TRIAL CHEMICAL CLEANING OF FOULED APH BASKETS

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Boiler has three inputs

1. WATER
2. COAL
3. AIR
Air enters to the Boiler & exits from the Boiler through APH. Though it cost only 2% of total cost of boiler but transfer 20% of total heat fed to the boiler.
The purpose of air preheater is to recover the heat from the boiler flue gas which increases the thermal efficiency of the boiler by using the useful heat which would be lost in the flue gas.
• 1% improvement in boiler efficiency is realized for each 20°C increase in boiler inlet air temperature
• 1% improvement in boiler efficiency
  = 1% improvement in heat rate
  = 24 K Cal / KW Heat gain
WHAT IS AIR PREHEATER FOULING?

Air heater fouling is usually in the form of plugging of the element channels by deposits of:

- Fly Ash
- Sulfur (and Sulfuric Acid)
- Other Corrosion and Flow limiting Deposits

An increase in pressure differential across the air heater is directly related to the degree of fouling.
An increase in pressure differentials across the air heater can cause:

- Increase in Fan Amps/Aux. Power
- Decrease in Mw Output
- Reduced Boiler Efficiency
- Increased Heat Rate
- Increased CO$_2$ Emissions
EXAMPLES OF PREHEATER FOULING

Severe fouling of fin tube surfaces in steam coil air preheaters

Severe Fouling of element channels in rotary air preheaters
AN INSIGHT INTO COLD END DEPOSIT

- **Precipitation fouling**: Precipitation of dissolved substances on lowering of temp.
- **Chemical reaction fouling**: Deposits formed due to chemical reaction.
- **Particulate fouling**: Deposition of impurities from gas stream & reduction of heat transfer, increase in pressure drop.
- **Corrosion fouling**: Heat transfer surface reacts itself.
- **Deposition of Al₂O₃, Fe₂O₃, SiO₂ particulates, sulfur, sodium, vanadium & chlorine from oil.**
- **Dew point condensation of Na₂SO₄, K₂SO₄, P₂O₅, Na₂CO₃, NaCl.**
Excess air increases dew point of flue gas from designed 129°C. Below dew point temp free sulphuric acid appear and dissolve calcium and depositing calcium sulphate retarding heat transfer. Calcium sulphate can not be removed by water or acid cleaning.
Common methods for cleaning of air preheater elements include:
- High pressure water jetting
- Saturated/superheated steam
- Compressed air

The most common method is high pressure water jetting
ISSUES WITH WATER JET CLEANING

- The amount of wastewater produced during cleaning can exceed 17500 M³.
- Removing one waste at the cost of generating another waste.
- Tenacious deposits & sulphate scales cannot be removed by present methods of cleaning.
- Even in a freshly cleaned Air Preheater air temp does not go beyond 260°C to 280°C.
- Reducing Mill outlet temp threatening moisture separation in P.F.Pipe.
Comparison between HP hydro jet cleaning versus chemical cleaning

Hydro jet cleaning
- Oil on basket surface remains
- Due to criss cross geometry of the mess of basket, water enters at one angle and leaves the basket at another angle leading to taper formation of the deposits rather than complete removal
- Metal loss / damage of the baskets due mechanical rubbing
- huge amount of water required and cleaning not effective
- Being hard siliceous deposits, longer cleaning time (10-12hrs per basket) required with proportionate labour cost
- Too cumbersome,

Chemical cleaning
- Effective removal of all deposits including oil with simultaneous protection of the metal as the chemicals including inhibitors are carefully selected for this specific lot of baskets exactly in the similar manner as we usually do for post operational chemical cleaning of boilers which has been an established practice in NTPC so far.
- Total cleaning time is reduced by 50% and so is the labour cost
- Quality of cleaning with due protection of the base metal is far superior as compared to that of water jet cleaning.
TRIAL CHEMICAL CLEANING OF FOULED APH BASKETS
During operation the Air Pre Heater Basket became fouled with oil, grease, dust and carbonaceous matter. Deposits of these materials has affected the performance of the system.

