



*Innovation in Environmental &
Process Technology*

For All Your Waste & Waste Water Monitoring Needs

Measuring TOC in return condensate feed to Boilers.

High pressure boilers and steam generators are used to drive turbines for generating electricity. Energy to heat the water will come from a nuclear reactor or burning fossil fuels. Whatever the energy source, the drivers of reducing costs, increasing process efficiency, maximising profits and protecting the environment will all combine to push those managing the process to optimise the overall energy recovery from the initial fuel.

The high pressure steam will have significant energy in it after it has passed through the turbines and done its first work. The first standard means of energy recovery is to use the medium pressure steam to pre-heat the boiler feed water. After this the steam will still be a viable source of energy. One very efficient tactic is to use the steam in heat exchangers for nearby industrial processes. During each of these steps the temperature and pressure will drop to some extent and eventually there will be a liquid condensate. Even this condensate is worth re-using in the feed water.

Feed water for boilers and steam generators is always managed carefully to avoid corrosion of the boiler and other pipework. Dissolved carbon dioxide will form carbonic acid which will cause an increased corrosion rate. Feed waters are protected by a range of chemical treatments which might include oxygen scavengers, neutralising amines, polymers, lime and phosphates. To recover as much energy as possible, and to reduce the costs of treatment chemicals, it makes sense to take return condensate back in to the boiler feed water. To ensure that it is safe to re-use the water it is standard practice to deploy analysers on the return feed. The minimum requirement is sometimes stated as pH and conductivity. If the treatment chemicals are consistently used then measuring conductivity and pH may pick up changes in water quality.

The use of steam in heat exchangers may introduce contaminants into the return condensate. Any leaks in the system when used in petrochemical or similar plant can introduce organic chemicals which might break down into carbon dioxide in the feed water and/or increase corrosion in the system. For this reason it is vital that organic chemicals are kept at very low levels. In this situation it might be worth checking that pH and conductivity can detect contamination in the return condensate to an extent which will protect the boiler. It is undoubtedly the case that some organics compounds can be detected to some extent by pH and conductivity measurements; and that some organic compounds cannot.

Should instruments detect unacceptable levels of carbon in returning condensate it really should be diverted away from the boiler feed water.



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Let's see what might be expected to happen if contamination is detected. From that we can see how to select a TOC analyser to protect the boiler.

The first priority will be to divert the return flow away from the boiler feed tank. This will involve costs as the fresh water coming in needs to be checked and treated.

Finding the source of the contamination is next.

Those are easy to write down. In practice there will be different views being expressed and many questions being asked. The question which is very likely to be asked is "are you sure the TOC is high?" While this question is being answered people will be switching flows, ensuring that the boiler feed water is maintained, and with every minute that passes costs will be increasing. Clear proof of the validity of the reading is needed very quickly in these circumstances. Valuable product could be leaking away, and different departments may well want water samples tested to see if they are the source of the problem.

Once the source of the contamination has been identified it will need to be isolated and repaired. After each of these steps has been completed the TOC analyser needs to confirm that the water is safe to be returned to the boiler feed.

Purchasing Check List

Considering the sequence of events above let's put together a list of things to look for when purchasing a TOC analyser for applications such as boiler condensate return.

Analysis time.

The instrument must give you an answer as quickly as possible. Check what the measurement cycle is and how long between readings under normal circumstances. This will enable detection of any issues quickly and ensure that the situation is resolved and back to normal quickly. Delays here cost money.

Check for memory effects. Any carry-over of sample through the sample delivery system will increase the time before the operators can be sure of having a reliable measurement of any given sample.

Check that the supplier can give good information about the sample system as this will have an impact on system response time.

Optimising all the above can allow a single instrument to measure more than one sample stream and give the information needed to protect the boiler and steam infra-structure. For example if the overall safety of the boiler can be assured to an acceptable level by a TOC reading every 6 minutes and the analyser can give a reading every 3 minutes then one



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instrument can measure two sample streams. The advantage of this is self-evident and it is quite normal for readings to be needed from more than one location on a plant as different people work to trace what is leaking and from where.

Grab Samples.

Identification of the source of the contamination may well lead to a queue of people with samples which they would like to be analysed. This is another situation where speed of response of the instrument is important. This happens frequently enough for it to be raised here as an issue.

Once the leak has been repaired the analyser needs to confirm that the organic contamination has been eliminated. This can mean an analyser measuring less than 1 ppm TOC after measuring TOC in the range of hundreds, or thousands of ppm. This will test memory effects (carry over) in a rather extreme way.

Good Data.

The answer must be reliably correct. "are you sure of this reading?" needs a clear answer. There is little point in getting an incorrect reading quickly. This adds several things to look out for.

- 1 Look for an analyser which has a good system for checking and validating the measurements. Routine calibration checks are not straightforward as liquid standards for low TOC values (20ppm or lower) are not inherently stable. Ask about calibration or validation methods. What materials are needed? How long does it take? What skill level is needed to check that the readings are right?
- 2 It is also vital to ensure that all possible contaminants will be properly detected. TOC analysers vary in their methods for digesting the sample to produce CO₂. These different methods will break down different chemical compounds to varying extents. This is often termed "recovery" to indicate the response of an analyser to a particular compound. This is a large subject and is often approached empirically by trying a range of samples and noting their measurements. Ask if the potential supplier has information about instrument response to a range of different organic compounds.
- 3 Instruments designed to detect failures need to have a high level of reliability. Look for track record, and consider the mechanical design. Look at the service and maintenance needs.
- 4 The length and design of the sampling lines and sampling system can have a significant effect on the response time of the analyser. It might be worth asking about experience in this area as part of the purchasing decision.



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Each process plant is different and in spite of this there will be many common themes to the requirements for a TOC analyser for boiler protect by measuring return condensate.

Each point above will be more or less important for every situation. Some can be resolved with a simple “tick box” approach, others may need more detailed theoretical or experimental investigation.

Good investment in analysers can produce significant savings by protecting the boiler systems.

Naturally Envitech feels that it can offer a proven, effective analyser for this application. We invite you to contact us to discuss your steam generator or boiler and how you might be able to improve the operation of boilers and steam generators.