

The boiler room height should be sufficient for the location of boiler accessories, and for proper installation of piping. In general, the ceiling height for small steam boilers should be at least 3 ft above the normal boiler water line. With vapor heating, especially, the height above the boiler water line is of vital importance.

CONNECTIONS AND FITTINGS

Steam outlet connections should be the full size of the manufacturers' tappings, in order to keep the velocity of flow through the outlet reasonably low, and to avoid fluctuation of the water line and undue entrainment of moisture, and should extend vertically to the maximum height available above the boiler. A steam velocity in boiler outlets not exceeding 25 to 30 fps at maximum load is recommended, unless data are available to show that a higher velocity is satisfactory. See further data on pipe connections to boilers in Chapters 26 and 28 and in the *ASME Boiler Construction Code for Low Pressure Heating Boilers*.

Where a return header is used on a cast-iron sectional boiler to distribute the condensate to both rear tappings, it is advisable to provide full size plugged tees instead of elbows where the branch connections enter the return tappings. This aids in cleaning of sludge from the bottom of the boiler sections through the large plugged openings. An equivalent cleanout plug should be provided in the case of a single return connection.

Blowoff or drain connections should be made near the boiler, and so arranged that the entire system may be drained of water by opening the drain cock. In the case of two or more boilers separate blowoff connections must be provided for each boiler, on the boiler side of the stop valve on the main return connection.

Water service connections must be provided for both steam and water boilers, for refilling and for the addition of make-up water to boilers. This connection is usually of galvanized steel pipe, and is made to the return main near the boiler or boilers.

Fitting connections for pressure gage piping, water gage connections, and safety valves, should be made in accordance with the *ASME Boiler Construction Code for Low Pressure Heating Boilers*.

Smoke Breeching and Chimney Connections. The breeching or smoke pipe from the boiler outlet to the chimney should be airtight and as short and direct as possible, preference being given to long-radius and 45-deg instead of 90-deg bends. The breeching entering a brick chimney should not project beyond the flue lining, and where practicable it should be grouted from the inside of the chimney. A thimble or sleeve usually is provided where the breeching enters a brick chimney.

Where a battery of boilers is connected into a breeching, each boiler should be provided with a tight damper installed in conformity with local ordinances. Good connections made to a good chimney will usually result in a rapid response by the boilers to demands for heat.

ERECTION, OPERATION, AND MAINTENANCE

The directions of the boiler manufacturer should always be read before the assembly or installation of any boiler is started, even though the contractor may be familiar with the boiler. All joints requiring boiler putty or cement, which cannot be reached after assembly is complete, must be finished as the assembly progresses.

Five precautions that should be taken in all installations to prevent damage to the boiler are:

1. There should be provided proper and convenient drainage connections for use if the boiler is not in operation during freezing weather.
2. Strains on the boiler, due to movement of piping during expansion, should be prevented by suitable anchoring of piping, and by proper provision for pipe expansion and contraction.
3. Direct impingement of too intense local heat upon any part of the boiler surface, as with oil burners, should be avoided by protecting the surface with firebrick or other refractory material.
4. Condensation in steam systems must flow back to the boiler as rapidly and uniformly as possible. Return connections should prevent the water from backing out of the boiler.
5. Automatic boiler feeders and low water cut-off devices, which shut off the source of heat if the water in the boiler falls below a safe level, are recommended for mechanically-fired boilers.

Boiler Troubles

A complaint regarding boiler operation generally will be found to be due to one of the following:

