Safer maintenance of steel heating boilers

A modest investment in a sound maintenance program for steel heating boilers can return dividends to both owners and operators.

For owners this can mean less expenditures for repairs, more efficient operations, and longer life for the equipment. Most of all, a planned program, properly executed, can reduce the likelihood of an accident capable of curtailing production or even closing down the plant.

For operators, maintenance results in safer operations -- reason enough to adopt the program -- and a generally improved working schedule. Many minor difficulties that frequently lead to major problems can be avoided.

General characteristics

Most steel heating boilers possess characteristics similar enough to afford a general discussion of maintenance practices in a single article. However, some belong to service or size categories that require special maintenance--for example, very large fire tube and water tube boilers--and can therefore be included here only as general practices apply. For the most part this article is concerned with steel boilers in moderate size factories, schools, and office buildings.

Any discussion of heating boiler maintenance is incomplete if connected equipment is not included, especially closely associated major equipment such as the heating system. Accident reports show that boilers often become victims of troubles originating somewhere else. No amount of care of boilers alone can prevent such accidents.

Most service and maintenance should be performed during idle seasons, when equipment is available for examination, testing and repair; some must be completed immediately following in-service testing that discloses defects.

Cleaning practices

Some owners and operators of boilers are of the opinion that cleaning of the external and internal surfaces of the boiler may be accomplished anytime during the idle season. Therefore, the boiler receives little or no attention while it is out of use, and cleaning is virtually forgotten until just prior to the heating season.

To be most beneficial and to keep corrosion at a minimum it is important that all cleaning be performed at the start of the idle period. By so doing the working life of the equipment can be extended. Preparation for the idle season should first include proper cleaning of the boiler. External cleaning should receive priority.

As soon as possible after the close of the heating season, soot and ashes should be removed from the fire side surfaces of the boiler. Otherwise, moisture from the atmosphere or from a leak in the boiler may combine with chemicals, especially sulphur compounds from the fuel, to form an acid that will quickly corrode the boiler plates. Damp ashes behind furnace brickwork should be given special attention. Moist soot in chimney connections and fire tubes poses a threat to the serviceability of metal that was already relatively thin when it was new. External cleaning must be prompt and thorough.

Internal cleaning, by comparison, usually requires little effort. Heating boilers use only small amounts of makeup water and little scale is produced. However, these boilers often are found to contain deposits of sediment, largely rust from the heating system, that may become troublesome if left inside. It can form dams that will create puddles in hard-to-see parts of water legs. This moisture promotes corrosion, To do a necessarily thorough job of cleaning, all washout plugs and hand hole or manhole plates should be removed.

In addition, certain attachments to boilers are likely to collect deposits that must be removed periodically. Connecting lines for water columns, low-water fuel supply cutouts, and emergency water feeders -- including the chambers for the cutouts and the feeders -- at times become clogged. The clean-out plugs in the connecting line fittings should be removed and the chambers should be opened. After the lines and chambers are cleaned they should be left open if an internal inspection of the boiler is scheduled during the idle season.

Idle season lay-up

Two methods, the dry and the wet for storing a boiler during extended idle periods are recognized. The advantages or disadvantages of each depend somewhat on the boiler size, type, kind of service, and length of idle season.

If the idle season is two or three months long, users of most steel heating boilers prefer the dry method. It entails little effort. It keeps the boiler prepared for inspection by the authorized inspector; and it prevents internal corrosion reasonably well in most instances.

After the cleaning and inspection is finished, the boiler is prepared further by blotting, sponging, siphoning, or otherwise removing all collections of water from the bottom of water legs and other low places. A vent opening for air circulation should be provided in or near the top of the shell, even if the removal of a safety valve or other connection becomes necessary.

Usually, the foregoing meets the needs of small boilers, those that are too small for manholes, but forced drying with heat often is recommended. Only an experienced engineer should consider such an undertaking.

After the drying operation is completed, a drying agent may be placed inside, and the boiler may be closed. Two pounds of quick lime, ten pounds of silica gel, or the equivalent of some other desiccant, for each thousand gallons of boiler water capacity will suffice in most instances.

The wet method has at least one advantage over the dry method of storage: the boiler requires little preparation for service, and therefore it may be fired soon after it is needed. When cleaning and inspection are completed, the boiler is closed and is filled to the top with water that has been treated to prevent corrosion.

Owners of small heating plants are advised to get instructions from a qualified boiler water chemist if the wet method of storage is used. If corrosion is to be controlled, proper lay-up procedures must be observed.

