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Use of Guide Vanes in KPCL`s new FGD Wet Stacks

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Introduction

Raichur Power Corporation Limited (RPCL) is a joint venture company of Karnataka Power Corporation Limited (KPCL), Bharat Heavy Electrical Limited (BHEL) and Industrial Finance corporation of India (IFCI). RPCL has built 2 x 800 MW Yeramarus Thermal Power Station (YTPS) near Raichur in Karnataka state. YTPS power plant was commissioned during 2018.

As per the new guidelines of the Ministry of Environment, Forest, and Climate Change (MOEF & CC) and to meet the required environment air quality standards, Flue Gas De-sulphurisation (FGD) plant is being implemented at YTPS plant.

In YTPS plant wet lime Flue Gas Desulphurisation technology is adopted. YTPS plant has two new wet stacks where fully saturated flue gasses exiting from the absorber is being sent into wet stacks to discharge effluents into the atmosphere.

Details of YTPS new wet stack:

YTPS new wet stack is of RCC with total height above ground level of 125.00m. The mean diameter is 10.01m, thickness of the shell for bottom 16.7m height is 0.50m and at top it is 0.40m. Solid raft of 21.00m diameter and 2.50m thick is provided for the foundation. Borosilicate lining is proposed inside wet stacks.

Figure 1: Chimney raft concreting

Wet Stack Design

In the design of wet stack for wet operation, several issues that were not present in the dry flue gas Chimney are to addressed. Some of the important issue to be considered in the design of the wet stack system are:

- Stack liquid discharge
- Plume downwash
- Corrosion and chemical attack
- Stack height
- Absorber outlet arrangement/ Geometry.
- Stack liner geometry and material
- Gas velocity in the liner.
- Liquid collection devices and drainage.

The design of a wet stack is based on the site-specific requirements, Operating conditions, Design conditions and Economic conditions.

Guide vanes

Guide vanes / turning vanes are typically used to optimise gas flow pattern, reduce pressure losses and to promote liquid collection and proper drainage. Conventional guide vanes will reduce the pressure losses but will cause stack liquid discharge / spitting in the wet stack.

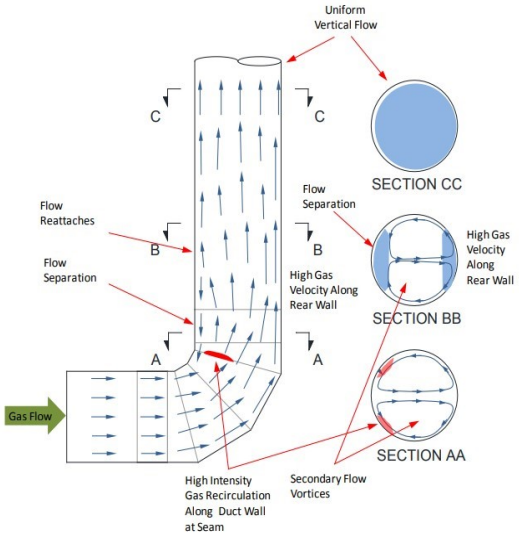

Figure 2: Stack Liquid collection

The gase exiting from the absorber is fully saturated and will contain suspended droplets. These gases will flow through the ducting, coming into contact with the duct walls and with any other internal structures within the duct. Liquid will be continuously condensing from the gases onto these surfaces forming a liquid film that will flow downwards under gravity. To the extent possible, the gas flow pattern should be managed in such a way as to move the resulting liquid film to drainage points for removal from the system.

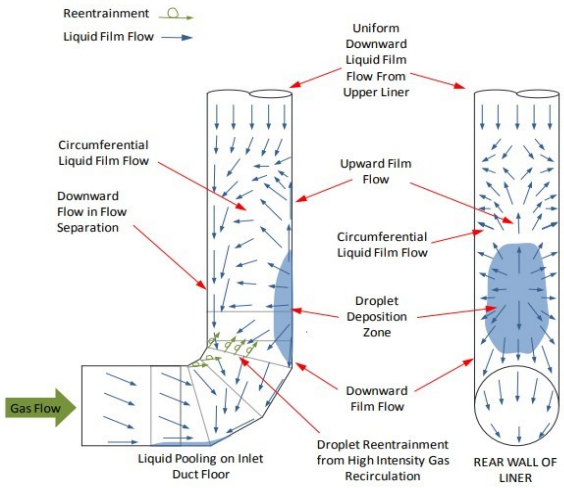

Figure 3: Stack Liquid collection

Guide vanes are to be properly designed to both reduce the pressure loss and efficiently drain away any liquid collected on it. Hence there is a need to revise the wet stack design to maximise the overall efficiency of the system and to minimise unfavourable gas flow patterns on both the high and low-pressure sides of the vanes.

To minimise the pressure losses associated with acceleration and de-acceleration of the gas flow as it passes through the system, it is desirable to maintain the constant area hence constant velocity through the system.

