A FREAK INCIDENT OF A BED SUPERHEATER FAILURE

Case studies are interesting. This case is very interesting one. The customer had a bed SH failure. At the time of the visit, the failed bed SH tube was not available at the plant. It was sent to boiler manufacturer for their analysis. However the photograph was available to see the nature of failures.

A brief on the boiler

This is a 100 TPH, 105 kg/cm2, 520 deg C coal fired AFBC boiler. The unit has been in operation for more than 3 years. The boiler is equipped with under bed feeding arrangement. The boiler has 5 compartments.

Occurrence of failure

It was informed that there had been coal flow problems in the bunker & fuel line choking problems. This had led to the frequent non availability of the compartments. The turbine had come to base load often and at times the turbine had to be tripped. During the turbine trip, the MSSV was closed after slumping of the boiler. As the lines were being cleared, the compartment no 3 was activated and at this moment the bed SH had bursted. The bed SH tubes are located in 3^{rd}, 4^{th} & 5^{th} compartments. The failure had occurred just above the fuel feed point.

Analysis of the appearance of the failed portion

As the failed bed SH tube edge appeared sharp (see photo 1) and there was no long term swelling of the tubes, it was concluded that the tube had failed due to sudden & localized overheating (no indication of starvation). Other bed tubes did not indicate any burning appearance nor did the tubes show up any swelling in OD.

Suggested failure mechanism

Localized overheating failure takes place when the metal is insulated from steam cooling by the presence of a dirt / deposit. The dirt gets transported from the steam drum to the failure spot. Above the fuel feed point the heat flux being high, the tube can fail. The combustion can take place when the coal is available from the fuel line or when the coal is spilled from the adjacent compartments.

Diagnosis of the failure

Up to this point summarizing the cause was easy for me. I had to now prove the carryover mechanism. I requested for the inspection of steam drum.

1. The steam drum was opened and checked for possible carryover. The evidence of foaming & carryover was seen inside the drum.
2. The foaming had occurred due to high phosphate chemical dosage in the slumped boiler. In the discussion, it came out that the HP dosing pump used to be in operation during the when the boiler was hot slumped for attending coal jamming in fuel lines. On restart of the boiler, water being hot and concentrated with phosphate, foaming had taken place. The presence of foams could be seen up to the secondary drier. See photographs 2 to 7. At two or three places the whitish powder accumulations were seen.
3. For the last three months prior to failure, the boiler had been on high pH (values seen up to 9.8) and phosphate level was seen up to 15 ppm. Though this is not a direct cause for this failure, but

the boiler had been corroding and the drum water is seen to be dirty. The drum surface up to NWL is seen to be brownish indicating there had been corrosion at times. The corroded iron particulate remains could be seen in the surfaces of drum internals.

4. It was learnt that the boiler was filled always through the economiser for hydrotest purpose. This can transport any dirt from the boiler water to SH circuit. At some point of the time the dirt can get inside the tube and lead to localized overheating failure.

I suggested following remedial actions to avoid future failure

1. The HP dosing pump start / stop shall be interlocked with the boiler feed pump.
2. The chemical dosing shall be regulated with respect to steam flow. For this purpose VFD is required at HP dosing pump. There can be additional control loop.
3. Always the SH should be filled first and the water should spill in to the steam drum and then filling can be continued through the economiser. A 65 nb filling line can be connected to SH drain header with suitable valves for isolation.
4. I advised customer not to operate the bed SH compartment unless the compartments with evaporator tubes are in operation.

I suggested the following permanent remedial actions to avoid boiler operational disturbances

1. The root cause of the problem is basically from the coal handling plant. The vibratory screen blinding seemed to have caused all the troubles. Screen blinding is a serious problem during monsoon in the conventional vibratory screen. Flip flop screen is the right choice to handle high moisture coals.
2. The present coal feed arrangement above the drag chain feeder is not OK. The load of coal in the bunker allows compacting of coal. This sort of defect is seen in several installations. The feeder chute should be designed in such a way, that the pressure from the coal column is used for loosening the coal.
3. When the coal has more powder content and water content, the lumps form in the bunker. Rectangular shaped bunkers have sharp corners where the hopper walls join. Circular bunker with conical hoppers avoid this problem. A static bar screen above the feed hopper was recommended so that lumps could get filtered. This will prevent the lumps going to feeder & fuel feed line. This will avoid the PA line choking.

