INSTRUCTIONS

Operation Manual
Operation manual
SCR+Oxi

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WÄRTSILÄ

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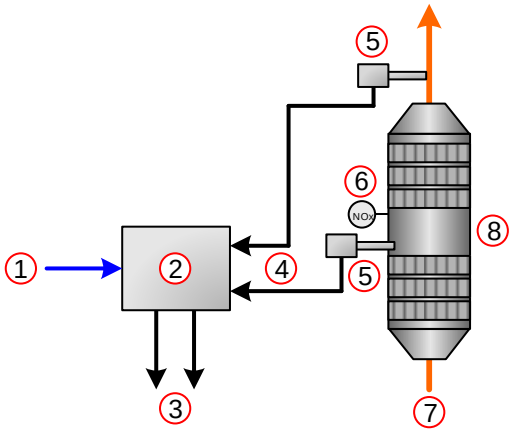
The system utilizes an electrochemical cell (EC) analyzer for process feedback control. This Wärtsilä EC analyzer is called NOxBOx.

The emission analyzer measures NO from inside the reactor (between the SCR and oxidation catalyst layers) and NO and CO (optional) after the oxidation layers. The NO measurement is used to control the reagent dosing to achieve the requested emission level at the reactor outlet.



1. Purge air/calibration gas inlet
2. Emission analyzer
3. Exhaust gas vent
4. Sample line
5. Sample probe
6. NOx sensor
7. Exhaust gas from the engine
8. Reactor

Fig 3-5 Flow diagram of the emission analyzing system

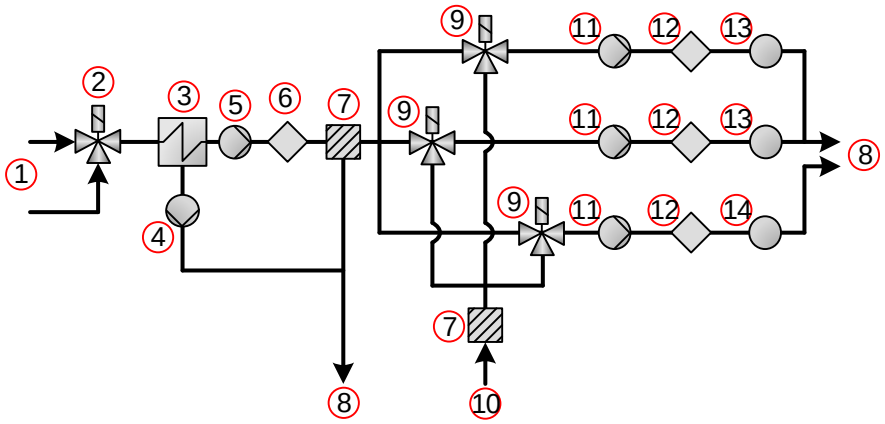
3.3.6.1 NOxBOx analyzer

The main components of the NOxBOx analyzer are the analyzer cabinet, the sample probes and the heated sample lines.

The emission analyzer pumps a sample of the exhaust gas from one of the sample points with the main sample pump. The sample point is selected with a three-way valve. The gas sample is dried in a sample cooler and is then pumped to a sample filter. There are two measurement cells and both of them has a secondary sample pump. Three-way valves are used to direct the gas sample or ambient air to the measurement cells.

A condensate pump removes the condensate from the sample cooler. The function of the condensate pump is vital to the measurement process.

The analyzer is completely controlled by the SCR PLC and will not do anything if disconnected from Ethernet.



1. Sample inlet
2. Sample selection valve
3. Sample cooler
4. Condensate pump
5. Main sample pump
6. Main flow meter
7. Filter
8. Exhaust gas drain
9. Cell selection valve
10. Purge air/calibration gas inlet
11. Cell-specific sample pump
12. Cell-specific flow meter
13. NO cell
14. CO cell

Fig 3-6 Flow diagram of the NOxBOx analyzer

3.3.6.2 Measurement technology

The measurement is based on electrochemical measurement cells. The main components of the measurement cell are a capillary diffusion barrier, a sensing electrode, a counter electrode and current collectors. The exhaust gas enters the cell through the capillary diffusion barrier. Thereafter, the measured component (NO or CO) reacts with the sensing electrode that is coupled with a counter electrode. The chemical reactions on the electrodes generate a measurable current. Since the rate of gas entry is controlled by the capillary diffusion barrier, the current generated at the electrodes is proportional to the concentration of the gas present outside the sensor and gives a direct measure of the concentration.

3.3.6.3 Measuring cycle

The measurement cells can not be operated continuously with exhaust gas, therefore they are flushed with ambient air at set intervals. This is done to prolong the useful life of the cells and to increase their measurement accuracy. To produce a continuous signal for the SCR control, the measurement is switched between two cells so that one cell is measuring the concentration in the exhaust gas all the time.

If the analyzer system is configured to monitor exhaust concentration from a second measurement point and/or measure CO, it will pause the measurement and suck exhaust from the second measurement point (typically in the outlet of the reactor) roughly every 10 minutes. This pause is about 2 minutes long.

The SCR PLC will start the measurement cycle of the analyzer when the SCR is ready to start.

1 Emission analyzer startup.

   1 The first NO cell selection valve will switch and exhaust gas will flow to the sample pump instead of air. This mode lasts 4 minutes.

