Case Study: Condensate Contamination

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Originally Published: CSTN – May 2003

An automotive facility had a powerhouse with four watertube boilers. Condensate from the various areas of the plant were returned to the powerhouse into a large condensate collection tank prior to flowing into the deaerator. The operators tested the condensate each shift and recorded the results. They started to notice slugs of high conductivity condensate being returned to the powerhouse occasionally. Sometimes the high conductivity would show up, other times it would not.

What could cause this elevated conductivity? What could cause it to suddenly show up, but only intermittently? Take a moment to consider these questions and to determine what the next course of action would be.

The elevated conductivity was, of course, a sign of condensate contamination coming back from the main plant. How do we determine the cause of this contamination? Approach the problem logically:

1. **Identify the Contaminant:** Using the test procedures on-hand, the conductivity was 160 µS, a trace of hardness was noticed, and phosphate was found. Each of these were very unusual for what should be high purity condensate. Where was it coming from?

2. **Boiler Carryover:** Boiler carryover can have both chemical and mechanical causes. If this is occurring, the condensate contamination may show up as elevated conductivity, elevated pH, and the presence of unique boiler water chemicals such as phosphate, molybdate, chlorides, etc. The boilers used a polymer/EDTA program with no phosphate. The boilers were not the source of the condensate contamination. Also, the powerhouse had the ability to isolate the condensate stream coming back from each section of the plant. Only one stream was found to be contaminated. If boiler carryover was occurring, all the condensate streams would be expected to show the contamination if enough time had passed for the carryover to get through the condensate system. This was not the case. The boilers were running properly and all chemical levels were within range.
3. **Unique Contaminant:** Now that the boilers were ruled out as the source of the contamination, if one of the contaminants were unique to a particular system it would be much easier to find the source. The phosphate found in the sample was unique and could have come from one of the several phosphate-based chemical baths used in the facility.

4. **Condensate Survey:** Now that the contaminant has been identified, a survey of the condensate system would help narrow down the source. As mentioned previously, the powerhouse had the ability to test condensate separately for each department, and one department had been identified as having contaminated condensate. The condensate receivers for this department were each tested for conductivity and phosphate, and one was found to have a conductivity of 5,000 µS and phosphate concentration of 1.19 ppm. The ultimate source of the contamination was very close. Plant drawings were referenced and a nearby picklehouse with a phosphoric acid bath returned condensate to this condensate receiver.

The source of the condensate contamination had been found! When the area manager was asked about the steam-supplied heat exchanger in the picklehouse phosphoric acid bath, she said it would get really scaled up and the operators would take it out and beat the scale off with a hammer! That certainly explained why the heat exchanger would have a leak! The chemical tank was made up with hard city water, and the resultant calcium phosphate was scaling up the heat exchanger.

You may be wondering how the phosphoric acid could leak into a pressurized steam heat exchanger even if it had a small hole. This was a temperature-controlled bath. When the bath was at the proper temperature, the steam supply to the heat exchanger would turn off. The steam would then condense inside the heat exchanger as it cooled and eventually form a negative pressure that would suck the phosphoric acid solution into the heat exchanger. When the bath’s temperature would drop too low, the steam would be turned back on and a slug of phosphoric acid contaminated condensate would be sent back to the powerhouse.

With a little logical thinking and a few troubleshooting skills, condensate contamination can be tracked down. If boiler carryover is found to be occurring, it must be eliminated first before any further analysis can be done. Boiler carryover may be the sole cause of the contamination or a result of the contamination. Either way, it must be eliminated by dumping condensate, lowering conductivity setpoints, fixing faulty equipment, etc.