While in storage by either the dry or the wet method, a boiler should be treated with reasonable care. The furnace must never be used as a receptacle for trash, especially not if it is to serve later as an incinerator for the collected trash. To prevent such abuse by others, the person in charge should either fasten a warning sign to the firing door or should place a lock on the boiler room door, or both. To avoid almost certain damage that would result from firing an empty boiler, appropriate fuses in the firing system should be removed or other means should be adopted for keeping the unwitting or would-be operator from firing the boiler.

Maintenance and service

As soon as possible after the boiler has been prepared for an idle period, attention should be directed toward the heating system and associated equipment. The kind and extent of the service effort to be applied is frequently determined by experience -- the type of experience, unfortunately, that makes itself known most forcefully via boiler accidents.

The type of boiler accident known as a low water accident occurs if the fuel continues to burn in the furnace of the boiler when the boiler water level falls below the minimum safe point of operation. From a frequency point of view it outstrips all other types of boiler accidents. Usually, heating boilers require little makeup water. This means that most such accidents happen because something stops the supply of return water.

Condensate return pumps, though not the greatest source of trouble, fail in service for many reasons, resulting in low water accidents. Pumps fail to deliver water when they become steam bound or when bearings burn out. and moving parts in time become so worn that the pump can no longer carry its load. At times, moreover, the pumps and return lines freeze during cold snaps only because those in charge forgot to replace nearby broken windows.

The piping and other parts of the connected heating system cause return water losses for reasons less subtle than wintertime freezing. Usually piping corrodes internally. Sometimes it makes its presence known by causing minor leakage at some threaded joint in an open place, where fortunately it may be found before some form of water damage results or a low water accident happens. When the steam fitter makes the repair, he often finds that all adjacent piping requires replacement. Internal corrosion penetrates the pipe wall and corrosion products clog pipes and fittings. In time, these products can be expected to interrupt the return flow of condensate. Also, if either the supply or return piping passes unprotected through coal bins or underground, failure from external corrosion will occur eventually.

Traps in heating systems also contribute to water loss difficulties. Defective traps pass steam to the return system, and the steam escapes through the vent on the condensate return tank. Steam in this tank may also heat the condensate enough to cause steam binding of the return pump. If the emergency water feeder should fail (it often does through lack of use), or if the boiler has no emergency water feeder, the steam loss might well result in a deficiency of boiler water.

Defective vents on the piping, especially those installed in isolated places, also may waste steam in amounts large enough to lower the boiler water level in time.

Expansion tanks on hot water heating systems require periodic attention too. At least once a year, preferably before the start of each heating season, they should be drained. Otherwise, they may become waterlogged and cause the water relief valves on the boilers to discharge each time the water undergoes thermal expansion. The cause of such a discharge has been misunderstood occasionally and has induced uninformed operators to tighten relief valve springs or to plug discharge ends of escape pipes, an obviously dangerous "cure".

The firing system, particularly the burner for the boiler, is another part that must have attention, and many users contract with service organizations to check and maintain it. Failure to keep it in order may result in loss of heat during a cold period or, worse still, in a furnace explosion as a result of a delayed ignition of accumulated fuel.

If the fuel is gas or oil, a few general remarks on common faults found during inspections will indicate what to expect. Ignition electrodes may burn, become coated, or become displaced. Ignition transformers may deteriorate or fail completely. Fuel lines leak,. fuel strainers become stopped, and fuel valves leak or fail to close when dirt lodges between discs and seats. Air-fuel ratios drift until the flames stifle when someone closes the last open window or door to the boiler room, thus eliminating needed combustion air. Many owners and operators have learned too late that a permanent opening to the outside is required and must be installed so that it won't cause wintertime freezing of condensate return lines.

Fast-acting, modern flame-failure safety devices serve a definite purpose. No one can estimate how rapidly boiler accident frequency would increase without them. But like all safety devices, combustion safeguards are not foolproof. Not only are the electronic parts themselves certain to fail now and then, but non-electronic parts--valves, burners, pressure regulators, piping--if neglected, are sure to produce accidents and outages at least occasionally.

Safety devices of all kinds require attention. Safety valves head the list of such devices that must be kept in working order. In recent years inspectors have traced the causes of a number of boiler explosions, some that have injured and killed, to valves with moving parts that had "frozen" in place from neglect and disuse.

Section VII of the ASME Boiler and Pressure Vessel Code proposes a way to avoid such troubles with safety valves on lower pressure power boilers. It suggests that the boiler pressure be raised high enough at least once a year to pop each valve. It further suggests that the safety valve disc be raised to the full open position several times a year by using the lift lever.

