# STUDY ON FACTORS AFFECTING THE THERMAL REGIME AND HEAT LOSS IN TOP CHARGED COKE OVEN BATTERY IN INDIAN SCENARIO

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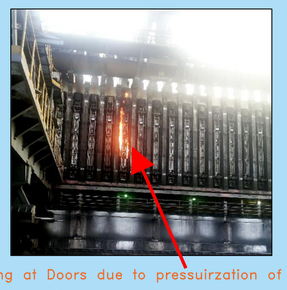
Abstract: In a compound heating system in Coke oven battery, heating is either done by C.O gas or by pure BF gas/ mixed gas(C.O.Gas + BF Gas). On study of the thermal regime of coke oven battery with CO/B.F/Mixed gas heating, it has been observed that various factors as indicated below are affecting the performance of coke oven battery. These factors are attributed to maintainence, operating conditions, construction defeceinces, prolonged heating up of coke oven batteries etc. This paper is to identify & eliminate the various parameters affecting the thermal regime of the a top charged coke oven battery.

## FREQUENT CHANGING OVER FROM C.O. GAS TO MIXED GAS/BF GAS

Due to frequent change over, end verticals of the H/W will be affected quickly. If heating regime of Coke oven is not regulated to maintain the end vertical temp it will damage the refractory bricks & mortar joints at end vertical due to spalling resulting in cross leakage and thereby reducing the life of battery. So it is impor-tant to control the end vertical temp before going for rated production. Also frequent change over should be avoided to maintain proper end vertical temperature. End vertical temperature should never be less than 100°C from Control vertical temp.

## UNDER CHARGING OF OVENS:

Under charging of Ovens
→ Increases Free space temperature.
→ Cracking of Hydro carbons.
→ Chocking of Gas off take system.
→ Pressurisation of ovens
→ Cross Leakages. Blazing at Doors.
→ Temp. rise in Tie Rods
→ Necking & Snapping of Tie Rods
→ Failing of H/W Anchorae
→ Formation of Open joints at bricks in end vertical Flues
→ Cross Leakage
→ Equipment failure & Pollution



Blazing at Doors due to pressuirzation of ovens

## FREQUENT VARIATIONS IN PUSHING/CHARGING SCHEDULE:

During frequent variations in the pushing/ chargings, improper control on regulation of thermal regime may occur & this will lead to over or under heating of coke mass and heating wall temperature which in-turn lead to premature damage to refractories as well as opening up of mortar joint in refractory.

Delay in pushing of oven
→ Augmentation in carbonization time
→ Augmentation in Control vertical Temperature
→ Over heating of Oven
→ Sticking of coke on the refractory Heating wall.

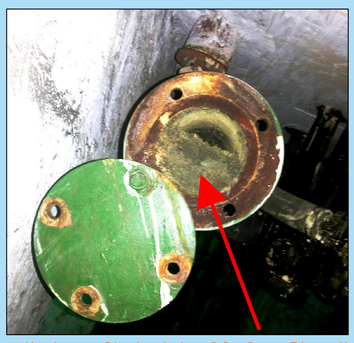
Remedial actions to avert over heating of oven during delay in pushing
1. Reduce Heating Gas
2. Closing of Gas Cocks
3. Increase in Pause Time
4. Air Reversals

Sudden rise in pushings after the temperature drop due to remedial actions should be avoided as it will cause further reduction in temperature resulting in pushing of green coke(incompletely carbonised coke)

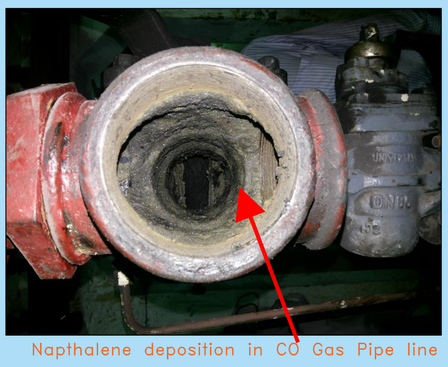
Pushing of Coke in a typical Coke Oven

## QUALITY OF HEATING GAS:

Quality of the CO gas used for under firing/ heating should be free from impurities like tar, napthalene or any other organic compounds. If not , the same will choke the heating accessories like nozzles, orifices manifold pipes, isolation cocks, Reversing cocks and even tubes of CO gas pre heater. Presence of Sulphur or ammonia beyond limit may corrode C.O.gas manifold pipes.



