REAL TIME TOC ANALYSIS IN STEAM AND CONDENSATE

Steam in petro/chemical plants could be contaminated with hydrocarbons (TOC = Total Organic Carbons) from various sources. This is often a sign of defects in the process, whether they occur in the heat exchanger, the blow down vessel, the condensate recovery or other parts of the system. Conventional solutions to monitor such contaminations use TOC-analysers that have been developed for water (drinking water, waste water, boiler feed water etc.). This paper presents a solution that is based on an online FID (flame ionisation detector) to monitor TOC-contamination directly in the hot steam/hot condensate in real time to allow for quick and reliable treatment (i.e. removal) of the polluted condensate.

The Technical Environment

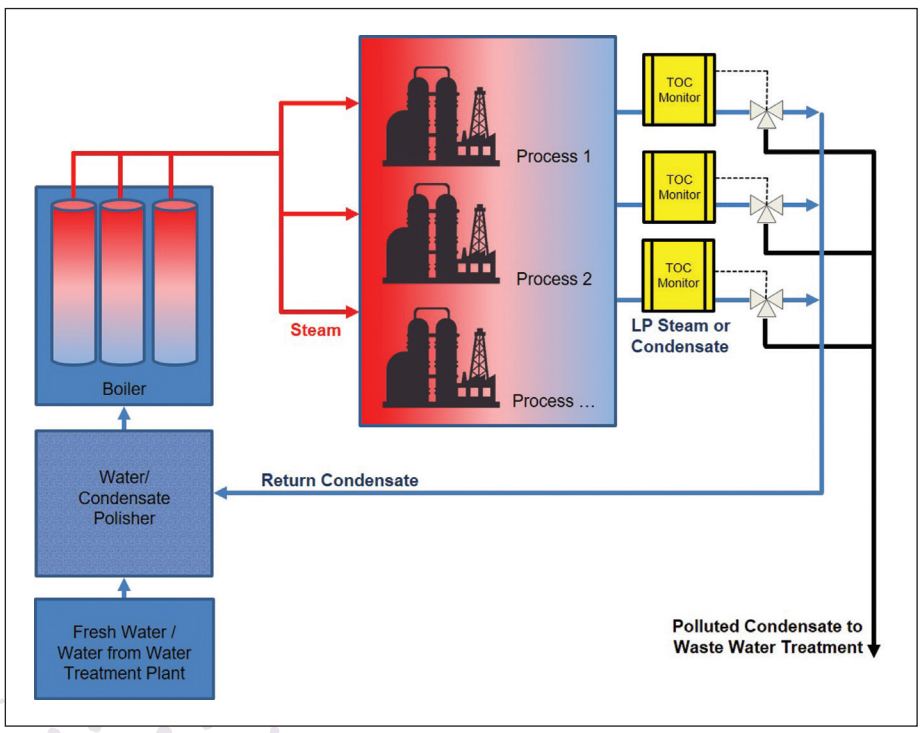
Steam (LP up to 15bar – 180°C) is one of the major resources in all chemical and petro-chemical plants.

The steam has to be as clean as possible and any contamination of the steam, especially from hydrocarbons (TOC), is a clear sign of an issue with the process.

Production of steam consumes a lot of energy and is expensive. Therefore, the "used" steam, which is now condensate, is re-polished and reused in the steam generator to save money (a closed loop).

The Problem

Contamination of the steam and the condensate with TOC can occur. Typically, such contamination results from leakages between the product cycle and the steam cycle.



This contaminated condensate can be hazardous for the whole condensate/steam cycle, the boiler, the pipes, the heat exchanger, the filters, and the condensate polishing process.

The Challenge

The TOC concentration of the pollution in the steam/condensate cycle has to be monitored to identify problem - but the steam is hot (up to 180°C) and under high pressure (up to 15bar). The quicker the monitoring system provides reliable readings the quicker the necessary action can take place to minimise negative effects in the steam/condensate process.

The Solution

A system with J-FID for the continuous monitoring of the steam and/or the condensate at the given conditions (high temperature and pressure) with a very short response time (<1 sec) and with low detection limits (<0.1ppm) provides the most reliable and robust solution available.

This system is also able to measure light Hydrocarbons (starting with CH4) as well as aliphatic and aromatic compounds.

The J-FID and the steam expansion device provided by the manufacturer JCT Analysentechnik GmbH are very easy to install and maintain.

A continuous and fast TOC-measurement by a J-FID will determine whether the steam can be recycled back to the boiler or has to be discharged.

The JCT TOC-Monitor for Steam Applications

A robust FID (Flame Ionisation Detector) provides monitoring results within seconds to grant quick outfall of the contaminated condensate, reliable control of the whole steam process and safe detection of leakages. The decision to either recycle or discharge the steam can be made within seconds. The solution is applicable in both, steam and condensate pipes.

Main Advantages Compared to conventional TOC-measurement

There are three main technologies that have been used to analyse TOC in condensate: High temperature oxidation to CO_2; Photochemical oxidation with UV light and reagent and Wet Chemical Oxidation.

