Continuous and Intermittent Blowdown

Learning Outcome

When you complete this module you will be able to:

Describe the purposes, equipment and operation of continuous and intermittent blowdown.

Learning Objectives

Here is what you will be able to do when you complete each objective:

1. Distinguish between the terms "blowdown" and "blow-off" with respect to boilers.

2. Describe the equipment and processes involved in continuous blowdown.

3. Describe the equipment and processes involved in intermittent blowdown.

INTRODUCTION

The term **blowdown** refers to the removal of dissolved and undissolved solids from a boiler. As the name suggests, continuous blowdown is usually an on-going process, whereas intermittent blowdown is performed on an as needed basis.

The type of blowdown system used in a plant depends to a large extent on the type of external water treatment system. This, in turn, is generally (but not always) related to the operating pressure of the boiler. Boilers that operate above roughly 5000 kPa tend to use demineralized water from a cation-anion exchange system or from an evaporator. In this case the water will be very pure, and the blowdown requirements will be marginal. Large central station type steam generators may require both continuous and intermittent blowdown only in special circumstances such as start-up. Utility boilers, operating below 5000 kPa often use sodium zeolite and/or hot or cold lime softening, in which case the continuous blowdown will be in constant operation, and the intermittent blowdown will be performed once per day.

The operation of the blowdown system is an important part of routine boiler care, and specific guidelines are described in Section VII of the ASME code, the ASME B31.1 Code on Power Piping, and the CSA B51 code. These guidelines will be referred to in this module.

Terminology

The terms **blowdown** and **blow-off** are sometimes used interchangeably. The ASME code uses both terms but in slightly different contexts. Blowdown is used to describe the process of removal, and/or the water-sludge solution itself. For example, we refer to the continuous blowdown line, or, the removal of the blowdown from the boiler. Blow-off is usually applied to the actual equipment. For example, both the CSA and ASME codes use the terms blow-off valves and blow-off tank, rather than blowdown valves or blowdown tank. This, however, is not a hard and fast rule, for example the ASME B31.1 Code on Power Piping refers to both blowdown piping and blow-off piping in the same sections.

Unfortunately, the term blowdown also refers to the difference between the opening and closing pressures of a safety valve. However, the context of this is quite different from the removal of solids from a boiler and should not result in any confusion.

CONTINUOUS BLOWDOWN

As steam is produced from the boiler water and drawn off for use, most of the impurities in the water remain behind. These consist of dissolved solids and some suspended solids, left over from the external water treatment and from chemicals injected into the boiler as part of internal water treatment. The water in the boiler therefore becomes highly concentrated in regard to these impurities and this concentration steadily rises as long as steam is being produced and drawn off. If this concentration is not reduced by some means then foaming and carry-over of impurities with the steam will occur, as well as the formation of sludge deposits within the boiler. Continuous blowdown (CBD) refers to the removal of the dissolved solids portion of these impurities.

Since steam separates from water in the steam drum, it is reasonable that this is the region where dissolved solids will concentrate. In fact this is the case, and a narrow zone of water just below the normal operating level is the region of highest concentration. At this location a long collection tube, with inlet holes, runs inside the steam drum along its length. This tube is connected by external piping to a blow-off tank, or pond, so that boiler water with a high level of total dissolved solids (TDS) can be removed.

The continuous blowdown rate depends on the TDS level in the boiler water. Routine water tests must be conducted and the continuous blow-off valve adjusted accordingly. This is usually a needle valve with an external valve position indicator, sometimes referred to as a vernier valve. On very high pressure systems, more than one valve may be needed to accurately control the flow, since the exhaust is at atmospheric pressure. A typical adjustment would be only a portion of a turn. If the valve is not opened sufficiently, the TDS will rise and foaming conditions and/or carryover could occur. If the valve is opened too much, the TDS will be low, which is not a problem in itself, but if the boiler is meant to operate with high TDS water then expensive treated water will be wasted with no advantage.

On boilers using demineralized water the CBD line may be almost or completely closed under normal operation. On other boilers it is typical to have a flow rate in the CBD line equal to 1% or more of the overall boiler steam flow rate.

Heat Recovery

The flow of CBD water from the boiler causes a slight decrease in overall steam system efficiency, since this water absorbed heat provided by the furnace. If this heat loss is sufficiently high, a heat recovery system may be used. Fig. 1 shows the basic equipment layout to accomplish this.

