DESIGN CHECKS in SLOP FIRED BOILER

Design based Troubles of Slop - Spent wash Incineration Boiler

Slop Fired Incineration Boiler is designed on Multi Fuel combination with individual fuel firing @100% within design boundaries. This combination of firing increase cost & design complication. Boiler should be designed on worst multi-fuel / Individual fuel condition with good margins, to meet the contract requirement & challenge.

BUT during engineering, a midway condition (not worst) has to be chosen by OEM to save project cost & margin assuming that the Incineration Boiler will never run on all individual / multi-fuel design conditions. This practice and design balancing between all fired fuels create a operational challenge to end customer.

Most of the time, Customer experiences that boiler is not able to sustain for all multi-fuel design conditions, however on some individual condition, it is performing very well.

These improper design defects are later manipulated by showing comparison between actual fired fuel analysis with design fuel analysis. Lots of modification were done in incineration boiler, after commissioning, to neutralise the design & operational defects, but it's just like to coverup a rathole.

We are trying to provide some basic design checks w.r.t. good engineering practices adopted in market, to assess safe boiler operating condition.

Basic Design Parameters need attention for safe Boiler operation:-

ΔP Pressure Drop in-between Steam Drum Operating Pressure & Main steam pressure at MSSV outlet. **Low & High pressure drop ΔP from design will lead to imbalance & tube failures**

ΔP Pressure Drop in Primary Superheater coils & Secondary Superheater coils. **Low & High pressure drop ΔP from design will lead to imbalance & tube failures**

ΔT Economiser Outlet water temperature in-between Steam Drum Saturation temperature @Operating Pressure & Economiser outlet feed water temperature. Normally this ΔT should be more than 18 degC. **Low Temperature difference ΔT from design will lead to disturb circulation ration, steaming and finally tube failures**

Grate Area Loading will be <1.7 max. in Mkcal/m2/hr for this boiler.

High Attemperation / spray water flow quantity to control final steam temperature. Normally this water quantity should be less than 10% MCR steam flow at boiler full load operation i.e. 100% MCR, however ≈ <2% MCR is good. **High spray water flow from design will lead to tube failures, improper steam-water mixing, deposition in superheater & turbine.**

SSH Inlet temp after Attemperation must be min. ΔT 25 degC higher than saturation temperature (@ SSH inlet pressure). **Lower than required temperature will increase the tube failures and deposition in superheater & turbine.**

Safety Valve Setting & design @ 110% MCR condition. This condition demand a higher pressure safety valve hence **normally avoided by OEM**

Steam Drum internals designing, missing or improper fitment primary cyclone separator, improper demister pad designing & fitment will **lead to carryover and bad steam quality**.

Material of Primary Super heater Header & Attemperator Piping (to Superheater) w.r.t. Operating temperature v/s design temperature. Normally Fluid temperature plus 30 degC.

Material of Primary Super heater coils w.r.t. PSH outlet steam operating temperature v/s design temperature. The temperature boundary at two different material junction point in PSH can't define during boiler operation. Normally Fluid temperature plus 39 degC.

Oxygen% fluctuation in flue gas in a large span while sufficient Excess air >45 % is supplied. At FEGT @600 to 625 degC, complete combustion is difficult hence back puffing, Oxygen% fluctuation, delayed combustion.

SA air pressure @ OFA at all headers @100% damper open is minimum required > 350 mmwc. A Higher OFA pressure means higher penetration & effective curtain to avoid secondary combustion & fuel carryover with flue gas. SA fan capacity may inadequate for constant pressure requirement.

Higher pressure drop across equipments in flue gas path as compared to design conditions, may be due to high velocities, more excess air, chocking & restriction in flue gas path. Need to check higher pressure drop ΔP area w.r.t. design pressure drop, to reduce ID fan loading.

Ash handling system's ineffectiveness due to ash lumps, need opening size correction with suitable pocking arrangement. RAV is not successful to remove ash lumps.

Design parameters usually considered in incineration boiler:-

Note: Gas side velocity depend on fired fuel, hence a velocity range selection started trouble for other fuels. Furnace design for FEGT will be affected by Dirt factor, Radiation factor, fuel moisture %age. Flue gas flow quantity is directly relate with fuel moisture %age. High fuel moisture will increase ID fan loading, Chimney inlet gas temperature.

