TIP 0416-28

ISSUED – 2022

Sootblower Safety and Upgrade Guidelines

Scope

The availability of the Recovery boiler is essential to the continuous operation of a Kraft pulp and paper mill. Sootblowers play a crucial role to the safe and efficient operation of the boiler. They operate on a continuous basis and, the lack of availability of any critical blowers for an extended period of time leads to heavy fouling of the heat transfer surfaces and the eventual plugging of the flue gas passes.

This TIP addresses the best practices for the operation and maintenance of these pieces of equipment, and some potential pitfalls. It provides a window into common problem areas and some suggestions to avoid them. It covers some of the crucial components and subcomponents of a sootblower. The owners should always consult their O&M manuals and the manufacturers for specific details on their equipment. This TIP serves as a reference to owners/users of sootblowers. This TIP does not provide design standards, specific operating parameters or guidelines for acceptance criteria for sootblower inspection. This TIP does not provide detailed welding procedures. It is expected that the tubes carrying steam satisfy the welding requirements under ASME section IX.

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.

It is important to ensure that the sootblowers are maintained and operated per the original manufacturer's guidelines. Periodically review of poppet pressures as a function of cleaning needs, lance and feed tube inspections are important.

Background

All sootblowers have a canopy, (also referred to as track beam/beam shell), which contains a track where in the carriage travels driven by an electric/pneumatic motor. The canopy is designed to provide the structural support for the entire sootblower. It attaches to the boiler wall at one end via a wall box while its other end hangs from the boiler structural steel. At this end of the canopy a poppet valve is attached which is secured to the steam supply line via a connecting flange. Steam flows through the valve into a stationary tube referred to as a feed tube. It passes through the traveling carriage to deliver the steam into the lance tube. The lance tube attached to the carriage rotates and reciprocates during the operation. A packing set in the carriage prevents steam from leaking out of the back. Figure 1 illustrates all of these key components. When it comes to sootblowers and pressure piping, the steam supply pipe to the sootblower, the companion flange, gaskets, bolts, and poppet valve up to valve seat/valve disc interface are the only components that fall under the jurisdiction of the ASME B31.1 power piping code. The sootblower and piping have to hold the steam pressure when the sootblower valve is closed. Since both the lance and feed tubes are open at one end, they are beyond the pressure boundary and do not truly act as a pressure piping. Hence, applying the criteria from the power piping code alone is not sufficient.

