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Recovery boiler sootblowers: the basics

Scope

The purpose of this TIP is to provide a brief description of sootblower components and the mechanisms by which a sootblower jet removes deposits in recovery boilers.

Safety precautions

A recovery boiler sootblower is connected with high pressure steam piping system and a power supply to drive its motor(s). Before any work is performed on a sootblower, it is important to the sootblower be put in the zero energy state. Zero energy state means that (1) the isolation valve is closed and a lock tag is placed in the valve to prevent the high pressure steam to enter the sootblower, and (2) the power supply to the sootblower is disconnected with a lock tag placed in the power supply to prevent inadvertent or unexpected start-up or energization of the motor.

Definitions

Poppet valve pressure: The poppet valve pressure is the steam pressure measured at the location immediately downstream of the valve seat. This is the steam pressure supplied to the feed tube.

Nozzle pressure: The nozzle pressure is often used interchangeably with lance pressure or blowing pressure. It is defined as the steam pressure supplied to the sootblower nozzles, and is the pressure measured just before the steam enters the nozzle (Points A shown in Figure 1). Note that the nozzle pressure is always lower than the poppet valve pressure due to minor losses and the pressure drop in the feed and lance tubes.

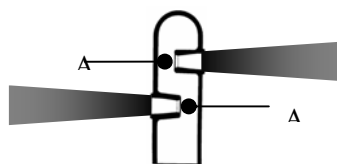


Fig. 1. Nozzle pressure

Reverse and rest positions. The reverse position is the point where the limit switch is triggered to send a signal to change the carriage forward direction and retract the sootblower lance. The rest position is the point where the limit switch is triggered to send a signal to stop the carriage retracting movement and park the sootblower.

Helix. The helix is the distance traveled by a nozzle to complete one full rotation (360°). See Figure 2.

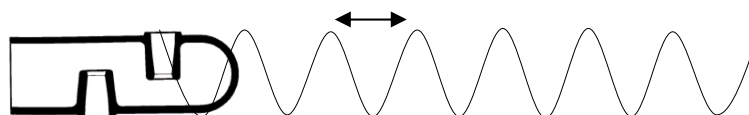


Fig. 2. Helix

Sootblower: basic principle

Function and operation

The entrainment of fly ash particles from the recovery boiler lower furnace to the convection sections of the boiler is an inevitable process. The accumulation of these particles in the fireside heat exchanger surfaces may reduce the boiler thermal efficiency, create a potentially corrosive environment at the boiler tube surfaces and, if the accumulation is not properly control, it may also lead to costly unscheduled boiler shutdowns due to plugging of the gas passages.

Sootblowers are by far the most widely used equipment to control the fireside deposit accumulation in recovery boilers. A sootblower consists of a lance tube with two opposing nozzles mounted near the tip of the lance. During the deposit removal process, the sootblower lance rotates and extends, through a small opening in the boiler wall, while blowing high pressure steam directed into the tube banks. After the lance is fully extended, it rotates in the opposite direction as it is inserted and retracts to its original inactive state. Figure 3 illustrates the cleaning process of a tube bank by a sootblower.

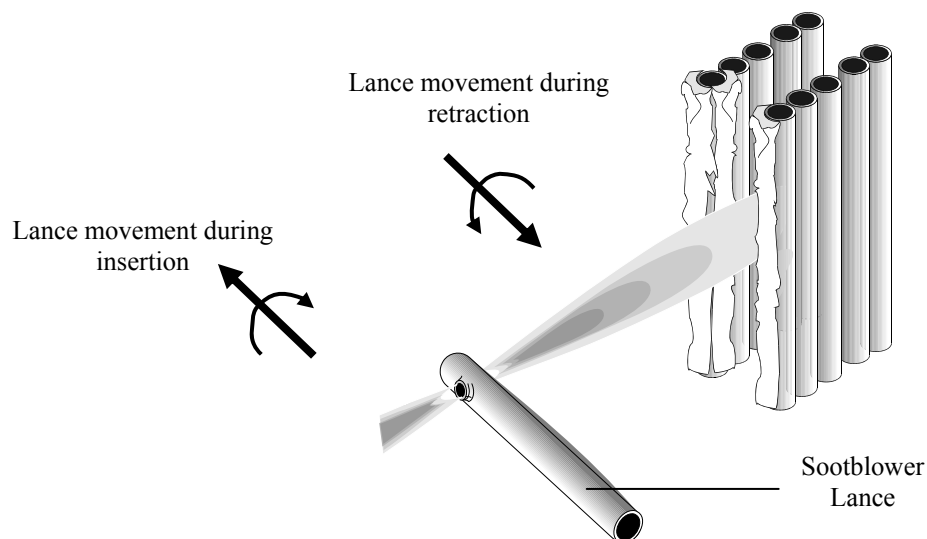


Figure 3. Cleaning process of a boiler bank by a sootblower

Deposit removal mechanism

When a sootblower jet hits a deposit that adheres to a boiler tube, the jet velocity is converted into impact pressure that is distributed throughout the jet/deposit contact area. To better understand the deposit removal mechanism, we define a deposit/tube control volume as shown in Figure 4.