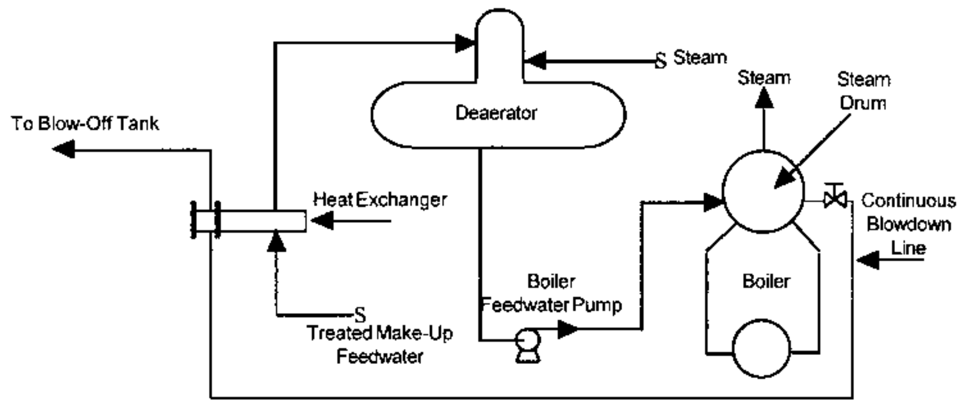

Figure 1
Continuous Blowdown with Heat Recovery

Hot blowdown water flows from the boiler through the continuous blowdown line to the heat exchanger. Inside the exchanger it gives up its heat as it flows through tubes. Incoming feedwater from the water treating system flows over the hot tubes in the heat exchanger, absorbing the heat from the CBD. The cooled CBD then exits to the sewer system by way of the blow-off tank. The feedwater continues on its way to the deaerator and boiler, along with the heat recaptured from the CBD.

INTERMITTENT BLOWDOWN

The purpose of the intermittent blowdown is to remove undissolved (or suspended) solids from the boiler. Although small amounts of these are dispersed throughout the boiler, the greatest concentration occurs in the bottom points of the water space. On packaged watertube boilers this will be at the bottom of the mud drum(s). On firetube boilers this is at the bottom of the boiler shell. On large steam generators there may be several such locations, such as the bottom of each waterwall section. In all cases, the intermittent blow-off connection is made at the lowest part of the boiler water space, and the term bottom blowdown is sometimes used instead of intermittent blowdown. The intermittent blow-off connection also serves as a place where the waterside of the boiler can be drained.

As discussed under continuous blowdown, the amount and frequency of intermittent blowdown depends on the quality of the boiler water. On utility boilers it may be a routine daily task to open the blow-off line for a short period of time. On large steam generators this line is usually opened only during initial start up or when shutting down and draining the boiler. In particular, if it is a very high pressure boiler, operating at close to the practical upper limit of natural water circulation, the blow-off valves may not be opened under normal working conditions. To do so might cause a temporary loss of water circulation in that section of waterwall tubing and expose the tubes to burnout from overheating.

The overall intermittent blowdown system consists of several important components: the blow-off tank (drum or vessel), the blow-off piping, and the blow-off valves. There are special considerations for these components.

Blow-Off Tank

Intermittent blowdown involves hot, high pressure water, flowing for short periods of time. When this water is reduced to atmospheric pressure it will partially vaporize. The combination of pressure, vaporization, and high temperature would result in extensive damage to sewer piping if the blowdown entered the sewer directly from the boiler. To prevent this, the blow-off lines are routed through a blow-off tank before entering the sewer piping. Fig. 2 shows a typical blowdown tank.

