Winter Operation of Steam and Hot Water Heating Boilers

Preface: The following article addresses some of the issues faced in operating fired steam and hot water heating systems in cold climates. These issues are addressed in a question and answer format. Please understand that the information contained herein is not and cannot be all-encompassing. Entire volumes can be (and are) written on the subject of care and maintenance of heating boilers.

What basic maintenance is required for a building with boiler heat?

1. As far as basic maintenance, I would say that regardless of whether a boiler is used for steam heat, or hot water heat, one of the most effective things that can be done is to make sure that your system is as leak-free as possible. Any volume of steam vapor or water that is lost from the system has to be made up from water introduced from outside the system. There are multiple consequences that stem from that fact;

a. The steam vapor or water that is lost generally has heat content that will be lost, hence energy will be wasted.

b. The make up water that has to be introduced into the system will generally be much colder and therefore will require additional heat (i.e., more fuel has to consequently be consumed).

c. The make up water will contain additional impurities such as calcium and magnesium carbonate salts. Those salts will tend to form internal scale deposits on the internal surfaces of the boiler. Carbonate Scale deposits are a very poor conductor of heat, and consequently, there is a reduction in heat transfer efficiency and therefore an 1/8" thick scale deposit will result in an approximate 25% decrease in efficiency. In practical terms, that means that fuel costs would increase an approximate 25 cents on the dollar.

d. Another consequence of the presence of this scale is that the cooling effect of the boiler water on the boiler metal is impaired, which will result in higher metal temperatures. If this condition goes on un-checked, it can result in metal temperatures greater than the design parameters of the boiler, and could conceivably lead to catastrophic failure of the boiler.

e. Another often overlooked area is underground or buried piping, or piping that runs through rarely or never frequented areas. Often times, leakage under such conditions can go undetected, with potential results as noted above.

f. One possible way to keep track of how much water is being lost is to install an inexpensive meter on the water make up line that will keep track of the numbers of gallons that have to be added. Some minute system losses are inevitable, but once a baseline is established of normal usage, any significant increase above that amount would trigger investigation. Another possible indicator is significant increases in the amount of boiler water treatment chemicals necessary to keep the boiler water within its established chemical parameters.

2. A boiler is a relatively complex piece of equipment that is comprised of multiple components. The interlocking system of controls and safety devices should be regularly gone through, cleaned, tested and adjusted (where possible and necessary) by a knowledgeable heating and cooling contractor to assure that the control system is functioning properly.

What should boiler users be aware of during cold weather months?

3. Make sure that any supply or return lines (especially return lines, as they are normally at a lower temperature than the supply lines to start with) that run near outer walls or through un-insulated / un-heated areas are properly insulated or protected with heat tracing to prevent them from freezing.

4. In the case of relatively large complexes, there are normally multiple heating zones serving various parts of the complex. Many of these areas are only used at certain times of the week, and for reasons of frugality, often times, the thermostats in these areas are turned very low or even off. It ***must*** be understood however that an undesired consequence of this can be that large volumes of water that are "trapped" in that zone are not returned to the boiler to be re-heated. Consequently, when these areas are needed, and these heating zones are put back into service, the water temperature will

have dropped to levels significantly less than the system as a whole, and especially the water actually in the boiler. A consequence of this can be (relatively) cold water coming in contact with the hot boiler metal. In extreme cases, the resulting shock from the rapid drop in temperature of the boiler metal that results can cause it to fail, oftentimes with disastrous consequences. This possibility should always be evaluated when measures such as shutting down heating zones is being considered for any reason.

5. Another potential source of trouble in cold weather is needed combustion air. The fuel burned in the boiler requires oxygen to burn. That oxygen comes from the atmosphere. For that reason, all boiler rooms by code are required to have an unobstructed outside air source whose size/volume is determined by the combined capacity of all fuel burning equipment in the boiler room. If there is not enough outside combustion air brought into the boiler room, the burner will draw the needed oxygen from the atmosphere in the boiler room. The consequences of this are potentially several fold.

a. The oxygen level in the boiler room will decrease, potentially to the point where there is a real threat of asphyxiation and death.

b. The atmospheric pressure in the boiler room will fall (atmospheric pressure is 14.5 PSIG at sea level). This decrease in atmospheric pressure may cause draft problems in the chimney. Atmospheric pressure decreases with altitude. Therefore, the atmospheric pressure at the top of a chimney that is twenty/forty etc., feet higher than the boiler will be significantly less than the pressure in the boiler room. This is the principal upon which any natural-draft chimney operates. The pressure at the top of the chimney is less than the pressure in the boiler room, so the spent air/fuel mixture is drawn out of the boiler and up the chimney. If the need for combustion air sufficiently lowers atmospheric pressure in the boiler room, a situation can exist where the furnace gas (carbon monoxide) is unable to vent up the chimney, again causing a potential hazard to life.

c. A lowered boiler room atmospheric pressure also increases the potential for a furnace explosion to occur.

d. As it relates to winter operation, the requirement for outside combustion air can result in very cold air being drawn into the boiler room. This cold air could cause pipes to freeze, and can also make the temperature of the room unpleasantly cold for those that have a need to spend prolonged amounts of time there. Oftentimes, someone decides to partially or entirely block these openings with cardboard or plastic to prevent the cold air from coming in, not understanding the potentially dangerous and deadly consequences. It should be frequently verified that the outside combustion air source has not been obstructed, restricted, or compromised in any way. An often used means of solving this problem is to provide the combustion air opening with louvers equipped with mechanisms that utilize an electric solenoid or compressed air servo and linkage to open and close them, actuated by the burner control circuitry. I.e., as part of the control sequence, the system has to sense/verify that the louvers are open.