Safety valves on heating boilers deserve no less care. A pre-season popping-pressure test and a monthly lift-lever test seem little enough effort to expend on such a vital device. Give it a full popping-pressure blow before the heating season starts; also, raise the boiler pressure to within five psi of the popping-pressure and pull the lift lever until the valve opens fully. This should be done no less than once a month throughout the heating season.

Low-water fuel supply cutouts, and the lines connecting them to boilers, follow safety valves in importance only because low water accidents, the kind the cutouts should prevent, kill or injure fewer people than do boiler explosions.

As a defense against these forms of distress, low-water fuel supply cutouts on steam heating boilers (they serve as well on hot water heating boilers, if maintained) stop burners or fuel flow when the boiler water level falls too far. They do, that is, when kept up, but they have many parts that otherwise can and often do fail either electrically or mechanically.

Tests to detect these faults merit a place in the boiler service schedule. A real test of a low water cutout takes but little of the operator's time. Reasonably often, say once a month, he must remain on constant watch while, by some convenient means. the boiler water level is lowered slowly until the burner stops, or until it should but doesn't stop. If it does stop when the water level reaches the cutout set point, the cutout may be regarded as having passed the test, and the boiler may be filled and otherwise prepared so that it will resume normal service. But if the cutout doesn't stop the burner, the cause of failure must be found and corrected without delay.

The low-water fuel supply cutout also requires regular service during both the heating and the idle seasons. Once a week while the boiler is under pressure, the operator should flush the float chamber (if the cutout is a chamber type) thoroughly enough to remove collected sediment. Naturally, the blow down valve must be opened wide enough to flush all the water from the chamber and to extinguish the fire. If it doesn't extinguish the fire the cutout should be tested and, if necessary, repaired. Like other parts of control and safety systems for modern, automatically fired boilers, cutouts might well be too complex for most boiler operators to service. The need for thorough service by an experienced serviceman can't be over-stressed.

Most frequent type of accident is burning and not explosion

Fire Tube Boilers		Water Tube Boilers		Cast Iron Boilers	
Type of Accident	Percent	Type of Accident	Percent	Type of Accident	Percent
Tearing Asunder (Explosion, Rupture)	19.0%	Tearing Asunder (Explosion, Rupture)	50.0%	Tearing Asunder	5.9%
Crushing (Collapse)	5.0%				
Burning (Overheating)	70.0%	Burning (Overheating)	46.0%	Burning (Overheating)	70.0%
Bulging	2.5%	Bulging	2.5%		
Cracking	3.5%	Cracking	1.0%	Cracking	92.4%
100.0%		**100.0%**		**100.0%**	

Contrary to common belief, the most frequent type of accident to heating and power boilers is not explosion. Although explosions are an ever-present threat to operation, the most frequent type of accident is burning, that is, overheating because of a deficiency of water. Burning not only accounts for the largest number of accidents but also the largest total dollars in any boiler accident classification.

This frequency table on types of accident classifications is based on an analysis of the type of accident, the specific part of the object that failed, and the primary cause of failure. It is also designed to provide statistical information to indicate the general direction toward which accident prevention efforts can best be directed.

The higher percentage of water tube boilers in the tearing asunder category, as compared to the percentage of fire tube boilers, is accounted for by the fact that most tube failures in water tube boilers are classified as tearing asunder cases even though burning (overheating) may have been a contributing factor.

The cracking category is confined to the cracking of cast metal parts. In the case of cast iron boilers, however, it is by far the most common type of occurrence. In many cases of cracking, overheating is a contributing factor although the final occurrence is cracking.

Safety check list for boilers

1. Test controls and safety devices regularly. Correct any defects immediately.

2. Keep controls and safety devices in proper working condition. For example, blow down the chambers of the low-water fuel supply cutout and operate the lift lever of the relief or safety valve regularly, while the boiler is in service.

3. Have a reliable service organization check and service the equipment periodically, both during and between heating seasons.

4. As soon as possible at the end of each heating season, drain the boiler and clean it both internally and externally. Remove all clean-out plugs. Open and clean the chamber of the low-water fuel supply cutout. Repair furnace brickwork and lay-up the boiler.

5. Examine and repair heating system components and boiler auxiliary equipment.

6. Don't leave broken windows or other openings that may permit wintertime freezing.

7. Don't block the combustion air supply opening for the fuel burning systems.

8. Don't use the boiler furnace as a trash receptacle or incinerator during the idle season.

9. Don't leave the boiler room accessible to unauthorized persons.

10. Don't leave the boiler during the idle season so that the burner can be operated in a routine way by an unqualified operator.

By W. H.. Russell, The Hartford Steam Boiler Inspection and Insurance Co. Photos and data courtesy of The Boiler Inspection and Insurance Co of Canada.
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