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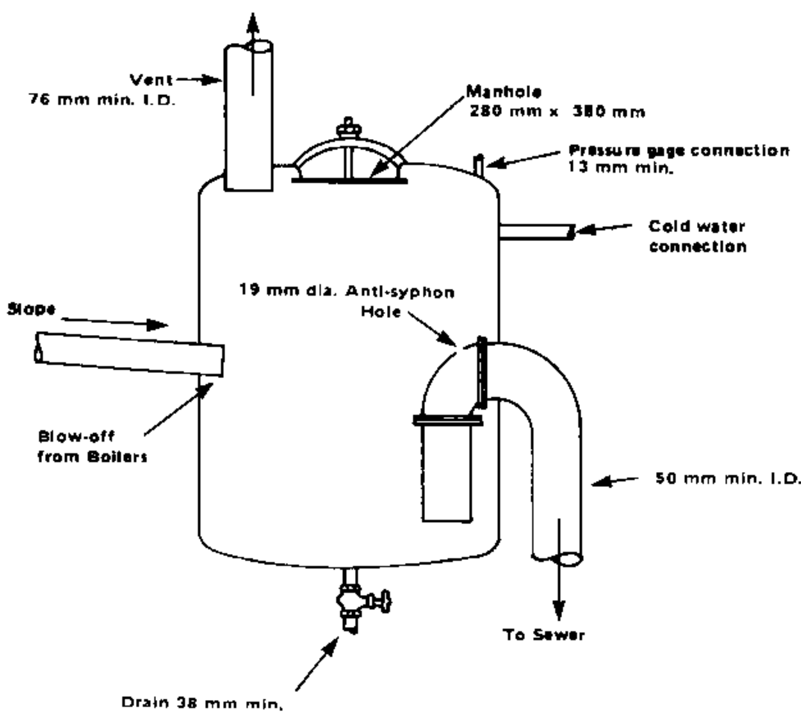

Figure 2
Blow-Off Tank

The blow-off tank provides a space for flash vapours to separate and vent, and for the water to cool. The inlet line from the boilers is positioned beneath the water level so that incoming hot water is submerged in the cooler tank water. This also agitates the water in the tank so that sludge is kept dispersed. As new water enters, the tank overflows to the sewer, carrying the sludge along with the water.

The CSA B51 Code requires the installation of a blow-off tank for all boilers operating at or above 103 kPa gauge, discharging to a sewer system. They are therefore not required if the boiler is low pressure (that is, operating below 103 kPa gauge) or if the boiler discharges to a separate pond, such as often occurs in large, remote thermal stations. The water temperature at the blow-off tank outlet may not exceed 65°C. The code also specifies the required vessel and piping thicknesses, design pressures, corrosion allowance for thickness, and inspection and cleaning access.

Blow-Off Piping

The piping leading to the blow-off tank from the boiler is subject to short duration flows. This means that it will experience rapid changes in temperature when the blowdown occurs. Allowance must be made for this piping to expand and contract during these temperature changes. If this is not done the piping will become stressed due to restricted thermal expansion. Worse yet, it would attempt to expand against the mud drum or water walls of the boiler, placing heavy stresses on boiler parts that are already working at high pressure and temperature. The piping must therefore be anchored in such a fashion that this type of motion cannot be transmitted back to the boiler. Provision must also be made so that the piping can be inspected for leakage.

The ASME B31.1 Code on Power Piping specifies the materials, pressure ratings, and required sizes for blowdown piping.

Blow-Off Valves

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The boiler is isolated from the blow-off tank by the blow-off valves. These valves are specially designed to handle the pressure drop from boiler operating pressure to atmospheric pressure, and to provide a safe means of controlling the flow of the hot water and sludge under these conditions. There are several possible valve types and arrangements, and each arrangement has a specific valve opening and closing sequence which must be followed to ensure safe operation and to protect the piping and valves. The B31.1 Code specifies the types of valves that can be used for particular boilers.

Every high-pressure steam boiler must be equipped with two approved blow-off valves, one of which should be of a slow opening type. A slow opening valve is one which requires at least five 360° turns of the operating mechanism to change from full closed to full open and vice-versa. Figs. 3 and 4 show some typical slow opening blow-off valve designs. One of the special features of these valves is that they do not allow sediment to collect under the valve seat.

Figure 3
Slow Opening Y Type Blow-Off Valve
(Everlasting Valve Co.)

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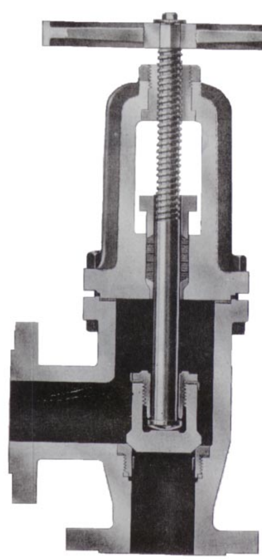

Figure 4
Slow Opening Angle Type Blow-Off Valve
(Everlasting Valve Co.)

