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IMPROVEMENTS IN P.F. COAL BOILER FOR BEST HEAT RATE PERFORMANCE

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Now with regulatory regime in India and also with many players entering the Power Generation field, it has become utmost important to keep the Generating Cost as minimum as possible. In this endeavor, it is essential to optimize the Heat Rate Availability and Load ability of the boiler.

Factors affecting Heat Rate Availability and Load ability of the boiler are:-

- Air Ingress
- Management of Combustion Air Flow
- Proper Combustion Process

AIR INGRESS

Air is most essential and vital component of the combustion process. Quantum of air includes basically the Theoretical Air calculated from the standard chemical equations and by knowing the chemical composition of the Fuel (Coal). In addition to this Theoretical Air, some excess air is required to be supplied to the Boiler to facilitate the combustion completely considering the very short residence time in the furnace say @ 1 to 2 seconds. This total air i.e. Theoretical along with Excess Air is supplied through F.D. and P.A. fans and is measurable and controllable. However over and above this air, some additional air ingresses in the boiler due to negative draft maintained in the Boiler.

This Air ingress causes increased mass flow of flue gases resulting into increase in flue gas velocity which in turn is responsible for erosion in 2nd pass, A.P.H., ducts, E.S.P. and I.D. Fans. The increased velocity further deteriorates the E.S.P. performance. The increased gas mass flow also overloads the I.D. Fans affecting the Generating Capacity of the Unit. Thus it can be concluded that Air Ingress in the Boiler is highly detrimental to the Boiler Performance and needs elimination or reduction to maximum possible.

In some boilers there may be 30 – 40% of air ingress. Arresting of air ingress itself can improve heat rate by 50 - 75 Cal/kWh.

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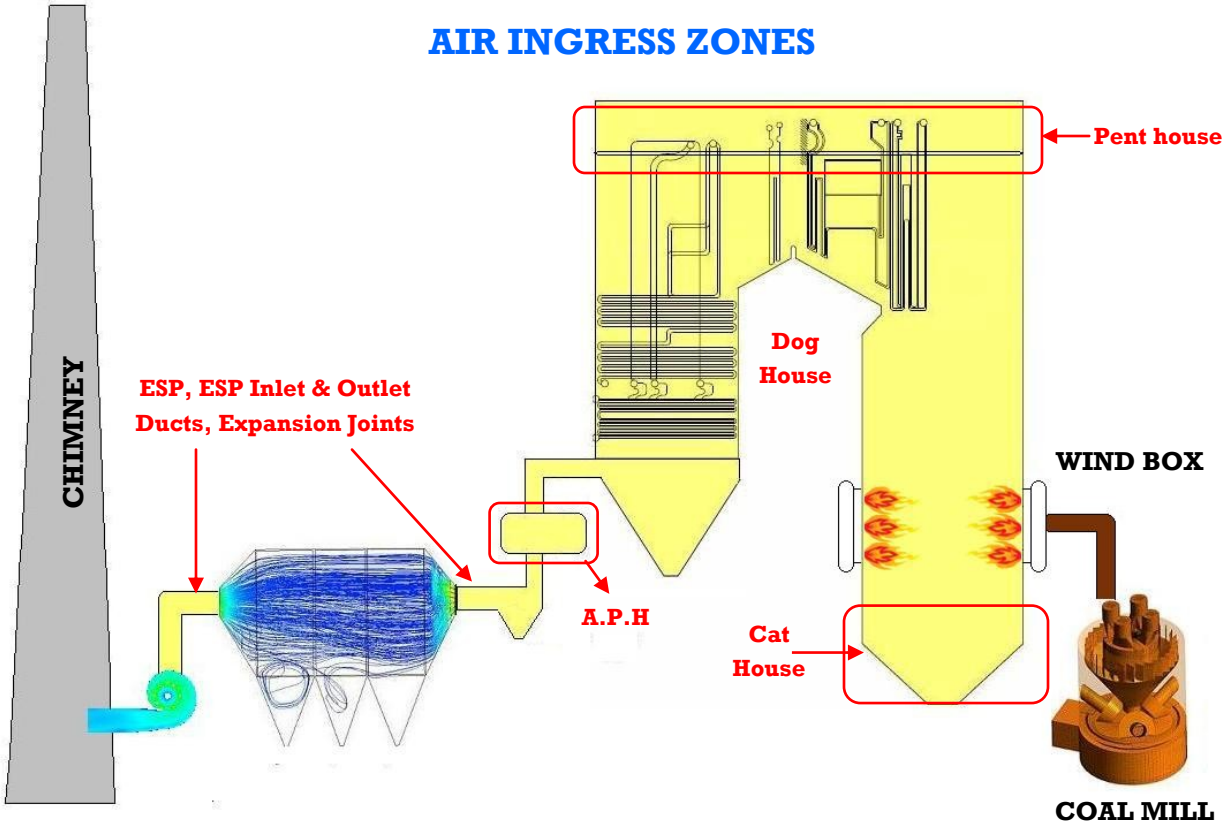
In most of the old boilers the performance has deteriorated due to air ingress through