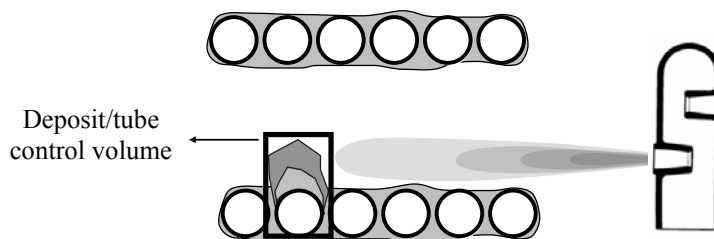


Fig. 4. Deposit/tube control volume

Two main deposit removal mechanisms have been identified; debonding and brittle fracture (1). The deposit will be removed from the boiler tube by debonding if the weakest link in the deposit/tube control volume is the strength of deposit adhesion to the tube (Fig. 5a). Brittle fracture occurs when the deposit tensile strength is the weakest link. In this case, the deposit will be broken into smaller pieces as the jet impacts the deposit (Fig. 5b). The deposit will stay attached to the tube if the stress imposed by the jet on the deposit is less than both the deposit adhesion strength and deposit tensile strength (Fig. 5c).

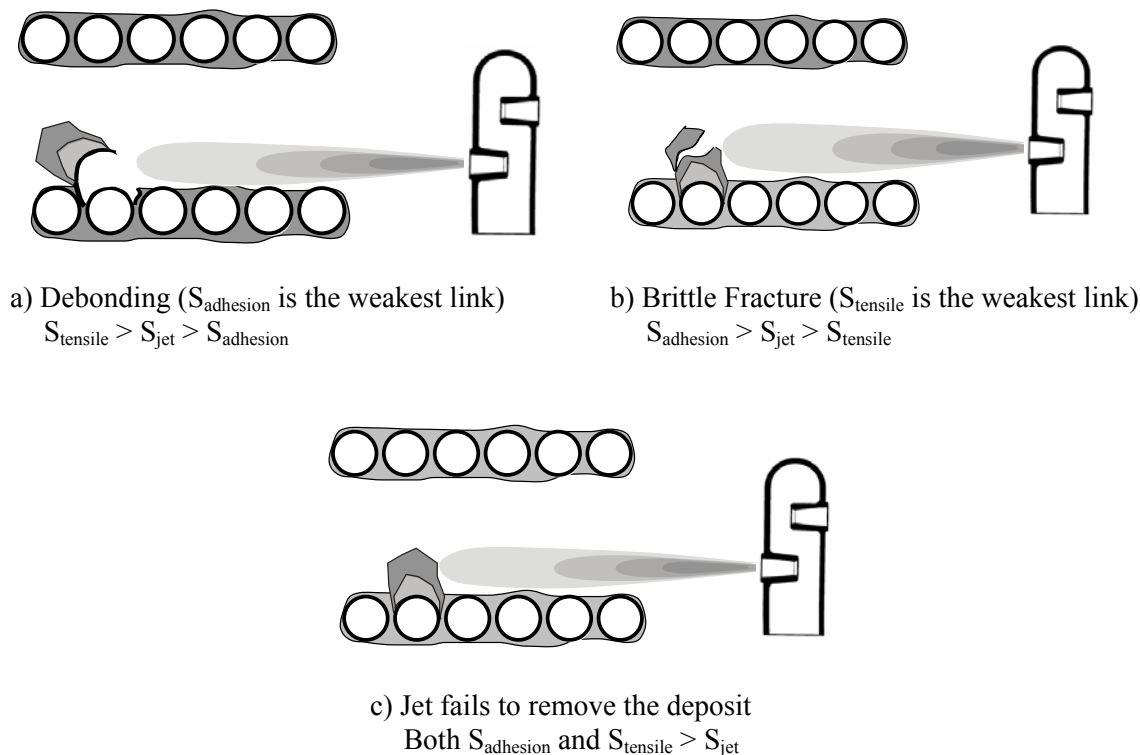


Fig. 5. Three scenarios of deposit removal attempt by a sootblower

The deposit removal criterion can be written as follows:

$$S_{jet} > S_d \quad (1)$$

where

S_d = either $S_{adhesion}$ or $S_{tensile}$, whichever is least.

As expressed in Equation 1 and conceptually shown in Fig. 5, the success of deposit removal process depends on three key parameters. They are the stress imposed by the jet on the deposit (S_{jet}), the strength of deposit adhesion to the tube ($S_{adhesion}$), and the deposit tensile strength ($S_{tensile}$). The magnitude of these parameters determines whether or not the deposit accumulation in the boiler tubes can be controlled by the sootblowers.