Boilers are often equipped with one slow opening valve and one quick opening valve, or they may be equipped with two slow opening valves. In addition the slow opening valves may be of the hard seat or seatless variety. The opening and closing sequences of these valves depends on the valve type and arrangement. In general, we can refer to two common combinations: i) one slow opening valve and one quick opening valve, or, ii) two slow opening valves of the seatless type.

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1. **Quick and Slow Opening Valves.**

A quick opening valve is one which is opened or closed by moving a lever or wrench through a small arc. Fig. 5 shows a typical design.

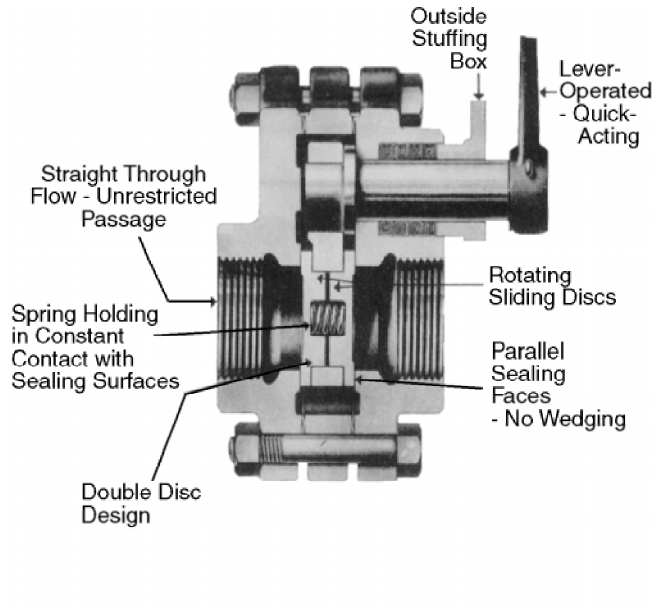

Figure 5
Quick Opening Blow-Off Valve
(Everlasting Valve Co.)

If a quick opening valve is used with a slow opening valve then the quick opening valve should be installed nearest the boiler. The quick opening valve then acts as a sealing or guard valve and the slow opening valve is the blowing off valve. Fig. 6 shows a typical arrangement.

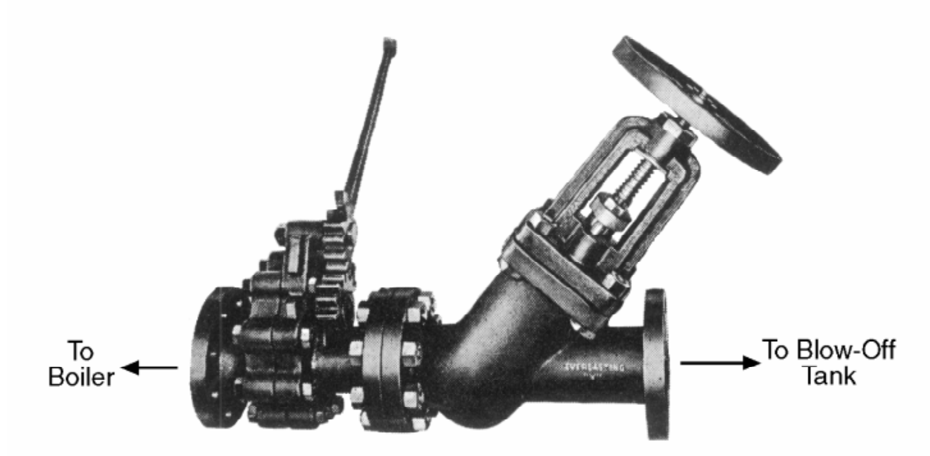

Figure 6
Quick and Slow Opening Blow-Off Valves
(Everlasting Valve Co.)

The sealing or guard valve should be opened first and closed last; the blowing-off valve is opened last and closed first. In this way the blowing valve will be subjected to wear due to the flow of abrasive water through it when it is starting to open and just before it closes. On the other hand the guard valve will not wear as there is no flow through it at the time it is being opened or closed. This means that there will always be a tight valve next to the boiler allowing the blowing valve to be repaired while the boiler is in operation.

Fig. 7 shows the correct valve sequence for these types of valves.