Napthalene Choked in CO Gas Pipe line



Napthalene deposition in CO Gas Pipe line

Below mentioned remedial actions may avert the above problems.
1. Control CO gas temp. after CO gas pre-heater b/w 65°-75°C.
2. Maintain the differential pressure b/w upstream & downstream of preheater by 10mmwc.
3. Periodically clean nozzles, vertical flue risers, orifices, isolation/reversion cocks.
4. Maintain pressure drop between two ends of CO gas manifold pipes between 2 to 3mmwc.

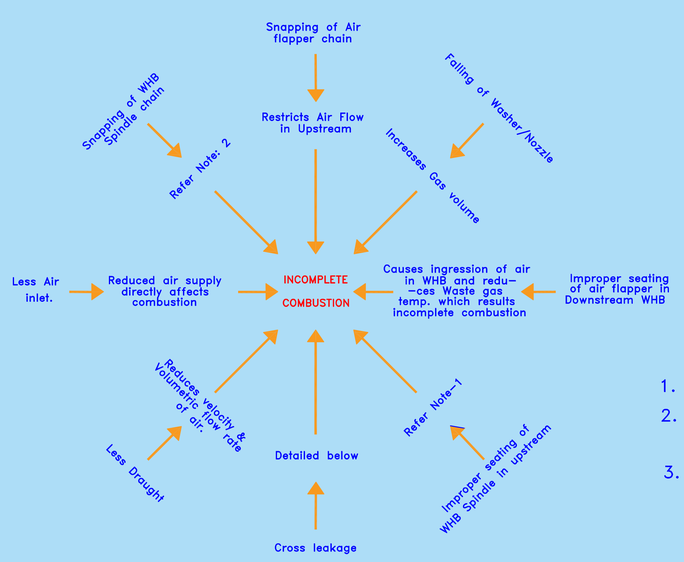
## BURNING OF GAS AT SOLE FLUE:

This happens when the mixed gas/ BF gas and air meets in the sole flue instead of at vertical flue. This happens mainly ,
1. Gap between the sole canal and branch pipe is not sealed properly.
2. When regenerator bottom cap is not sealed properly.
3. Ingression of fresh air from outside to gas canals via improperly sealed joints surrounding branch pipe.

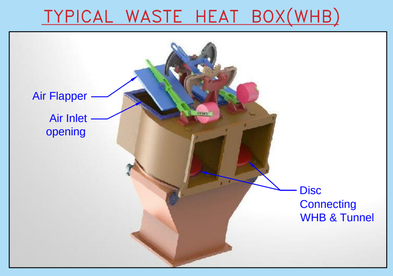
In case of CO gas heating, reduction in end vertical temp. casues further reduction of temp. in bottom portion of regenerator corresponding to end vertical flues resulting in spalling/ cracking of silica bricks at bottom which results in leakage of CO gas from bruner pipe to the sole flue causing burning in sole flue region.

Burning of gas at sole flue damages the waste heat box/ branch pipe due to the rise of temperature of WHB/branch pipes & also increases heat consumption.

## INCOMPLETE COMBUSTION:




TYPICAL WASTE HEAT BOX(WHB)




INDICATIONS OF INCOMPLETE COMBUSTION

1. Black smoke from Chimney.
2. Burning of flame with long height & black smoke in verticla flues & high top flue pressure.
3. Burning of Flues with black smoke at tip & Flues under suction.