1. Air preheater outlet to ID Fans.
2. Air preheater leakages.
3. Furnace to economizer including pent house.
4. Furnace bottom to furnace exit including cat house & dog house.

The air ingress is generally experienced through following areas:-

1. Improper bottom ash trough sealing.
2. Peep holes & man holes.
3. Fin welding of water wall tubes.
4. Cat house & dog house casing.
5. Pent house casing, expansion joints, refractory etc.
6. Corners of LTSH & Economizer.
7. Fin welding of S.C.W. tubes.
8. Duct connecting Economizer & air preheater & also the hoppers.
9. Expansion joints.
10. Air preheater leakages.
11. Ducts, expansion joints, isolating gates from APH outlet to ESP inlet & also from ESP outlet to ID Fan.
12. ESP man holes, roof, hoppers etc.

AIR INGRESS ZONES



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MANAGING COMBUSTION AIR FLOW

Air required for combustion must be supplied through air preheater (heated) this is the authorized air. Air ingress affects combustion as it may not allow to maintain required excess air.

Primary & Secondary Air:-

Out of total air supplied, 20 – 25 % is primary air while balance is secondary air.

High primary air flow is detrimental to the boiler. High primary flow causes:-

1.Poor fineness of coal & poor distribution in each corner.

2.Increased slagging (clinker) in furnace which leads to explosion /accidents.

3.More soot blowing operation.

4.High furnace exit temperature.

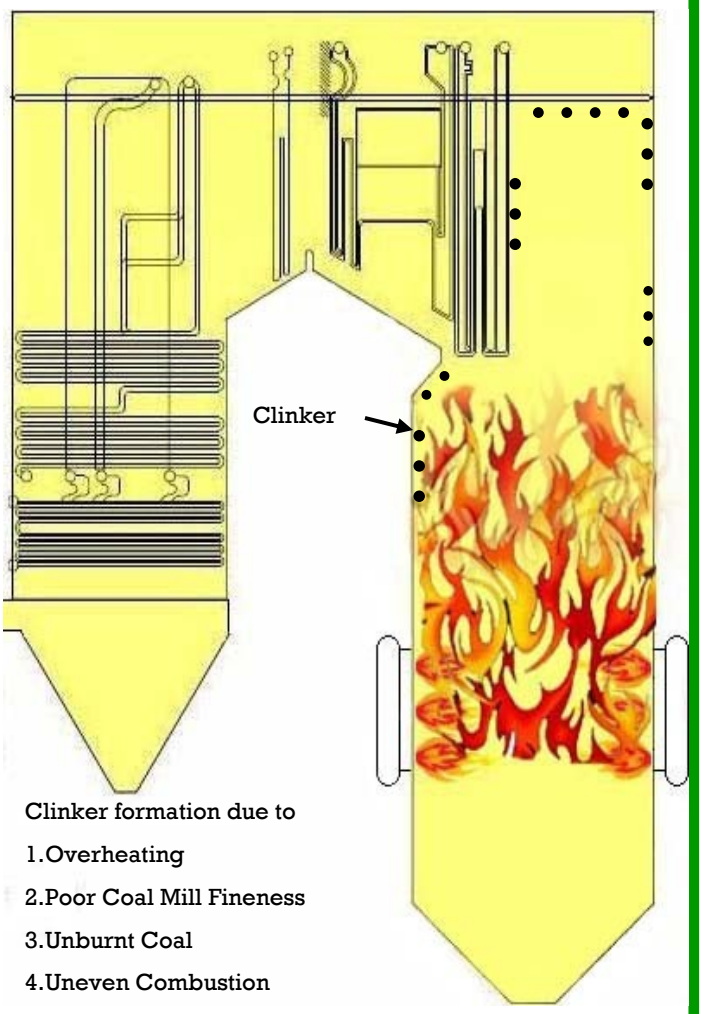
5.Overheating of S/H & R/H tubes. So also the increased S/H & R/H attemperation.