1. *The boiler fails to deliver enough heat.* The cause of this condition may be: (a) poor draft; (b) poor fuel; (c) inferior attention or firing; (d) boiler too small; (e) improper piping; (f) improper arrangement of sections; (g) heating surfaces covered with soot; (h) insufficient radiation installed; or (i) with mechanical firing, fuel-burning equipment too small.
2. *The water line is unsteady.* The cause of this condition may be: (a) grease and dirt in boiler; (b) water column connected to a very active section and, therefore, not showing actual water level in boiler; or (c) boiler operating at excessive output.
3. *Water disappears from the gage glass.* This may be caused by: (a) priming due to grease and dirt in boiler; (b) too great pressure difference between supply and return piping preventing return of condensate; (c) valve closed in return line; (d) connection of bottom of water column to a very active section or thin waterway; or (e) improper connections between boilers in battery permitting boiler with excess pressure to push returning condensate into boiler with lower pressure.
4. *Water is carried over into steam main.* This may be caused by: (a) grease and dirt in boiler; (b) insufficient steam dome or too small steam liberating area; (c) outlet connections of too small area; (d) excessive rate of output; (e) water level carried higher than specified.
5. *Boiler is slow in response to operation of dampers.* This may be due to: (a) poor draft resulting from air leaks into chimney or breeching; (b) inferior fuel; (c) inferior attention; (d) accumulation of clinker on grate; or (e) boiler too small for the load.
6. *Boiler requires too frequent cleaning of flues.* This may be due to: (a) poor draft; (b) smoky combustion; (c) too low a rate of combustion; or (d) too much excess air in firebox causing chilling of gases.
7. *Boiler smokes through fire door.* This may be due to: (a) defective draft in chimney or incorrect setting of dampers; (b) air leaks into boiler or breeching; (c) gas outlet from firebox plugged with fuel; (d) dirty or clogged flues; or (e) improper reduction in breeching size.
8. *Low carbon dioxide.* This may be due to oil burning boilers to: (a) improper adjustment of the burner; (b) leakage through the boiler setting; (c) improper fire caused by a fouled nozzle; or (d) to an insufficient quantity of oil being burned.

Cleaning New Boilers

All boilers are provided with flue cleanout openings through which the heating surface can be reached by means of brushes or scrapers. Flues of solid fuel boilers should be cleaned often to keep the surfaces free of soot or ash. Gas boiler flues and burners should be cleaned at least once a year. Oil-burning boiler flues should be examined periodically to determine when cleaning is necessary to remove soot deposits.

The grease used to lubricate the cutting tools during erection

Heating Boilers, Furnaces, Space Heaters

tion of new piping systems serves as a carrier for sand and dirt, with the result that a scum of fine particles and grease accumulates on the surface of the water in all new boilers, while heavier particles may settle to the bottom of the boiler and form sludge. These impurities tend to cause foaming, preventing the generation of steam and causing an unsteady water line.

The unavoidable accumulation of oil and grease should be removed by boiling out as follows: Remove the safety valve. Fill boiler to normal water line. Mix the boil-out compound with water and add to the boiler through the safety valve opening. Replace the safety valve, start burner and boil (in water boilers bring to approximately 150 F), for about an hour. Stop the burner and drain the boiler, the water column, low water cutoff bowl, and all points in the return piping (such as a loop return) where water might be trapped. When the boiler is cool use a hose to wash out thoroughly with high-pressure water. Fill boiler to normal water line and operate the boiler.

For boil-out compound use a detergent approved for this service. As an alternate, a mixture of 2½ lb caustic soda plus 2½ lb soda ash per 100 gal of water is advocated by some manufacturers.

It is important (to prevent damage to accessories used in the heating system) that such cleaners be completely removed from the boiler either by wash out with high-pressure water from a hose or by draining and refilling boiler several times after the compound has been used. Some manufacturers of boilers have found that best cleaning results are obtained by using the surface blowoff method described in the next two paragraphs and depending on it, for removal of the sludge and dirt, rather than on a boil-out compound to clean the boiler.

Many boilers are equipped with a surface blowoff tapping, 1¼ in. or over, at the height of the normal water line to permit removal of the scum of fine particles and grease that collect at the surface of the water when new systems are first put in operation. For sludge removal this tapping is connected by a full-size short nipple to a gate valve from which piping leads to a convenient disposal point.

