Industrial Guide

Dry Steam Production Systems

Technical Article by B.G. Peterson Co.

Boiler Plant - Where Can You Go Wrong ?

1. **Steam Space.** Treating a boiler's steam space as a reservoir or storage vessel to be used as if it is a balanced storage system like a hot water storage tank, fails to realize that anytime more steam is removed from a boiler than is replaced (by a load demand whether sustained or intermittent), the boiler's vapor pressure is lowered, and consequently steam quality and operating efficiency are reduced.

   Use a "steam accumulator" (storage vessel) if there are significant periods of operation that exceed the boiler steam production or even intermittent smaller periods of large excessive demand loads.

   Provide an automatic steam trap to drain the steam space to prevent flooding .

2. **Steam Pressure.** Arbitrarily lowering the operating steam pressure below the original system design to achieve lower steam costs, usually results in decreasing the steam quality and increasing the cost per pound of steam.

   2.1 Outlet steam nozzle velocity may be too high at lower pressures and promote water and/or mist carryover.

   2.2 The steam header velocity may exceed the recommended 50 fpm and function poorly as a moisture separator.

   2.3 Using night/weekend pressure reduction without considering the expanded volume and velocity of steam as well as the need for two different feed pumps requirements.

   2.4 Shutting down boiler plants at unoccupied times allows water to hold more oxygen.

3. **Surface Blow Off.** Poor or no surface blow down strategy may allow the total dissolved solids to exceed their recommendations and produce carryover. For continuous blow down, large amounts of heat may be lost to drain. These can be recovered with blowdown heat recovery units.

4. **Steam Headers.** Design these for moisture separation and not as a piping manifold for steam flow. Do not allow steam take offs in between two boiler steam supplies, trappingcondensate and promoting carryover of undrained water. Select and size steam traps to remove condensate as soon as it occurs in properly sized and placed drip legs. Consider mechanical means of moisture separation if necessary, including the use of moisture separators and/or back pressure regulating valves.

5. **Feed Water.** Sizing flow too low or too high, failure to balance pumps in the field, failure to match the pump type to the NPSH requirements, under sizing the pumps suction line, not consider modulating control versus on-off control, ignoring piping and control strategies for redundancy.

   5.1 Tank capacity must have adequate storage for the system's condensate return rate.
   5.2 Automatic make up valves must be adequately sized for replenishment.
   5.3 Failure to remove air promotes corrosion.
   5.4 Unheated or under heated water delivers more air, promotes both thermal shock and poor steam quality.

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Feed Pumps - Where Can You Go Wrong?

1. Pump flow is too low - boiler shuts down on low water

2. Pump flow is too high, surging and swelling of the water line in a boiler due to an unbalanced pump, may raise the water level above the normal high mark and displace steam. The volume of cooler water from the feed pump may further cool the steam, causing a drop in pressure which further reduces the steam space in the boiler.

   2.1 The resulting surging and swelling water may be pulled through the boiler's steam outlet nozzle and is known as "water carry-over". Steam quality lessens and the once dry steam becomes wet steam. Chemicals are removed from the boiler in the water carry-over and both are distributed through the steam system. Both water and chemicals are insulators and reduce the transfer of heat through heat transfer surfaces: air coils, tube bundles in tanks, heat exchangers, etc. Chemicals can cause fouling of heat transfer surfaces and valves.

   2.2 The reduction in heat transfer causes control valves to open wider to allow for more flow of steam than was designed. The boiler now fires harder to deliver this higher system demand and heat to steam the larger amount of cooler water sent by the pumps. Boiler may not be able to keep up with load.

   2.3 As water is pulled out of the boiler, gauge glasses and float bowls of low water cut-offs give false readings: water lines appear to be stable because the cold dense water in the lower portion of the boiler enters up into these columns. Increasingly larger slugs of water are pulled out of the boiler until it exceeds the pumping rate and the boiler will suddenly shut down on low water. The slugs of water can cause water hammer.

3. Pump discharge pressure is too high - boiler pop safety valve opens, too much water sent to boiler as above.

4. Pump discharge pressure is too low - flow to boiler is too low, the boiler will shut down on low water.

5. Flow is too high - automatic fresh water make-up valve in the tank introduces too much water into the system. As condensate returns there will not be enough volume within the tank for both the returning condensate and the excess make-up water. Water will flood the feed tank and spill out of the overflow vent.

6. Tank Capacity - sudden start-up loads, either the initial start-up, cycling on after a night or weekend temperature set back, morning introduction of fresh air, all can potentially drain a tank dry causing a pump to run dry and a low water condition in a boiler.

7. Long returns may prevent condensate from retuning at a rate able to maintain tank water level and cause the auto make-up valve to introduce unnecessary water that is wasted through the over flow later.

8. Automatic make-up valve sizing may be too small and starve both pumps and boiler for water. It may be too large and flood a tank when combined with returning condensate.

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9. Small tank volumes may not be able to blend cold make-up and warmer returned condensate to a temperature high enough to prevent thermal shock or loss of vapor pressure and carry-over.

10. Systems with small amounts of returned condensate and thus high amounts of cold raw make up water require more chemical make-up and water pre-heating inside of the feed tank to prevent build up to minerals inside of the boiler and prevent thermal shock. Condensate returns that are broken and leak are a prime example of above.

    The minerals that precipitate out in boilers as sludge can block float bowls of low water cut-offs causing them to fail to shut down a boiler in a low water condition. And the sludge can cause make-up water feeders with float balls inside of columns or castings to fail open, accelerating the conditions that cause boiler failures.

11. High levels of make-up water in small tanks with steam injectors have turbulent water lines, upsetting make-up floats and causing pump cavitation.

12. Steam traps that fail open send live steam and/or high pressure condensate back to the atmospheric feed tanks, where flashing occurs. Steam is wasted up the vents, pumps experience cavitation and loose the capacity to pump enough condensate back to the boiler. This can cause the tank to over flow and the boiler to experience low water.

13. Under heated make-up (steam injector valve too small) pumped into the boiler causes loss of vapor pressure, water carry-over, and possibly thermal shock. Boiler may have problems keeping up with load.

14. Night or weekend "pressure set back" that use the same set of pumps selected for the maximum design pressure, experience an excessive amount of pump water flow at the lower pressure which causes water carry-over. Ideally a second set of pumps should be used during the pressure reduction period, or manual discharge valves balanced at each change in operating pressure.

15. NPSH, high pressure systems and returns must consider the use of pumps that have low net positive suction head requirements and feed tanks that are elevated ASME pressure vessels otherwise pump cavitation occurs.

16. Modulating boiler with on-off pumps may experience carry-over due to loss of vapor pressure, consider using modulating feed water controllers.

17. Failure to provide a control strategy may leave the boiler plant down upon a pump failure.