Even cold primary air does not help for combustion. This air bypasses APH. Proportionately, it does not help in

Managing the exact quantity of primary & secondary air can help in improve the combustion efficiency.

Secondary air flow should be such that it can maintain 2% - 3% excess Oxygen at furnace exit & moreover the distribution be uniform to burners of each elevation. It should also impart turbulence to help combustion.

Measurement of primary & secondary flow should be accurate & the flow should be controllable.



Clinker formation due to

1.Overheating

2.Poor Coal Mill Fineness

3.Unburnt Coal

4.Uneven Combustion

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COMBUSTION

Let us get back to basics of combustion. Carbon on ignition forms CO_2, Sulphur on ignition forms SO_2, and Hydrogen on ignition forms H_2O. In order to achieve this & to ensure that there is no CO formation or incomplete combustion, excess air is supplied to the furnace. The residence time to burn coal completely is 1 – 2 secs. i.e. before it reaches super heater tubes. Finer coal particles with correct velocity & correct quantity of secondary air can achieve this. Complete combustion can be ensured with absence of CO formation & presence of residual (excess) O_2 at 2 to 3% level. This condition will ensure oxidizing atmosphere & prevent flame carry over or post combustion at super heater zone. Reducing atmosphere create high flue gas temperature at furnace exit with presence of CO. It is most detrimental condition as it results into clinker formation, & overheating of Super heater & Reheater tubes. Super heater & Reheater tubes metal temperatures are monitored outside the furnace & thus measure steam temperature exiting individual tube. The true individual tube temperature is much higher in the active heat transfer zone.

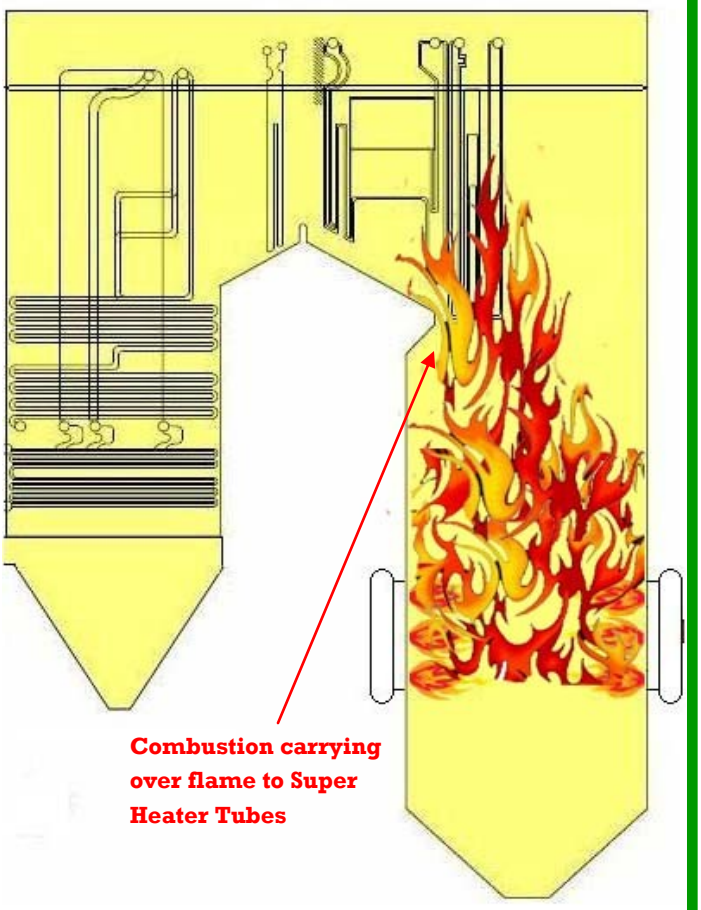
High Velocity Thermocouple (H.V. T.) probe can measure temperature variations from left to right as well as measure O_2 % & CO ppm. Periodic testing is essential to monitor combustion & counter check for metal temperature variations & excursions.

Coal mills play an important role in ensuring proper combustion. Coal mills should be healthy in respect of grinding elements, throat clearances, turbulence inside the mill & proper primary & secondary classification. Coal fineness should be 75% through 200 mesh & 99.5 % through 50 mesh.

Better fineness helps better distribution to each mill outlet. Clean air flow testing will ensure balanced P.A. flow through each pipe. Orifices to be adjusted on the basis of test results.

Tests will have to be repeated till 2 to 3 % variation from average or better is achieved.