The procedure is as follows: Raise water level to center of blowoff tapping. With fuel burning at rated input, and boiler steaming at 5 to 10 psig, open the valve suddenly to secure removal of the scum. Repeat the procedure until the water appears to be clear. Then shut off burner or draw the fire and drain the boiler. Refill with fresh water to the water line when the boiler is cool and raise water temperature to 212 F to remove absorbed oxygen and other gases from the water.

When addition of water to a system in service becomes necessary it is advisable to operate the boiler or at least to raise the water temperature to the boiling point in order to permit escape of oxygen and other dissolved gases that would be corrosive if the boiler is not put in operation immediately.

If rapid waterline fluctuations or priming occur in an old boiler system, the trouble may be due to: (1) an accumulation of mud or minerals carried in with the water supply, (2) products of corrosion, or (3) over-treatment with compound. Draining, followed by washing out with high-pressure water from a hose will usually correct the trouble. In severe cases, repeated washing or boil out may be necessary.

Treatment of Boiler Water

Corrosion on the water side of a boiler can be minimized by proper treatment of the boiler water. Generally, treatment

which will remove the dissolved oxygen and carbon dioxide and maintain a minimum pH of 11 (slightly alkaline water) will effectively minimize corrosion. Sodium sulphite is useful as an oxygen scavenger and may be added at the rate of ¼ lb per 100 gal of water and caustic soda may be used to control the pH. A pH higher than 11 may be used although the boiler water is more likely to foam and cause wet steam with the greater concentration of alkali.

Inhibitors may be used in hot water and low-pressure steam boilers (15 lb maximum). The Steel Boiler Institute adopted a conditioning compound for use with steel boilers after an extensive cooperative study and many members of the Institute either supply this compound with their boilers or have it available.

It should be emphasized that when the character of the water is such that treatment is required, the treatment should be administered immediately after the boiler and system have been cleaned. It is not good practice to fill a boiler with fresh water and allow it to stand idle as the dissolved gases in fresh water available in many localities can start corrosive action in a very short time. After refilling a system it is advisable to elevate the temperature close to the boiling point to drive off the dissolved gases immediately.

Care of Idle Heating Boilers

Both fireside and external surfaces of boilers usually remain dry during normal operation. Since moisture is one of the primary causes of boiler deterioration, such deterioration is more likely to occur during the non-heating season than during the heating season.

In the case of oil-fired or gas-fired boilers, if not used for summer hot water service, a preferred method of maintenance is to keep the boiler warm continuously by leaving the burner in operation and controlling it with a thermostat set to maintain boiler water at about 100 F. The amount of fuel burned in keeping the boiler warm (and the boiler room dry) is a small cost for the protection from boiler deterioration.

At the end of the heating season, the following precautions should be taken if firing is discontinued:

1. All heating surfaces should be cleaned thoroughly of soot, ash, and residue, and the heating surfaces of steel boilers should be given a coating of lubricating oil on the fire side.
2. All machined surfaces should be coated with oil or grease.
3. Connections to the chimney should be cleaned, and in case of small boilers, the pipe should be placed in a dry place after cleaning.
4. If boiler may be subjected to freezing temperatures, drain it completely and wash out thoroughly with a hose and high-pressure water. Then dry the boiler completely by placing a small kerosene burner or similar stove in the firebox, or by means of a small wood fire. Exercise care to see that the boiler is completely dried out but not overheated.
5. Filled-boiler storage is usually preferred when boiler will not be subjected to freezing temperatures. Do not drain the boiler but draw enough water off at the drain cock so that it runs clear. Then fill until the water level is in the outlet pipe and bring the temperature up to at least 200 F to drive off gases which were introduced in the feed water. If feed water is usually treated add enough compound to treat the added water. Open all doors to keep fireside surface dry. Leave boiler filled to the top until the beginning of the next heating season.
6. Do not use an idle boiler for an incinerator.
7. The grates and ashpit should be cleaned.
8. Remove any rust or other deposit from exposed surfaces by scraping with a wire brush or sandpaper. After boiler is thoroughly cleaned, apply a coat of preservative paint, where required, to external parts normally painted.