Note -1: In such case, the WHB remain connected with Waste gas tunnel flues resulting in air going to waste gas tunnel instead of upstream flues. This will result in incomplete combustion.

Note -2: If it happens, while the particular WHB will be under downstream, air supply to the upstream flues corresponding to that WHB will be drastically reduced to inadequate draught and causes incomplete combustion.

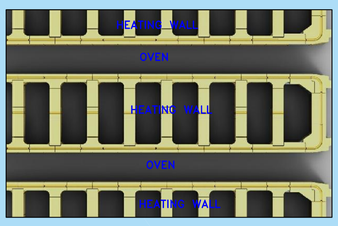
### REMEDIES TO OVERCOME INCOMPLETE COMBUSTION:

1. Vertical flue top pressure maintained b/w 0 to 0.5mmwc
2. Excess air efficient to be maintained b/w 1.25 to 1.35 for CO gas heating and 1.2 to 1.25 in BF gas heating.
3. Cross Leakage to be eliminated.

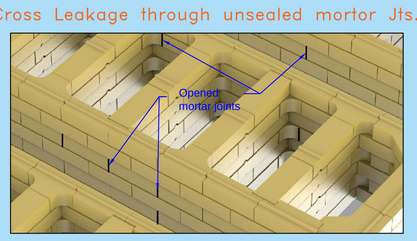
## CROSS LEAKAGE

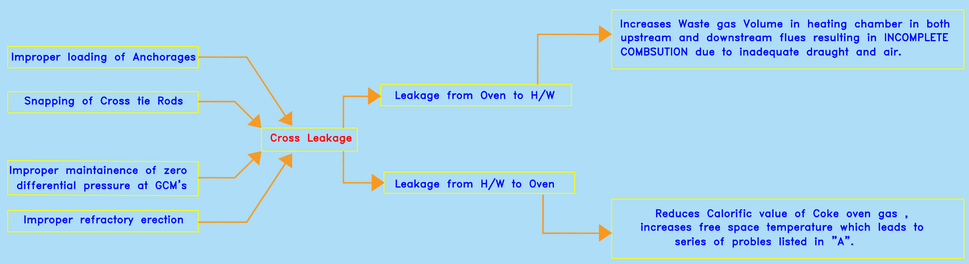
Cross leakage happens through the opening of mortor joints in refractory brickwork which develops mainly due to the improper loading of anchorage, snapping of cross tie rods.

Heating wall and Oven - Refractory brick arrangement




Cross Leakage through unsealed mortor Jts.




## MAJOR FACTORS TO BE CONSIDERED DURING VARIOUS STAGES OF BATTERY CONSTRUCTION & HEATING-UP TO MAINTAIN NORMAL THERMAL REGIME

### DURING CONSTRUCTION OF COKE OVEN BATTERY:

1. Proper sealing of all refractory mortar joints.
2. Good quality of all materials required for battery constr. should be ensured.

### DURING HEATING -UP OF COKE OVEN BATTERY:

1. Proper regulation of anchorage
2. Prolonged temporary heating of battery upto under firing should be avoided.

Temporary heating for prolonged period will abrubtly increase reg/ bus flue/WHB temp beyond 310/320°C(max allowable temp at the end of temporary heating) Though there are ways to reduce rise in vertical flue temp it is very difficu--cult to control the rise in temp of sole flue/ nozzle deck area. After change over to under firing, temp of regenarator/ bus flue will drop resulting in damage in refractory & mortar joints due to high temp difference in reg/Bf zone before . and after under-firing.

## CONCLUSION:

Since coke is an integral part of the iron making process it is significant to maintain the quality of battery for the better results in battery and also in other parts of the steel industry. Maintaining Thermal regime is a very important part in coke making process as it will influence the quality of the By-Products and CO Gas. This poster categorically detailed the major factors affecting the Thermal regime and the remedies/ actions to overcome such adverse factors.