

return piping preventing return of condensation; (c) valve closed in return line; (d) connection of bottom of water column into a very active section or thin waterway; and (e) improper connections between boilers in battery permitting boiler with excess pressure to push returning condensation 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; and (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; and (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; and (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; and (e) improper reduction in breeching size.

8. *Low carbon dioxide.* This may be due on 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 Boilers

All boilers are provided with flue clean-out 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.

The grease used to lubricate the cutting tools during erection 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.

This unavoidable accumulation of oil and grease should be removed by blowing off the boiler as follows: If not already provided, install a surface blow connection of at least 1½ in. nominal pipe size with outlet extended to within 18 in. of the floor or to sewer, inserting a valve in line close to boiler. Bring the water line to center of outlet, raise steam pressure, and while fire is burning briskly open valve in blow-off line. When pressure recedes, close valve and repeat process adding water at intervals to maintain proper level. As a final operation bring the pressure in the boiler to about 10 psi, close blow-off, draw the fire or stop burner, and open drain valve. After boiler has cooled partly, fill and flush out several times before filling it to proper water level for normal service. The use of soda, or any alkali, vinegar or any acid is not recommended for cleaning heating boilers because of the difficulty of complete removal and the possibility of subsequent injury, after the cleaning process has been completed.

Effective insoluble compounds have been developed and are available. Special instructions on the proper cleaning compound and directions for its use, as given by the boiler manufacturer, should be carefully followed.

Treatment of Boiler Water

Corrosion on the water side of a boiler can be prevented 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 prevent corrosion. 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. A number of compounds are being marketed for this purpose. 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

Heating boilers are often seriously damaged during summer months due chiefly to corrosion resulting from the combination of sulfur in the soot with the moisture in the cellar air. At the end of the heating season the following precautions should be taken:

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 there is much moisture in the boiler room, it is desirable to drain the boiler to prevent atmospheric condensation on the heating surfaces of the boiler when they are below the dew-point temperature. Due to the hazard that some one may inadvertently build a fire in a dry boiler, however, it is safer to keep the boiler filled with water, particularly in residential installations. Air can be excluded from a steam boiler by raising the water level into the steam outlets. A hot water system usually is left filled to the expansion tank.
5. The grates and ashpit should be cleaned.
6. Clean and repack the gage glass if necessary.
7. 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.
8. Inspect all accessories of the boiler carefully to see that they are in good working order. In this connection, oil all door hinges, damper bearings, and regulator parts.
9. If a system has been drained and refilled with fresh water, the boiler should be fired long enough to elevate the water temperature close to the boiling point to drive off dissolved oxygen and carbon dioxide. These gases can be responsible for excessive corrosion if allowed to remain in the system.

WARM AIR FURNACES

Warm air heating furnaces of a number of types and a wide range of sizes are listed and illustrated in the *Catalog Data Section*.

Warm air furnaces may be classified in several different ways:

1. According to method of heat distribution—these are either gravity or mechanical (blower) furnaces.