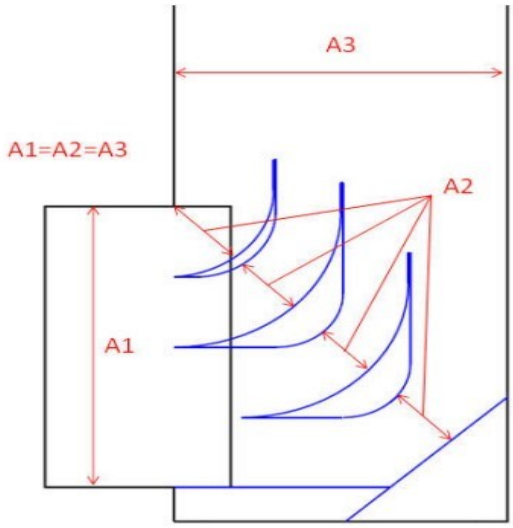

Figure 4: Guide vane

Wet ready guide vanes are specifically required to reduce or eliminate stack liquid discharge. Wet ready guide vane installation will be required to ensure that the gas flow entering the stacks is favourable for wet operation and possibly to minimise swirling of gas flow within the liner and the stack.

In order the address the above problem and to improve the efficiency of the operation of the plant, wet ready guide vane technology has been adopted in the YTPS wet flue gas Chimney.

New wet ready guide vanes are specifically designed to catch, retain, and drain off droplets contained in the flue gas stream. This will reduce the risk of liquid droplets carryover into the environment reducing the stack inlet pressure losses which leads to increased plant efficiency and reduced operating cost.

In the new guide vanes design, a provision of an additional slot along the length of the trailing edge incorporating a backward facing sharp edge which allows the liquid film to flip over into a collection gutter within the vane without re-entraining back in to gas flow.

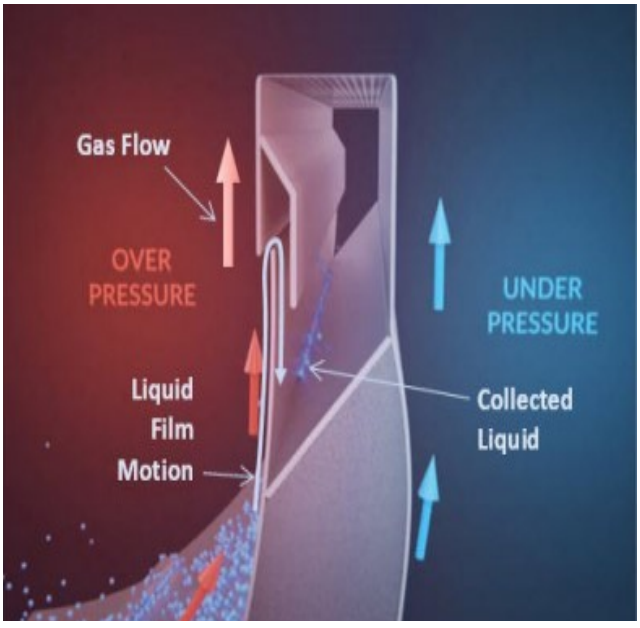

Figure 5: Wet ready guide vane

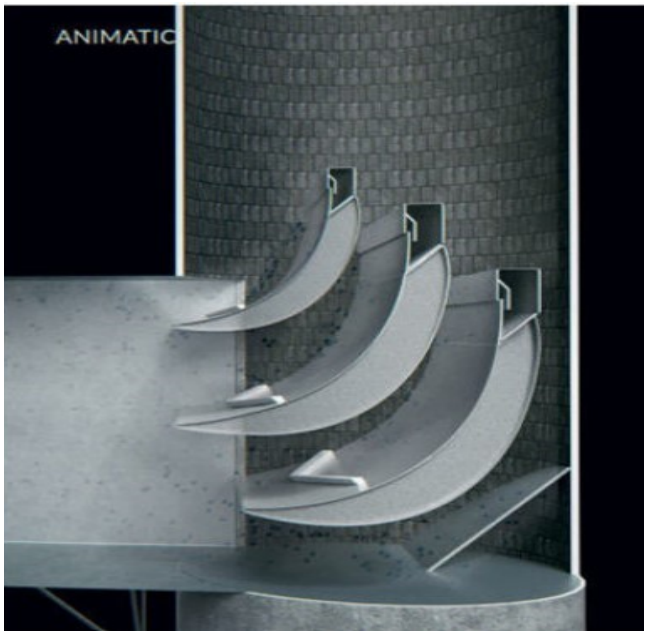

Figure 6: Animation guide vane system

Conclusions

Adopting a wet ready guide vane system in the YTPS wet flue gas will enable the Chimney to operate effectively in wet conditions and optimise the pressure loss reduction. It will reduce the potential formation of droplet and re-entrainment back into the flue gas flow path and reduce the operating cost.

Reference

EPRI-Revised wet stack design guide