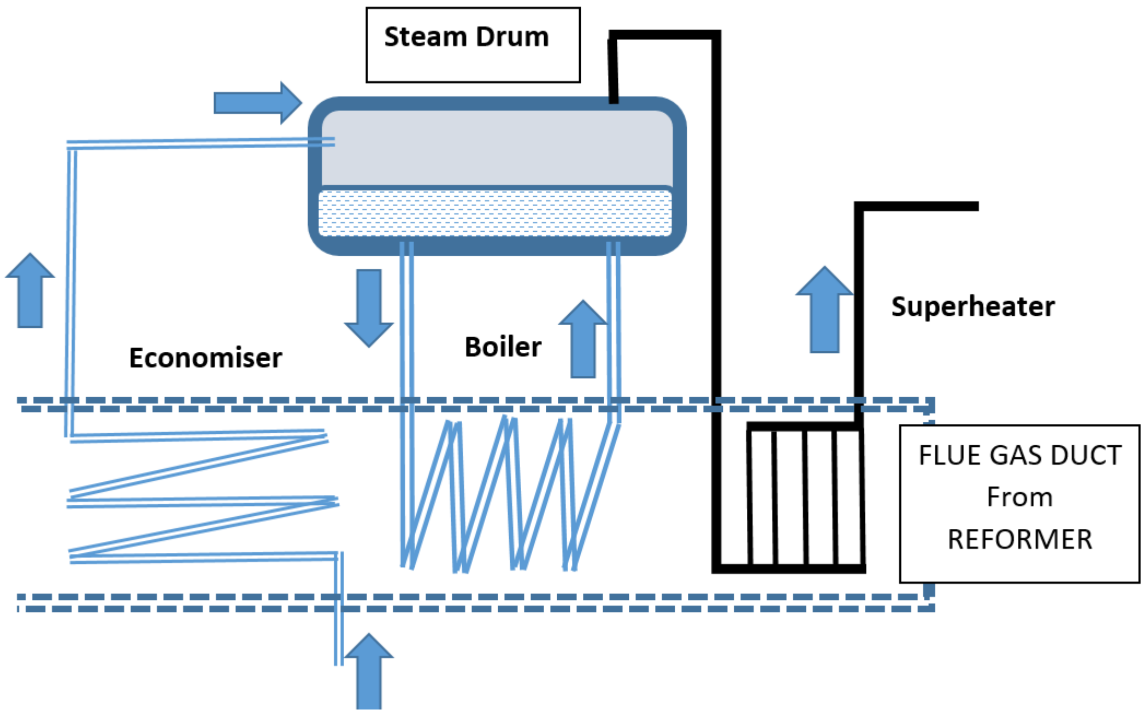
An Emergency Shutdown of a Town Gas Steam Reformer

Only Thirty Five Years to Explain!

Most unplanned shut downs on steam reformers were of the panic stricken, headless chicken type, where shift engineers ran around not really knowing what was going on. In my short time at Hitchin I was involved in a few, one caused by myself, and another that almost killed me. These stories will have to wait. This one relates to something much more leisurely whereby the steam drum level on the reformer was slowly falling, but unless we shut down the plant, we were in for a real disaster.

First, a bit of background, a steam reformer was a method of making town gas by passing a mixture of steam and naphtha, a sort of low grade gasoline, through banks of tubes heated to 750°C. There was a great deal of ancillaries, the whole looking a bit like a refinery. Much of the complexity was associated with cooling the reformed gas, and using the heat to generate the vast amounts of steam needed for the reforming process.

The way things worked at Hitchin, because it was our shift, and although no one, at all, could account for what had happened, and none of us were carpeted over the matter, we knew that Richards and Caine, the Station Engineer and his deputy, were holding us to blame. I was with the Gas Industry for exactly thirty years, without properly understanding what had gone on, or its cause. Years, after I left, when writing professionally about gas based power generation, comprehension dawned. It's something called a "boiling economiser". This can stop the generation of electricity from a Combined Cycle Gas Turbine unit, as surely as it stopped the production of gas from our Catalytic Rich Gas Process, back in the summer of 1967.



To re-emphasise, as the name suggests, steam was vital. The production of steam was a three step process. But, each of the steps used heat in the flue gas duct containing the combustion products coming from the reforming furnace, on their way to the stack. First the water was brought up from room temperature to near boiling point in the **economiser.** And although we didn't realise it at the time, this was the source of our troubles.

This very hot water, from the economiser then entered the steam drum, a pressure vessel about 8ft in diameter by about 25 ft long. This normally ran about half full of boiling hot water, in which the steam that was being made passed off, through pipe work to the superheaters. These were also situated in the flue gas duct; the superheating of the steam can be regarded as the third step.

For the second step, we go back to the steam drum. The hot water from this was pumped down to the evaporator or boiler, where the heat in the flue gas duct turned some of the water into steam. At the exit of the evaporator, this mixture of hot water and steam returned through pipework to the steam drum. Here the steam was taken off and, as described, sent to the superheaters, the hot water then being sent back to the evaporator. It will be apparent that to maintain the level in the steam drum, the evaporator has to keep supplying preheated water.

The picture shows the plant under construction. The reforming furnace is the rectangular block in the centre of the picture. The large towers are used to help upgrade the reformed gas by removing CO_2. The exhaust or flue gas stack is the tall chimney near the centre of the picture. The steam drum is on the level with the top of the reformer, and is viewed as a white cylinder seen end on.

On the day in question, it being hot, the Area Controller over at Watford, had asked the previous shift to cut back on gas output. This was the origin of the falling water level in the steam drum. In my view, this shift had rather overdone it, to the extent that so little steam was being taken off, that the water level in the steam drum went up and up. At some point, to prevent over filling of the drum, automatic valves closed on the supply coming in from the economiser. That is when the fun began.

There was now no flow through the economiser tubing, but the flue gases were still feeding in heat to the trapped water. It began to boil, giving us classic boiling economiser syndrome. Then at some point, as steam was still being taken off, the water level in the steam drum dropped to the point where the valves reopened. But it was now too late. The volume of steam that had formed in the economiser tubing had given us the equivalent of an air lock. It was impossible to push water through. As the minutes ticked by, because there was no flow of water, the bubble of steam got bigger.

All this I eventually comprehended thirty five years later. All we could do at the time was glumly watch the steam drum level falling past the danger mark, and agree to turn off the reformer plant burners and the supply of naphtha. The plant was shutting down.

With some trepidation, when everything had cooled off, we began the restart. To our complete and delighted surprise, there were no difficulties. Who was to blame? Not our shift, I now know!

As in CCGTs, it really comes down to over sophisticated design, where plant efficiency overruled all other considerations. But it also shows that in those early days of steam reforming, no one, designers, constructors, station management, and shift engineers had a complete grasp of what it was all about.

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