Lesson learnt

For every problem the diagnosis must be completed before simply putting back the boiler in operation. I liked the customer approach that he did not give up after the manufacturer failed to identify the cause. At least the future failure can now be avoided. I was very happy to talk in the group discussion arranged for the entire operating team.

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Photo 1: This is the bed SH tube failure experienced. The failed portion is in the 3rd compartment. The edge of the failed portion of the tube is thin in nature. This indicates there has been sudden overheating situation.

Photo 2: The drum is with the mark of excess of phosphate in the drier area.

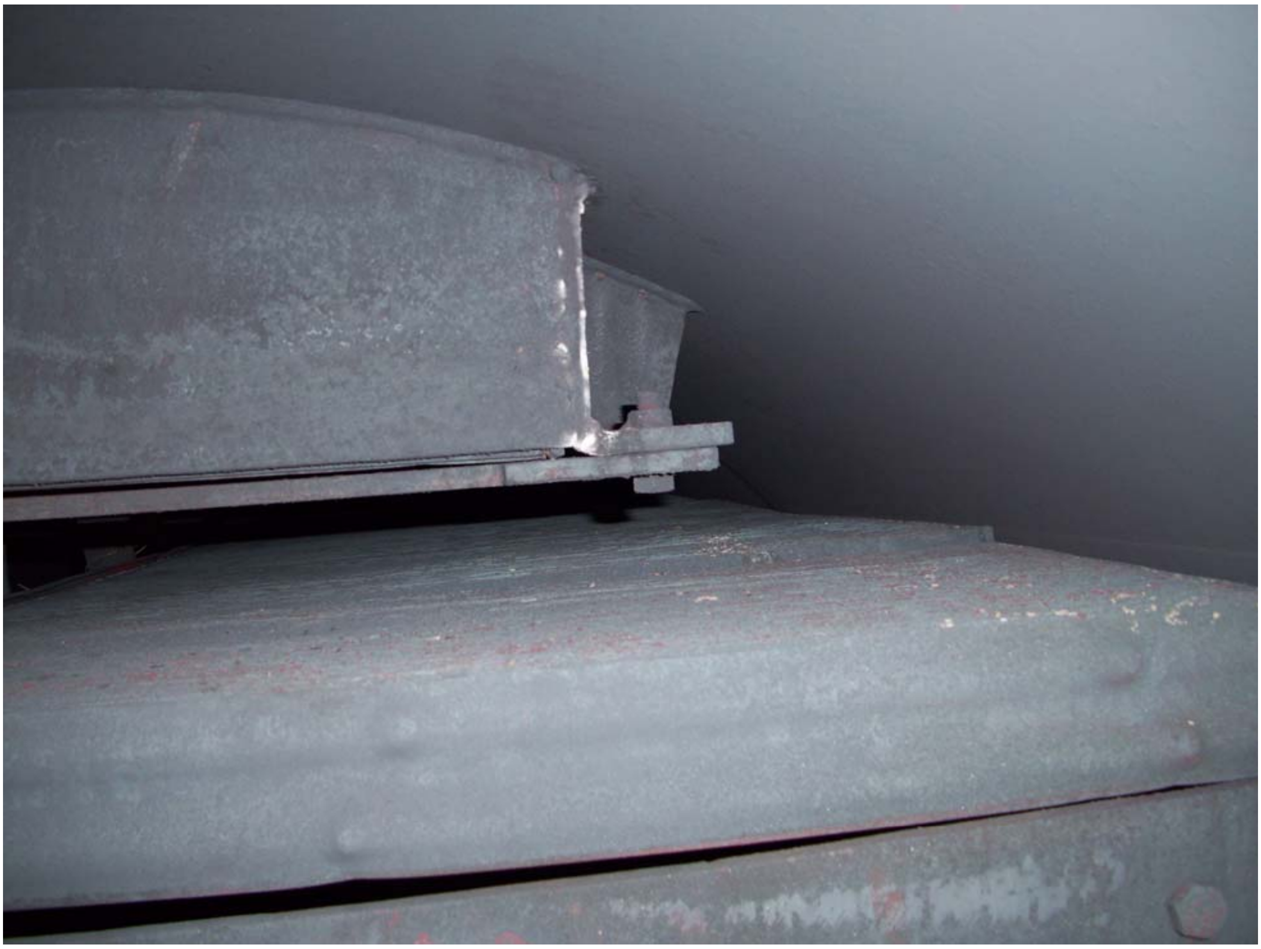
Photo 3: Presence of whitish deposit in the second stage drier.
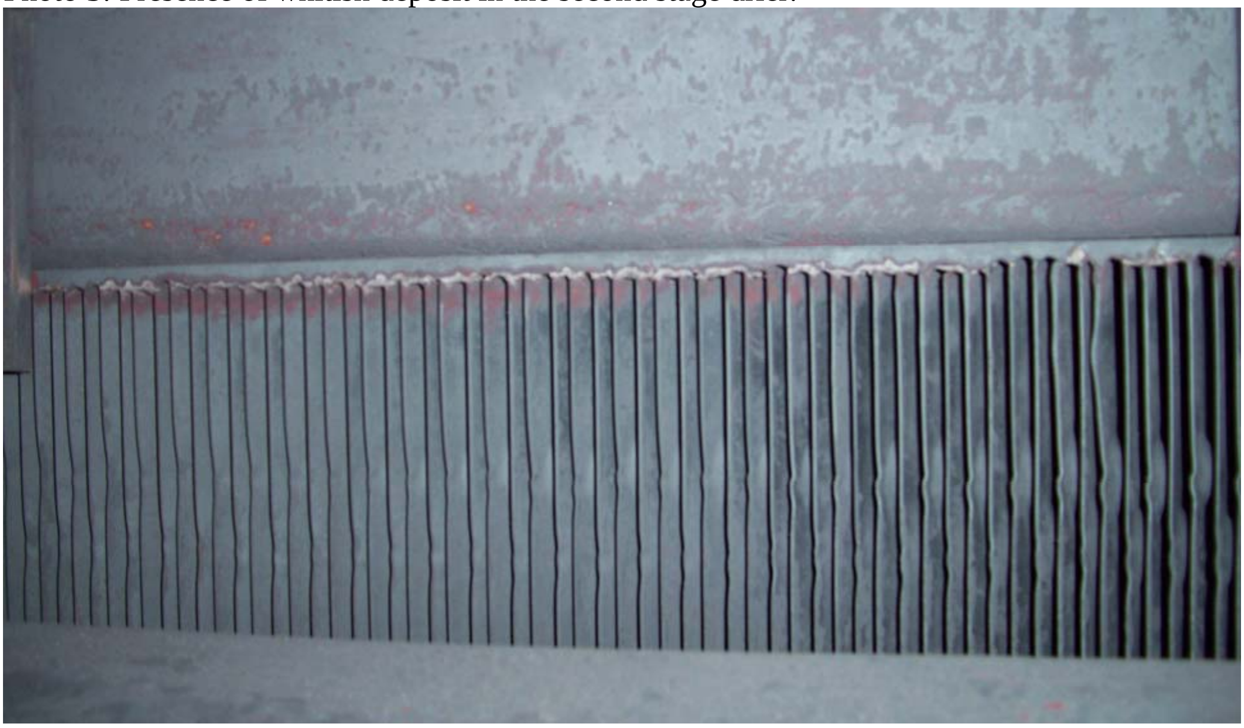
Photo 4: The presence of whitish marks along the edge of the primary drier in the steam space.