What are two or three examples of things that could go wrong with a boiler that is not properly maintained?

6.

a. Controls could malfunction causing unreliable operation.

b. Deposits of scale could result in the boiler being incapable of producing sufficient heat to provide comfortable temperatures in the building.

c. Overheating, deterioration, and leakage could cause physical damage to the boiler to the extent that it was unusable, or could ultimately lead to catastrophic failure of the boiler.

How can these types of things be avoided?

7.

a. Regularly arrange for a knowledgeable, properly trained service technician to clean, test and adjust (if necessary) all of the boiler controls.

b. Make sure that a competent, properly credentialed/***licensed boiler inspector*** completes and documents the periodic inspections that are mandated by most, if not all, jurisdictions. These inspections provide the basis for a certificate of operation or certificate of inspection to be issued, without which the boiler cannot legally be operated.

c. If a problem is suspected, contact one or both of the trained professionals noted above.

d. Make sure, even if not so mandated by jurisdictional requirements, that personnel operating boilers are trained and knowledgeable, and never, never, allow anyone that has not received the proper training work on, or adjust, any of the boiler controls or system components.

What is a safety relief valve?

8. A safety relief valve, or safety valve, or relief valve, is a mechanical device that is intended to assure that boiler/system pressure can never exceed the design parameters of the boiler or system to which it is attached. Relief valves normally found on heating boilers utilize a hollow body through which the medium being relieved moves. The fluid flows to a point under a valve seat that has an opening in its middle. This opening in the valve seat is normally closed off by a valve disc attached to a spindle that goes through the top of the valve bonnet, where a hand/manual testing lever is required to be attached. The disc and spindle are held in place by a spring that exerts tension on the valve disc that keeps it pressed firmly against the valve seat. When fluid pressure under the disc increases, a corresponding force is exerted on the valve disc itself. When this pressure increases sufficiently, the force exerted on the valve disc will cause it to lift away from the valve seat, overcoming the spring tension that it is under, thereby allowing fluid to flow through the valve outlet to a safe point of discharge, preventing excessive pressure in the boiler.

Why is this valve so important on a boiler?

9. It can be argued that the relief valve, or safety relief valve, is one of the most important safety devices on the boiler, or perhaps even ***the*** most important safety device. It is intended to prevent catastrophic failure if there is a failure of any component in the control circuitry that regulates the firing of the boiler. Excessive heat input will ultimately cause an increase in system/boiler pressure attributable to thermal expansion of the liquid being heated. When this pressure increases sufficiently to cause the relief valve to open, liquid flows through the relief valve to a safe point of discharge, thereby preventing a further increase in pressure. The relief valve set pressure, and relief capacity (in BTU's per Hour) of a given relief valve application are carefully selected to assure that set (or opening) pressure is no greater than the design pressure of the boiler, and that its relief capacity is equal to or greater than the maximum thermal input that can be generated by the fuel burning equipment.

What do boiler users need to know about this valve?

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a. Indiana adopts by reference ASME Section IV (the Heating Boiler Code) for essentially all of the boilers under discussion here. The Heating Boiler Code is published by the American Society of Mechanical Engineers (ASME). That standard stipulates that only relief valves designed in accordance to the requirements therein, that have been properly capacity certified, and that bear the required markings (an "HV" inside of the ASME cloverleaf logo) be used. If a given boiler relief valve does not bear these markings, it does not comply with the code, and cannot be relied upon to provide the needed protection.

b. Additionally and as noted previously, these relief valves are carefully selected based upon their size, set pressure and relief capacity. Any time that it is necessary to replace a relief valve, the boiler inspector responsible for making the inspection on the boiler should be consulted to assure that the relief valve application is correct for the boiler in question.

c. The discharges from these relief valves are very hot, and should be piped to a point here they can discharge safely, without danger of burning or scalding anyone.

d. If there are occasional discharges from the relief valve, the cause should be investigated because this is an abnormal event that calls into question the reliability of the relief valve. Additionally, if occasional discharges occur over an extended period of time, this will eventually render the valve inoperable, as water flowing between the disc and seat will eventually form scale deposits that will essentially weld the disc to the seat.

e. Visual evidence of scale/lime deposits observed on the internal surfaces of the relief valve should cause its reliability to be questioned.

f. Bushing down/reducing in diameter either the valve inlet or outlet will violate the capacity rating of the valve, as it creates a flow restricting “bottleneck”. As an example, if the inlet of the relief valve is 1 ½” diameter, and the opening into the boiler into which it is mounted is only 1.0” diameter, a bottleneck is created resulting in the relief valve being unable to flow its rated capacity. The same is true of the relief valve discharge. If the relief valve discharge opening diameter is as an example 2.0”, any reduction in size at all below that 2.0” diameter that occurs between the relief valve discharge opening, and its termination point, will cause a restricting bottleneck that will prevent the relief valve from being able to flow its rated capacity.

In closing, it is my hope that those reading this article will derive some benefit from doing, so but I must reiterate that these responses are not all encompassing. They merely address ***some*** of the important things that must be considered.

Any further questions may be addressed to :

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