The main applications for this type of analyser are defined by their capability to give the actual concentration in mg C/ltr. The initial task of such TOC analyzers was to measure TOC in drinking water, waste water and boiler feed water.

Thus, the disadvantage of such oxidation-based technology is the complex design of high temperature oxidisers, reagent, electric pumps, gas- dryers, air-treaters for TOC and CO_2, strippers and scrubbers depending on the technique used.

Bear in mind that an analyser-installation should incorporate minimal sample handling and preparation, running costs and down time. Therefore, the main disadvantage of conventional TOC analysers in steam applications is that it takes several minutes until the steam is condensed and transformed into the gas-phase again so it can be measured with an NDIR detector.

Benefits at-a-glance

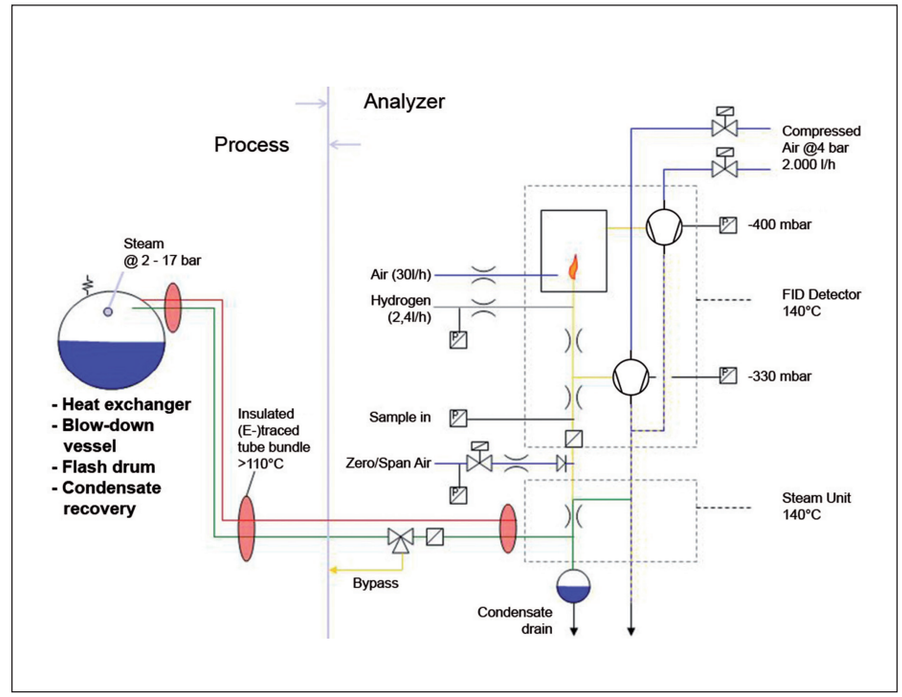
There are several clear benefits for the proposed FID solution to monitor possible contamination of the steam or the condensate:

- Very fast response time.
- Simple automatic calibration.
- No time consuming sample conditioning (e.g. cooling of the condensate to <45°C).
- Quick analysing results due to fast response time of the FID.
- No moving parts.
- Very low maintenance.
- No chemical reagent required.
- Self-cleaning system design.
- Proven reliability with maximum uptime.
- Available as single channel configuration or automatic multichannel switch (delay-free!).
- Available for Safe area or Ex Area Zone 1 or 2 – ATEX certified
- Vortex cooling >40°C ambient available.

Conclusion

The JCT J-FID TOC-Monitor for Steam Applications provides an easy to setup and cost effective solution for the continuous monitoring and control of contamination caused by hydrocarbons.

- Keep the steam clean.
- Reduce costs for condensate polishing.
- Protect the investment of the steam processing system in chemical and petrochemical plants.



Brief Description of the FID Analyser

In vapour phase there is a continuous flow. A heated pressure-reducing-unit conditions the steam (2 - 17 bar) and ensures a permanent flow to the analyser. A small part flows to the detector and the excess of the sample is purged out together with the analyser exhaust.

The corrosion proof detector is heated up to maximum 200°C; the twin air-jet aspirators for the sample flow in a heated detector are maintenance free. Flow controllers, sensors and valves are in contact only with clean (instrument) air, hydrogen and span gas. This, in combination with the dilution of the sample gas with compressed air as exhaust gas, results in an analyser with low service costs and high availability.

The unique close couple detector design (no cables; direct AD coupler to electrode) provides low drift operation, a wide dynamic range and an optimum signal to noise ratio. All digital input features are designed according NAMUR guidelines, all digital outputs are potential free contacts. Analogue output signals 4 x 0/4-20mA with optical galvanic isolation. Instrument operation, configuration and remote control is also available on 2 x RS232.

Best measurement performance is provided by offering constant sample mass flow and pressure conditions to the detector chamber. Due to the optimum design of the instrument, pressure variation at the sample point is allowed between 800 mbar – 1600 mbar absolute without lack of performance.

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