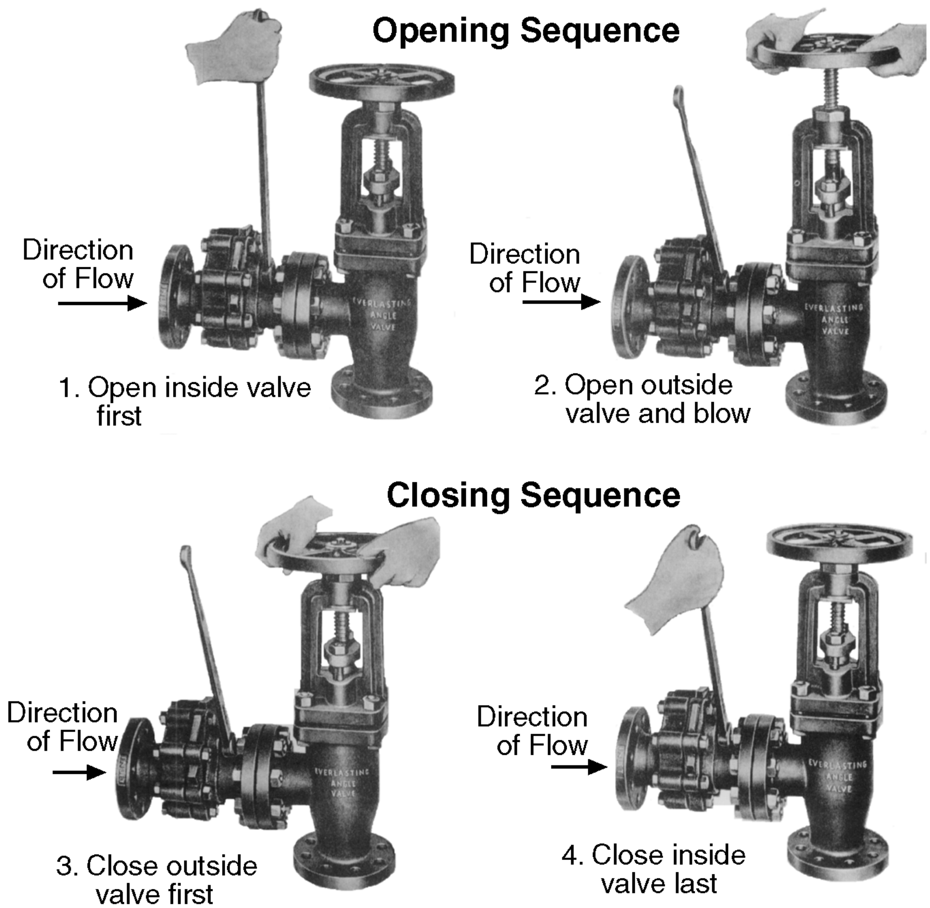

Figure 7
Opening and Closing Sequence for One Slow and One Quick Valve
(Everlasting Valve Co.)

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The fact that the blowing valve is slow opening reduces the possibility of water hammer and subsequent damage to pipe and fittings when the blow-off is begun or ended. In addition, as in the case of opening or closing any valve under pressure, the slow opening valve must be opened and closed slowly in order to further prevent the possibility of water hammer.

2. Two Seatless Slow Opening Valves

This type of valve uses a cylindrical piston as the valve element. This has a hard surface, ideally suited to withstand the abrasive effect of blowdown water. As the piston descends into the valve body it displaces water which is in the valve. If the water in the valve has nowhere to go the piston will compress the water as it closes, which could cause the valve body to crack. The correct closing sequence is designed to prevent this from occurring.

In this case the valve furthest from the boiler is opened first and closed last. If it were closed first, water would then get trapped between the closest and furthest valves, so that when the closest valve is closed the compression problem described above could occur.

Of course, this system means that the valve closest to the boiler is now no longer the protected valve. If this valve begins to leak due to the abrasion of the water, we would have to shut the boiler down to replace it. For this reason, this system of two slow opening valves often incorporates a third gate valve, located immediately next to the boiler. This valve is always kept wide open so that it experiences no wear on the valve disk. It is only closed in the event that the boiler is being shutdown and isolated, or if the first slow opening valve requires repair or replacement.

When blowing down a boiler, one person should watch the gage glass level while another operates the blow-off valves. The valve operator should remain beside the valves until the procedure is complete. When there are several boilers in a battery or header arrangement, the valves and boilers should be visibly numbered or identified, so that there is no chance of blowing down the wrong boiler.