Photo 5: The whitish sparkling particles seen above the normal water level in the drum. This must be due to foaming created by excess phosphate chemical dosing in the drum. The dosing had been on when the boiler was under slumped condition.

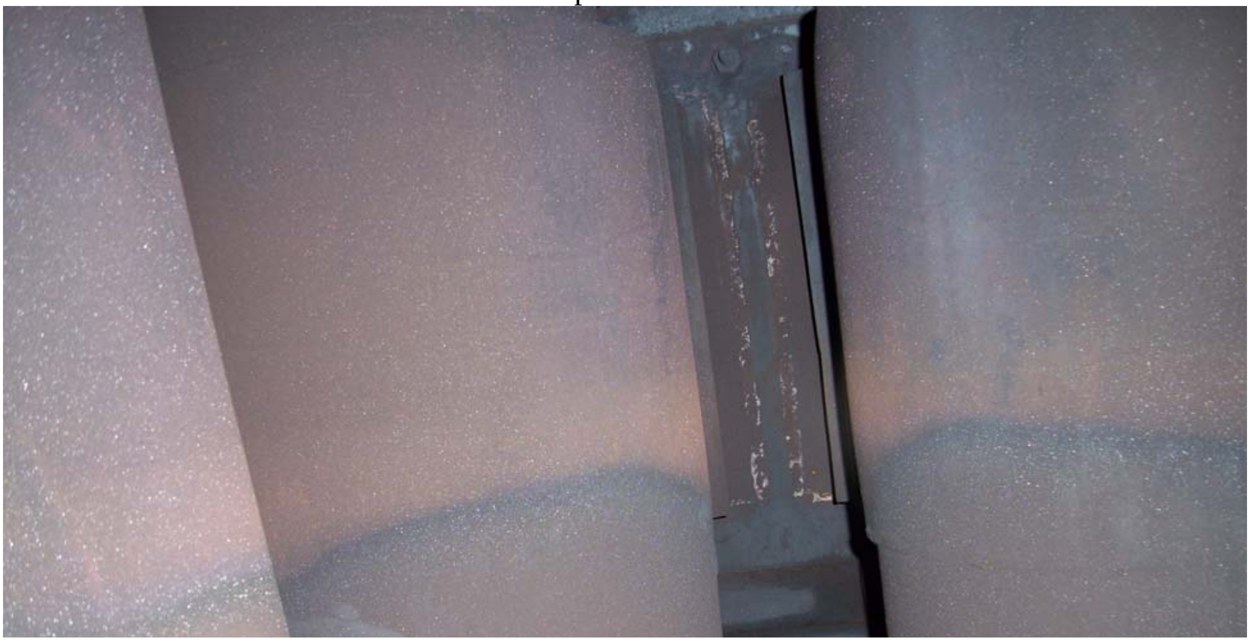

Photo 6: The whitish deposit seen at the weldment. The sparkling particles are seen above the normal water level. The dark colored water indicates that there had been high pH in the boiler water corroding the boiler.

Photo 7: The boiler water chemistry had not been alright. The boiler water regime had been outside the even the coordinated phosphate control curve.