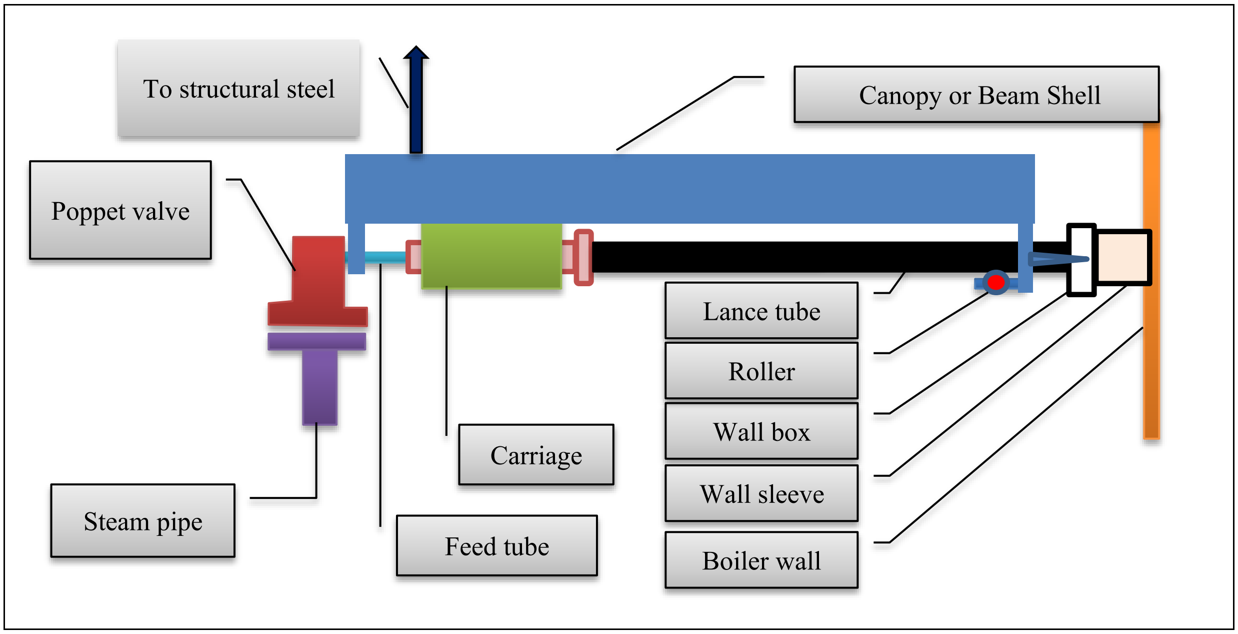


Figure 1: Illustration of a typical sootblower

Lance Tubes

The lance tube is one of the most critical components of a sootblower. This tube has nozzles at one end, which continuously discharges high pressure steam into the ambient atmosphere of the boiler. Due to the presence of the nozzles that are open to the atmosphere, a lance tube does not have to hold pressure like a process pipe. Unlike a steam pipes that primarily see the stresses due to internal pressure over prolonged periods, the lance tube experiences the pressure only for a brief period when it is in operation. At this time the tube extends into the boiler. The extension of the lance tube into the boiler resembles a cantilever beam with a single simple support at the roller shown in Figure 1. The highest stress by far is the bending stress as a result of the over hung weight of the lance beyond the support roller.

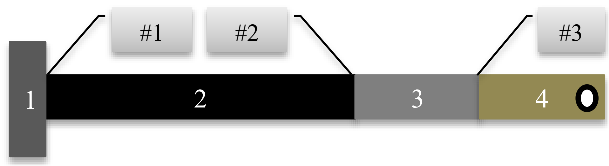
Therefore, in design it cannot be evaluated like a steam pipe based on pressure and temperature alone. The yield strength at elevated temperatures is an important parameter in its design. In addition to the static bending stress, the lance will also experience dynamic forces due to the nature of its operation. Hence the allowable stress for a lance has to factor in a margin that accounts for all of these.

When it comes to a lance design and selecting minimum wall thickness, one cannot ONLY use the minimum thickness required to hold pressure. It is also necessary consider service factors and make an allowance for corrosion. For very long lances, larger diameter tubes as well as tubes with two or more wall thicknesses are used.

At a minimum, for recovery boiler applications the lance tubes are comprised of four (4) segments. A sketch of a lance illustrating this is in Figure 2. Each of these components have to be welded together to make the final tube. The longest piece being section 2 is made of medium to high strength alloy steel. Common materials used in North America are Cr-MO alloys such as T11, AISI 4130 and B&W 6330 (Timken 17-22AS). Each OEM has design criteria that goes into the selection of both the material, the tube OD and thickness in each segment as well their thicknesses. The welding and post welding treatments are dependent on the materials being used. Please consult with the OEM for guidance. Under special circumstances, there may be a need to look at alternate materials. They are not common in recovery boiler applications.

A typical recovery boiler sootblower travels at ~100-110”/min. Based on this speed and a travel length of 25ft, the total time for which the lance tube is in the high temperature environment of a boiler is only about 6 minutes. This is quite short in comparison to the many hours of continuous exposure to higher temperatures and pressures experienced by both process piping and boiler tubes. Therefore, the long-term material creep strength which is important for these applications play no significant role here. For a soot blower lance tube, what is more important is its short-term material strength at elevated temperatures. The allowable stress for a lance is a fraction of its elevated temperature yield strength, which decreases with an increase in temperature. This implies that common stainless steels like AISI304 are not superior lance tube materials when compared to the Cr-Mo steels used today.

As a minimum, the total number of welds for a recovery service lance is three (3). Due to the nature of its application all segments would have to be welded in a manner that gives a uniform outside diameter (OD) that will ride properly on the roller and pass freely through the wall box attached to the boiler wall sleeve. Any variations in the thickness of individual segments have to be taken up through changes of the inside diameter.



1 - Steel Flange	2 – Medium or High strength Cr-Mo Tube	3 – Stainless steel tube	4 - High temp. cast stainless nozzle

Figure 2: Illustration of different material sections for a typical recovery service lance tube

When it comes to the fabrication/welding, the OD lance tube is ground at the joint to form a smooth OD. On the inside, excessive weld penetration is not acceptable since they will interfere with the feed tube and eventually score its surface causing short packing life and steam leaks.

