler beam fitted on the pusher car would level the charge height of coal in the oven through the oven doors.

## **2.5 Coke Pushing System**

Once the coke is ready for pushing as per proper pushing sequence, the pusher car would travel on rail to the particular oven and align itself in front of the coke oven door. Two travel speeds, fast and slow has been provided in the pusher car. Slow travel will help in precise alignment of the pusher beam. Once aligned, the pusher beam would travel and push the coke mass from one side of the oven and out from the door on the other side.

## **2.6 Coke Quenching System**

### **Manual Quenching**

Coke mass is pushed directly on the coke platform where it is water quenched manually using high pressure water hose.

### **Quenching Car System**

Coke mass is pushed in the platform of the coke quench car. The quench car aligns itself on the door opposite to the pushing side. The quench car travels with the coke mass below the quenching tower where the coke is quenched using high pressure nozzles. The quenched coke is then pushed out of the quenching car by a stationary pushing system into the coke hopper.

## **2.7 Coke Screening and Sizing System**

Coke from quench car will be taken into ground hopper by stationery pusher. The coke will be fed in the primary screen through conveyor over

size material shall be fed into coke cutter for sizing. From the coke cutter the sized material shall be fed into a secondary screen where under size fractions shall be separated.

## **2.8 Sump and Water Circulating System**

The system consist of a water sump with electric pumping system to feed water to quench tower through suitable dia M.S. pipes to quench the coke in the quench car.

## **2.9 Electrical System for oven machineries.**

## **2.10 Laboratory (Optional)**

## **2.11 Pollution Control System**

Non-recovery coke oven is a way of producing metallurgical coke without chemically purifying the distillation gases evolved during the carbonization process. The ovens are unique in nature such that no external heat source is required. All the energies for carbonization are supplied by burning the gaseous volatile products, released from the coal charge during carbonization. The combustion air (oxygen) is drawn into each chamber through primary air flue and secondary air flue. The heat generated by the combustion of the volatile product is in high temperature zone in the free space above the coal charges. This heat is radiated back into the coal charges so inducing downward carbonization. The product of combustion is drawn through gas exit flues down into a series of sole flues located below the oven floor. As the hot combustion products pass through sole flue, they give up some of their heat, which results in carbonization occurring in an upward direction. The gases leave the sole flues through connecting flues and pass along common gas flue to a discharge stack. Hence, carbonization results from application of heat both above and below the charge. This results in reducing the coking cycle and the better coke is produced from the optimum portion of coal charge.

**POLLUTION CONTROL:** As the heat is generated due to the combustion of hydrocarbon evolved during carbonization and no coal particle is burnt directly, the pollution created by the system is different from the conventional coal burning where coal is used as source of fuel. The system operates at high temperature (1300°C). Hence, any external apparatus

cannot be used for pollution control. The system for pollution control is integrated with the construction of the ovens. Moreover, the complete coke oven works at negative pressure. Hence there is no leakage of hot gases from the oven. To minimize the pollution, following measures have been proposed in the design:

**PRINCIPLE:**

There are two types of pollutants present in the combustion system:

1. Hot Gases like CO<sub>2</sub>, CO, NO<sub>x</sub>, SO<sub>x</sub> etc.
2. Suspended particulate Matter (SPM)

**HOT GASES:** These are generated due to combustion of hydrocarbons released during carbonization. When hydrocarbons come in contact with oxygen, it breaks into carbon dioxide, carbon mono oxide, nitrous oxide and other variants. A system of **recuperator** has been incorporated with the design to generate hot air from the waste heat. This hot air is injected as primary air inside the oven, as secondary air inside various points of sole flue, waste heat tunnel and main tunnel for almost complete combustion of gases generated. Throughout the system, fuel : air ratio is maintained at 1 : 5 as per the norms for complete combustion. As a result, only traces of NO<sub>x</sub>, SO<sub>x</sub> are recorded from the chimney.