Next step involved is fuel flow balance. This is carried out with the help of dirty pitot tube testing. Primary air to fuel ratio should be between 1.8 – 2. Velocity of air + fuel should be more than 18 m/sec. Isokinetic sampling will help in achieving equal distribution of flow through each pipe. Variation should be below $\pm$ 10 % or better.



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MECH-WELL'S ROLE IN PERFORMANCE IMPROVEMENT

Mechwell can carry out following tests to identify air ingress:-

1. H.V.T probe traverse at temperature at furnace exit for measurement of temperature profile, O_2 & CO profile.
2. Grid measurement of Oxygen & temperature at Economizer outlet.
3. Grid measurement of Oxygen & temperature at APH inlet & outlet for measurement of temperature profile, O_2 & CO profile.
4. Grid measurement of flow & O_2 & particle size at ESP inlet & outlet.
5. Temperature & flow at ID outlets.

Comprehensive testing will reveal:-

1. Air ingress before Economizer & APH.
2. APH thermal performance.
3. Air ingress from APH to ID Fans.
4. Air ingress before combustion zone.

Once identified, Mechwell will analyze the results & advice regarding action to be taken. Action plan can be worked out to arrest air ingress.

Mechwell on its own can undertake some of these jobs:-

1. Arresting leakages in pent house by installing flexible membranes without preventing expansion of tubes, headers, supports etc.
2. Duct leakages from Economizer to ID Fans.
3. Fabricate & install non metallic Expansion Joints.
4. Ensure equal distribution of flow in all the passes of ESP.
5. Gas distribution test in ESP.

On Combustion side:-

1. Clean air flow test on coal pipes; adjust the orifices to achieve variation within + 2%.
2. Dirty pitot tube testing to carry out fuel balancing within + 10% variation. Correct setting of primary air flow can be made. Adequate secondary flow can be adjusted provided flow measurement arrangement is available at each burner.
3. H.V.T. probe testing to ensure complete combustion & mapping of temperature at furnace exit.

   H. V. T. probe may be spared to us for testing. Pulverizers be tuned & classifier adjusted to achieve 75% through 200 mesh & 99.5 % through 50 mesh.

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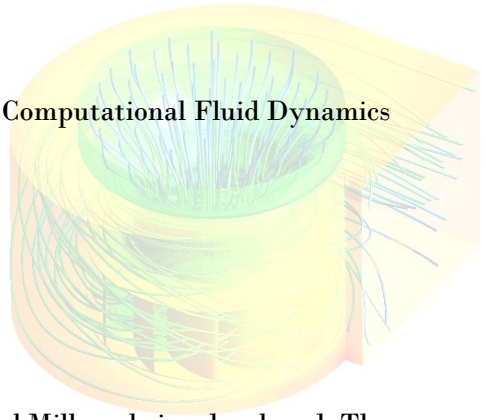
CFD ANALYSIS:-



Mechwell has the facilities for Computational Fluid Dynamics (CFD) Analysis & the same can be carried out for:-

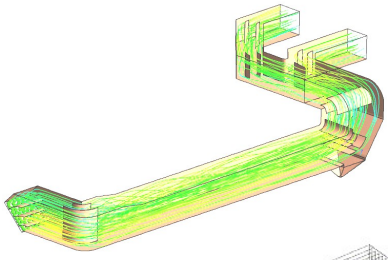
1. Second pass of boiler.
2. Ducts.
3. Fans.

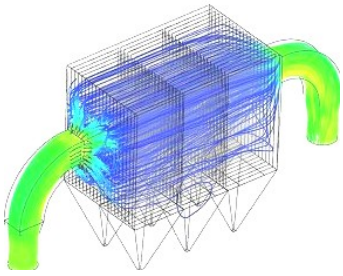
Models for Air preheater & Coal Mill are being developed. These models can help in solving all the major O&M problems. Modifications can be made in models to predict the performance to achieve the desired results, which can be listed as below:-

1. Reduced Clinker formation.
2. Avoid over heating of S/H & R/H tubes.
3. Reduction in APH outlet temperature.
4. Reduced erosion of LTSH & Economizer.
5. Reduced erosion of ducts.
6. Improved ESP performance.
7. Reduction in unburnt Carbon in ash.
8. Reduction in S/H & R/H attemperation flow.

Mechwell can undertake the comprehensive testing, analyze & suggest remedial measures & procedures to attend to the problems.

It can also help in planning the activities, executing the works & supervise the activities during execution.





Our vision is to conduct an integral program of research, consulting & professional development to promote & demonstrate globally the role of design & innovation in achieving environmentally sustainable future.