Welds

When it comes to welding the various segments of the lance tube fully penetrated butt welds are the most common. Due to the functional requirements mentioned above, the OD of the tube has to be uniform over its length. All joints except lance tube flange welds are finished by smoothing out the welds. Figure 3 is a photograph showing before and after finishing of a weld joint.

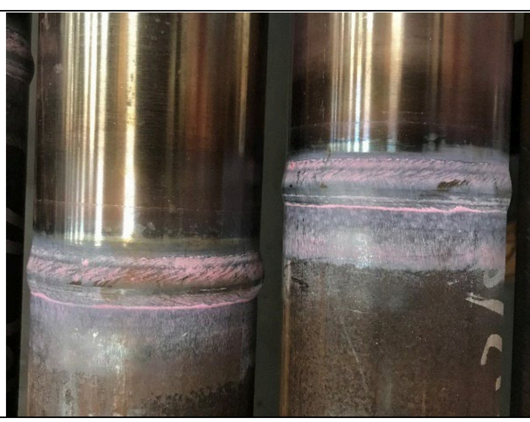


Figure 3a: Weld pre finishing

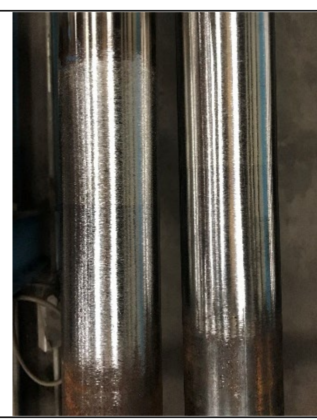


Figure 3b: Weld post finishing

For tubes with the same OD and varying wall thicknesses, the joint design requires a transition to be made at the internal diameter (ID) of the tube. Figure 4 shows recommendations made by the AWS Code D1.1/D1.1M:2010 – Steel for the welding of two pipes of varying thickness. It is highly recommended that proper weld joint designs from standard welding codes be followed.

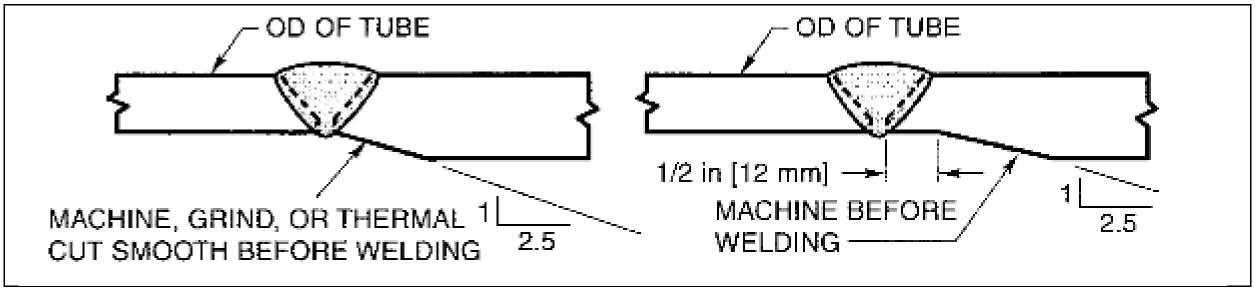


Figure 4: Transition of thickness at the ID of tubes

All welds must meet Section IX of the ASME boiler code. Having NDT checks of the weld by code acceptable methods like X-ray, phased array/shear wave plus dye penetrant/mag particle methods are highly recommended.

Tube repairs

Due to the critical nature of the lance tube, every effort must be made to ensure good welds. Figure 5 below is an illustration of a lance in service where the tube/weld repair is compromised, and steam continues to leak at the joint while the lance remains in service. Lance tubes should be regularly inspected for leaks and material thickness and any defective lances replaced immediately.

Figure 5: Lance tube leaking at a bad weld joint

All lance welds and any repairs by should be qualified to ASME Section IX for the materials to be welded and the filler metals used for the WPS (Welding Procedure Specification). OEM equipment manufacturers recommends using factory welds for lance tubes and replacing the lance tubes when they are no longer fit for service. This will avoid a bad joint like the one shown in Figure 6.