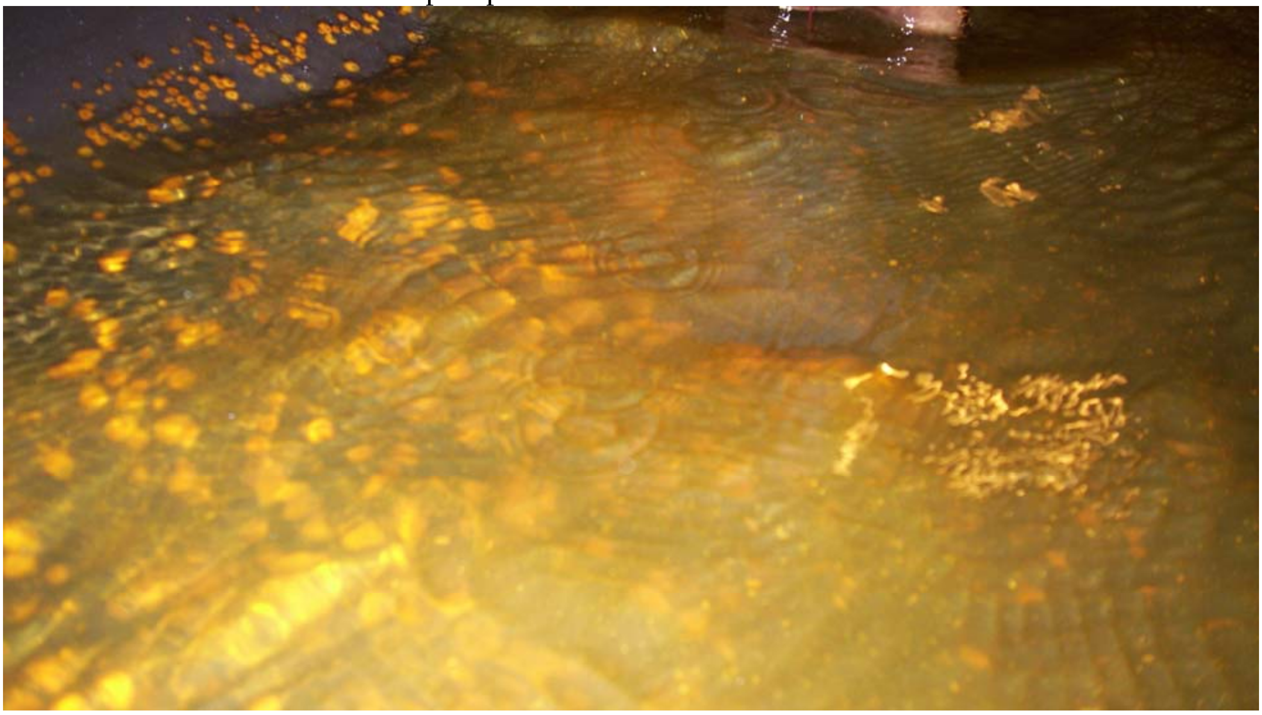

Photo 10: Presence of mud in the boiler water. The back filling of SH to be practiced to avoid carryover of dirt to SH sections.

Photo 11: This is a boiler wherein the drum internal surface & turbo separators indicate the perfect boiler water chemistry.

Photo 12: The fuel feeding on the left side is what is in this plant. The weight of the coal acts on the feeder. It makes cakes of coal. The one on the right is what is in another plant. The coal slides through by virtue of the hydrostatic head of coal. The lump formation will be avoided.