1. **Circulation ratio** ≈ 27 to 30
2. **Downcomers** - water velocity ≈ 1.7 to 4.1 m/sec max.
3. **Risers** - water phase velocity < 5.5 m/sec max.
4. Velocity to avoid separation of steam & water in **Risers** < 19 m/sec max.
5. **Feeders** - Water velocity ≈ 1.3 to 3.6 m/sec max.
6. Avoid separation of steam & water in **Evaporators** < 23 m/sec max.
7. **Primary Superheater** Steam Velocity ≈ 12 to 20 m/sec max
8. **Secondary Superheater** Steam Velocity ≈ 18 to 32 m/sec max
9. **Primary Superheater** Duty ≈ 52 to 59 % Superheater duty max
10. **Secondary Superheater** Duty ≈ 41 to 48 % Superheater duty max
11. **Superheater, Economiser & Evaporator Longitudinal pitch, (Along the gas flow)** ≈ as much as higher (>130mm) to avoid bridging but increase cost.
12. **Superheater, Economiser & Evaporator Transverse pitch (Across the gas flow)** ≈ as much as higher (>170mm) to avoid jamming but increase cost.
13. **Water wall & Economiser** header velocity ≈ 2.0 to 2.8 m/sec max
14. **Boiler Feed Pump Suction** water velocity ≈ 0.5 to 1.0 m/sec max.
15. **Boiler Feed Pump Discharge** water velocity ≈ 1.2 to 2.2 m/sec max.
16. **Economiser** water velocity through coils ≈ 0.6 to 1.0 m/sec max.
17. **Superheater Gas** Velocity ≈ 6.0 to 8.0 m/sec max.
18. **Economiser Gas** Velocity ≈ 7.0 to 9.0 m/sec max.
19. **APH (air through tube) Air** side velocity ≈ 6.5 to 8.5 m/sec max.
20. **APH (air through tube) Gas** side velocity ≈ 11.0 to 14.0 m/sec max.
21. **APH (gas through tube) Air** side velocity ≈ 6.5 to 8.5 m/sec max.
22. **APH (gas through tube) Gas** side velocity ≈ 11.0 to 14.0 m/sec max.
23. **ESP** inside gas velocity ≈ 0.6 to 1.0 m/sec max.
24. **ESP outlet to ID fan** gas velocity ≈ 13.0 to 16.0 m/sec max.

Vigilant / Control in Slop - Spent wash in boiler

Do not try to avoid steam drum level fluctuation by applying DAMPING in drum level transmitters, This DAMPING will not reduce Water Carry Over from Steam drum to Super heater & Turbine.

Design Metal Temperature Maximum Limit for Various material:-

A- TUBES

1. **SA 210 Gr A1**- Metal Temp. **427** degC, Fluid Temp **388** degC
2. **SA 213 Gr T11**- Metal Temp. **552** degC, Fluid Temp **490** degC
3. **SA 213 Gr T22**- Metal Temp. **580** degC, Fluid Temp **530** degC

B- PIPES

1. **SA 106 Gr B**- Metal Temp. **427** degC, Fluid Temp **388** degC
2. **SA 335 Gr P11**- Metal Temp. **552** degC, Fluid Temp **490** degC
3. **SA 335 Gr P22**- Metal Temp. **580** degC, Fluid Temp **530** degC

Unite Energy Corporation LLP is assuring customers that this article shall help them to get best results from Slop fired boiler. Our mission of **"ENERGY CONSERVATION & TROUBLE FREE WORK ENVIRONMENT"** with an idea to reduce plant's cost & maintenance.

Unite Energy Corporation LLP is keen to provide best support to you to mitigate the irregularities in the plant, best technical services to mitigate breakdown, minimize downtime, improvise design and system performance, operational recommendations, genuine analysis, training and skill enhancement etc, to improve the overall plant's health and performance.

Pramesh Kumar Jain
Chief Executive- Technical

Mb +91 9555082622, +91 9868499319
pramesh.uniteenergy@gmail.com

Unite Energy Corporation LLP, Ghaziabad, UP
uniteenrgycorp@gmail.com