Composition of the deposit:
- Acid insoluble
- Ca
- PO4
- Oil
- Initially HP water jetting has been tried on these fouled baskets. But issues with water jet cleaning are:
- Too cumbersome,
- time taking (8-10hrs per basket)
- huge amount of water required and cleaning not effective.
- Particularly oil on the basket surface remains which is a potential problem when the baskets will be put back into service.

In view of above, a chemical cleaning has been attempted.
Basic Mechanism on which this chemical composition works
The Air Pre heaters Basket are immersed in a bath containing Composite chemicals. By continuous Air agitation in the liquid it creates microscopic vacuum bubbles, which implode forcefully onto the surface that is to be cleaned. This phenomenon is called cavitation.
Surrounding liquid

Increased static pressure

Cavitation bubble imploding close to a fixed surface generating a jet (4) of the surrounding liquid.
This energy produces a powerful cleaning effect that is able to remove stubborn contamination, even in spaces that are hard to reach, drastically shortening the cleaning time. Then composite chemicals penetrates the deposits dissolving oily matter and loosening insoluble solids, so that they can be easily removed by agitating.
The Cleaning has been envisaged by using eco-friendly readily available chemicals with appropriate cleaning performance.

1. A temporary tank of suitable capacity has been prepared to immerse the APH BASKET with air header, water line and drain point connection.

2. WATER FLUSHING: Before immersing the APH Basket, flush with plenty of water to remove all loose, deposits, dirt, dust, etc. This can be carried out to the duration of 15 minutes and drain the dirty water.
PROCEDURE FOR CHEMICAL CLEANING OF one no of fouled APH BASKET .

Composite chemical consist mixture of (a) 1 kg of Formic acid (85% Purity) Commercial grade, (b) 2 Kg Phosphoric acid (85% purity) commercial grade, (c) 500 ml Corrosion inhibitor , and (d) 3 Kg Wetting agent and Dispersant - Fill up the tank with fresh water. Now add the composite chemical cleaning Compound in the ratio of 1:10 (i.e.) one part of chemical and 10 parts of water
- Allow for soaking to the duration of 4 Hrs. Compressed Air purging should be given throughout process period.
- The ratio of the cleaning chemical and also the process time of soaking may increased or decreased depending upon the extent of deposit.
- Drain the entire solution.
- WATER WASH: Fill up the tank with fresh water and carry out the mass flushing.

- Remove Air Pre Heater Basket from the Tank and flush with water if required.

- Apply High pressure cleaning to remove the loosened dislodged deposit from the system.
Seeing is believing !!
Fouled basket inside the tank
After putting the chemicals inside the tank with air blowing
Continuous air scouring in progress
Soaking step nearing completion
Basket taken out of tank after completion of soaking period
First we tried with fire water
Flushing with fire water in progress
Jet piping got ready
Flushing with HP jet pipe in progress
Flushing with HP jet pipe in progress
After flushing Cleaned basket resembling very closely to new one
Even side plates are thoroughly cleaned
More than 95 % of the mesh has been cleaned effectively
Before cleaning

After cleaning
Cost comparison

• Approx. Cost New APH basket is Rs 60000/-Per basket. Once reclaimed there is a realistic prospect of a savings of Rs 58000 per basket and let us say for a set of 100 baskets of one APH, it translates into a direct savings of Rs 5800000/-besides other associated benefits.

With a fleet size of 100 (+) of thermal units, there is a great opportunity of savings!!

• Cost of in house chemical cleaning of one basket is Apprx.2000/-

• Time taken is approx. 5 hrs (4 hrs soaking +1 hrs flushing)*.

• *(This can be optimized with simultaneous cleaning using a bigger tank)

Since it is proposed to be an in house activity, therefore worth trying.
But we have to keep in mind the following:
Cleaning of each set of baskets shall be taken up on case to case basis, as the chemical composition needs to be formulated based on the deposit material on the target baskets.

Conclusion:
We plan to go for one more trial cleaning of affected basket for one of our stations for finalizing the structured procedure of this cleaning method. And of course,

Most important point is support from all concerned!!
Together we can
Together we will