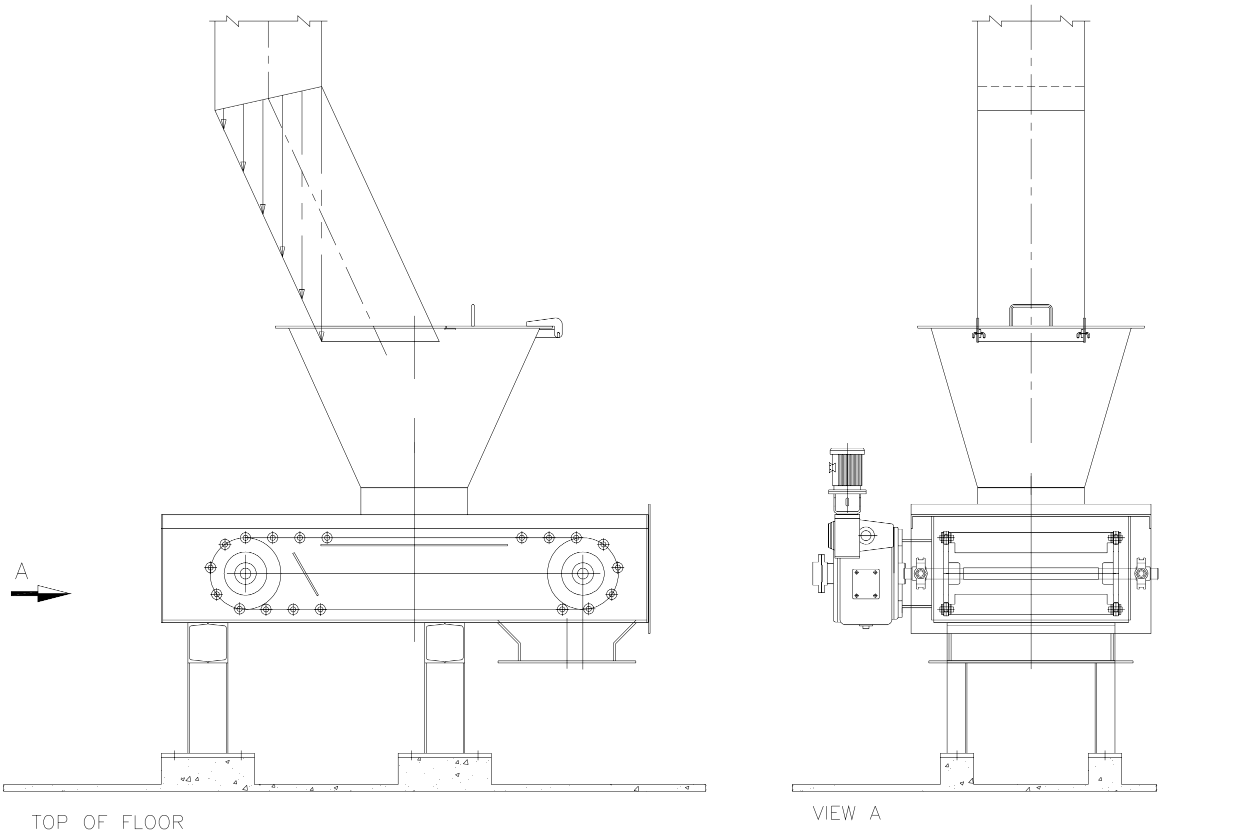

Figure 1: This is an illustration of the bunker outlet chute in which the hydrostatic pressure does not act on the feeder. At the same time the pressure helps in loosening the coal avoiding the coal flow problems and caking of coal powder during monsoon times.

Typical applications for Flip-Flow-screens

- Coke at 3 mm with 18 % moisture
- Lignite at 6 mm with 50 % moisture
- Coal at 6 mm with 15 % moisture
- Lime stone at 3 mm with 5 % moisture
- Iron ore at 5 mm with 10 % moisture
- Raw sand at 3 mm with 6 % moisture
- Compost at 10 mm with 40 % moisture
- Slag at 3 mm with 5 % moisture
- Salt at 5 mm with 3 % moisture
- Building rubble at 5 mm with 10 % moisture

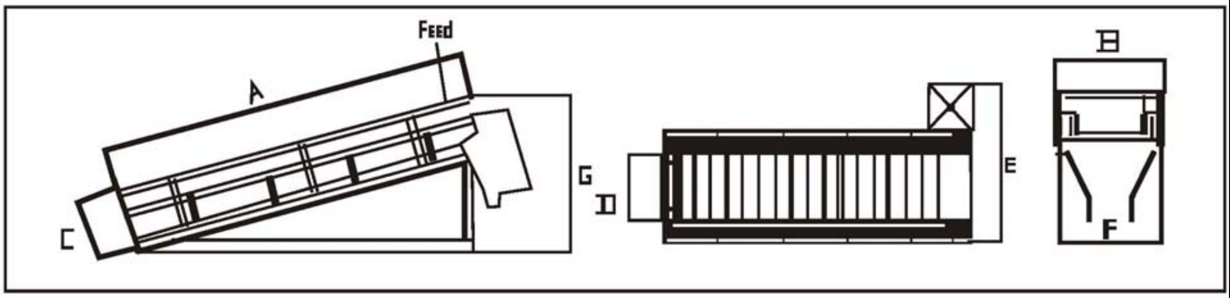

Figure 2: The flip flop screen is designed to work on high moisture.