**SPM:** These are generated in very small quantity during the process. It should be well understood that coal as such is not being burnt as fuel and no ash is being generated. However, method of expansion and contraction is adopted to separate SPM from the waste gases at various stages. The hot gas generated in the oven is brought down to sole flue through a relative small duct under high pressure. As soon as it enters into sole flue, the cross section of the flue is increased by at least three times to induce capillary action as in refrigeration. Due to sudden increase in volume, the pressure of the gas drops and it releases temperature and SPM. This SPM get settled in the bottom of the flue, which is cleaned periodically. Same principle is applied in the waste heat tunnel and main tunnel. In addition to this, **baffle wall** is constructed inside the flue channels to trap any SMP present in the waste gas. All these measures control the pollution as required. Hence the chimney emission is restricted around **150 mg/NM<sup>3</sup>**.

**CHIMNEY:** It is a very important and complex part of the coke oven system. The chimney is responsible to produce sufficient draught in the oven system to operate the recuperator and other pollution control

equipment as these are integral part of the system. To ensure the efficiency, the height of the chimney is increased to 145 feet. Provision for hot air injection through tertiary air ducts around the chimney has also been provided at various heights so that combustion of residual unburnt hydrocarbon takes place and harmful carbon monoxide is converted into carbon dioxide. This also help for sedimentation of the SPM to settle down in the bottom of the chimney. As the chimney creates natural draught due to high temperature at the bottom of the chimney, Electrostatic precipitator or wet scrubber can not be used. As such installation of ESP is not required as there is no generation of ash in the system.

**ENVIRONMENTAL PLAN:** An elaborate action plan has been incorporated to reduce the CO<sub>2</sub> content and suspended particle content due to **coal storage area** around the plant. It is proposed to develop thick green belt around the boundary wall which is capable of fixing 120 gm Mol of atmospheric CO<sub>2</sub> per min. calculated on the basis of annual dry matter accumulation.

All cares and precautions have been taken to create pollution free environment and to obtain the optimum efficiency in this technology.

**It must be kept in mind that pollution in terms of suspended particles are due to COAL STORAGE AREA and not due to ovens itself.** Periodic water sprinkling on coal is only solution.

The non-recovery coke ovens as per above modifications are capable of producing a coke, which is large, strong and abrasion resistant. The coarse mosaic microstructure, low porosity, large mean cell wall thickness, minimal temperature strength and stability and superior post reaction strength.

#### **PLANT AND EQUIPMENT FOR POLLUTION CONTROL:**

1. Recuperator at the bottom of ovens
2. Recuperator in the waste heat tunnel

3. Recuperator in the main tunnel
4. Tertiary Air ducts around the chimney

**WATER POLLUTION:** Water is used to quench the hot coke in a quenching tower. Water is circulated in closed circuit and hence not discharged out. At the time of quenching only steam comes out. There is no water pollution in this project.

## 2.12 Technology Features of Castron Coke – Oven

A new low capital non-recovery type coke-oven project is replacing the traditional capital intensive By-product ovens. Our Ovens are Simple to operate yet highly advanced

	Technical Features	Advantages
1	Total Mechanization	Right from the point of raw coal receipt in stockyard to sized coke loaded onto trucks the process is completely mechanized.
2	Preheated air injection	Instead of cold atmospheric air required for burning flue gases inside the oven, pre-heated air is used. This increases the thermal efficiency of the ovens.
3	Foundation Cooling	If the foundation of coke-oven is allowed to cool, the life of the coke oven increases.
4	Higher Oven Temperature	With a combination of oven design and refractory quality, the temperature inside our ovens is much higher than the drag type or the by-product type of ovens. <b>This gives us the flexibility to charge lower cost blended coal.</b>
5	Oven and Door Sealing	Proper oven and door design ensures excellent sealing resulting in higher coke yield.
5	Simple Control	The Damper control in individual are made simple to maintain individual oven temperature
6	Pollution Control	Chimney and the waste heat tunnel are designed to ensure that the coke oven plant meets the stringent pollution norms.

7	Uniform Coal Charging	The specially positioned charging holes (three on top of each oven) and the charging car allows for uniform coal charging.
8	Mechanised Coke Quenching	Ensures minimum moisture level at around 3% as against 20% in manual quenching

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