Out of these three parameters, only S_{jet} depends on the sootblower performance, while the magnitudes of both $S_{adhesion}$ and $S_{tensile}$ are controlled by factors outside the sootblower equipment. $S_{adhesion}$ and $S_{tensile}$ are influenced by the design of the boiler, operating conditions, and the liquor chemistry. Detailed and more elaborated discussion can be found in references (2, 3)

In order to achieve high recovery boiler thermal efficiency and prevent unscheduled interruption due to fouling or plugging, the recovery boiler system should be designed to ensure that the rate of deposit removal by sootblowers is greater or at least equal to the rate of deposit accumulation.

Major components

Sootblower major components can be divided into three parts: steam carrying, mechanical, and auxiliary components. Figures 6 and 7 show the schematic diagram of sootblower major components.

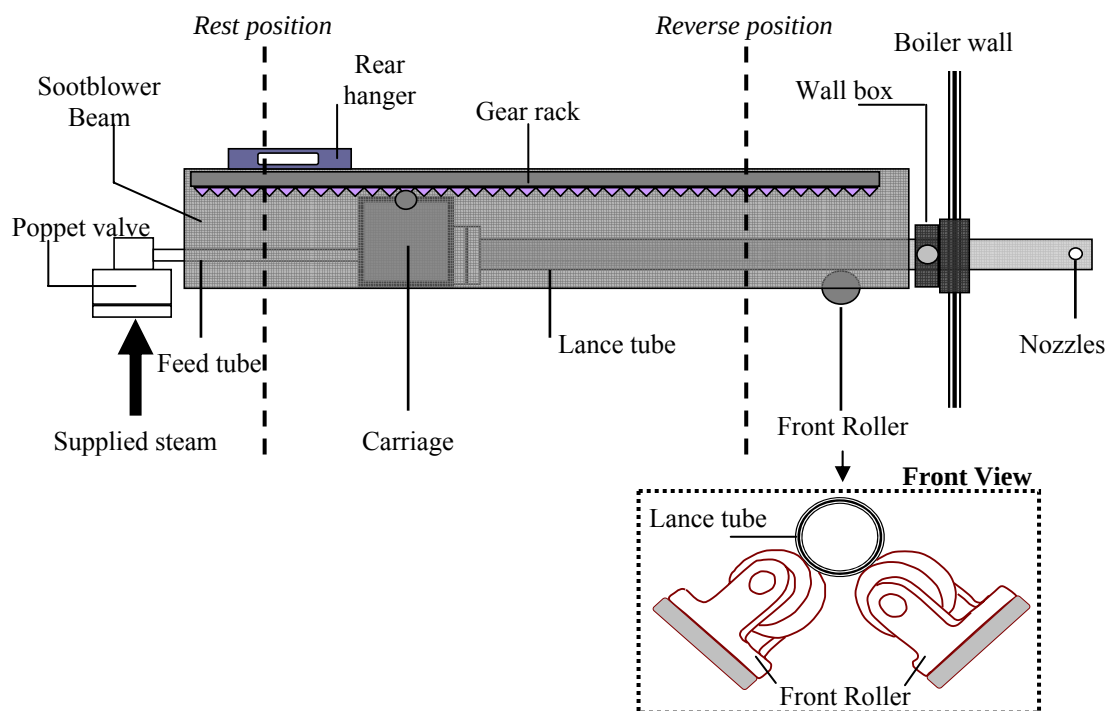


Fig. 6. Sootblower major mechanical components (side view)

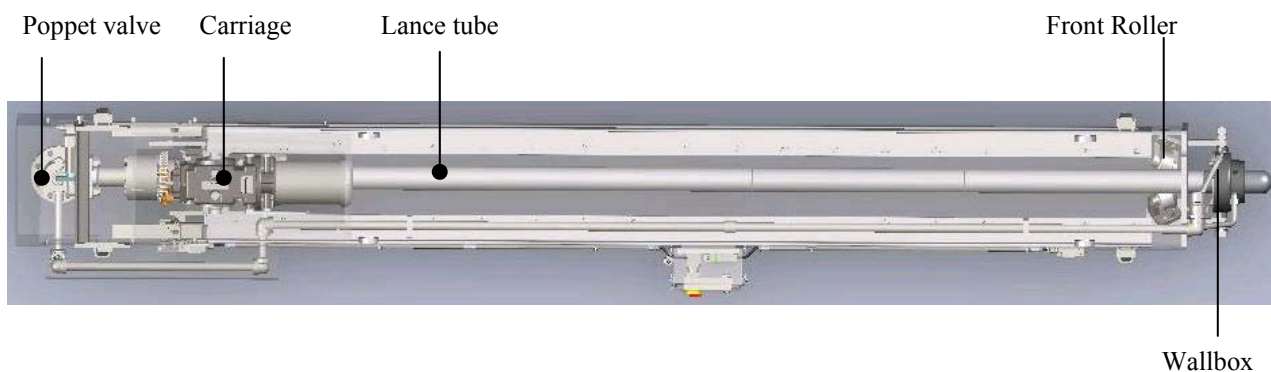


Fig. 7. Sootblower major mechanical components (top view)