   2 The second NO cell selection valve will switch and exhaust gas will flow to the sample pump instead of air. The exhaust gas will flow simultaneously to both NO cells. This will allow the second NO cell to stabilize its measurement of the exhaust gas.

2 The first NO cell selection valve will switch and the cell is flushed with ambient air. At the same time the measurement is transferred to the second cell. The analyser will compare the measurement levels of the first and second cell when they are measuring in parallel. If there is a too high deviation between the levels of NO, a calibration request warning may trigger. The system will repeat this cycle unless it is configured to monitor the second sample point and/or CO.

3 If the second sample point is measured, the system will stop the measurement of the first sample point after 5 minutes and the sample selection valve will switch to let exhaust gas from the second sample point to the measurement cell. In case CO is measured, the CO cell selection valve will switch and exhaust gas will flow to the CO measurement cell.

   - The system will skip the second sample point and repeat the earlier cycle if the engine is ramping or has just stabilised at a new load.
   - A few minutes after the engine has stabilised at a new load point, the analyser will transfer the measurement to the second measurement point.

3.3.6.4 NOx emission analyzer control

Limp mode

If one of NO measurement cells are faulty or disconnected, the other cell will cycle between measurement and flushing. The system will not measure NO or CO from the second measurement point after the reactor.

Fault mode

If the sample gas cooler is not cold enough, or both NO cells are disconnected or have too high zero point, the analyzer will go into fault mode.

Auto-zeroing

Each time the NO cell is flushed with ambient air, its average reading will be calculated in 30 second windows. This allows the system to continuously keep track of the zero-drift of the NO cells.

3.3.7 NH_3 analyzing system

4.3.4 Catalyst ageing

4.3.5 Calibrating the measurement cells of the analyzer

WARNING

Hazardous and toxic gas. Calibration gas may be hazardous or toxic. Follow all safety instruction supplied with the calibration gas bottle.

The calibration gas and the T-piece (required for connecting the bottle to the analyzer) are not part of the standard scope of supply. The calibration gas (N_2) should contain 10-20 ppm of NO.

Procedure

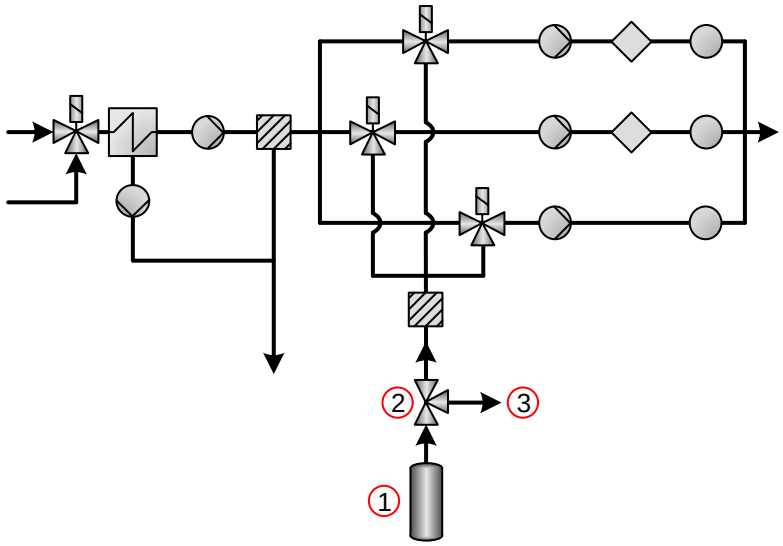
1 **Open the analyzer cabinet and turn on the service mode selector switch.**

2 **Wait 2 minutes.**

3 **Connect the T-piece and the calibration bottle to the purge air inlet port on the left side of the cabinet (see *Fig 4-1*).**

NOTE

The regulator must be connected to a T-piece and one end of the T-piece must be open to atmosphere. This will ensure that there is no overpressure on the suction side.



1. Calibration gas bottle
2. T-piece
3. To atmosphere

Fig 4-1 Calibration bottle connection to the analyzer

4 **Open the calibration gas regulator until there is a slight but distinct flow of calibration gas out of the open end of the T-piece.**

This will ensure that the measurement cells are only sucking calibration gas.

5 **Wait 3 minutes.**

6 **Turn off the calibration gas and reconnect the Teflon tube.**

The calibration gas shall not be continuously connected to the analyzer.

7 **Turn off the service mode selector switch.**

8 **Trend the raw values of the sensor cells from WOIS for the time when the calibration was performed.**

9 **Check the value immediately before the calibration gas was fed to the analyser and what the actual value was when the calibration gas was fed.**

- The new calibration factor is

$$K_{calibration} = 100 \cdot \frac{c_{CALGAS}}{c_{CELL1MAX} - c_{CELL1MIN}}$$

- Example: a typical trend of a measurement cell when calibration gas has been fed to it is shown in *Fig 4-2*. In the example figure, the calibration gas that was used was 19.7 ppm, and then the new calibration factor for that cell would be

$$K_{calibration} = 100 \cdot \frac{19.7\,ppm}{15.5\,ppm - 0.5\,ppm} = 131$$

The calibration factor should be compared to the last calibration and if it has changed too much, cell may be too worn or old and need replacement or there may be issues with flow or how the calibration was done.

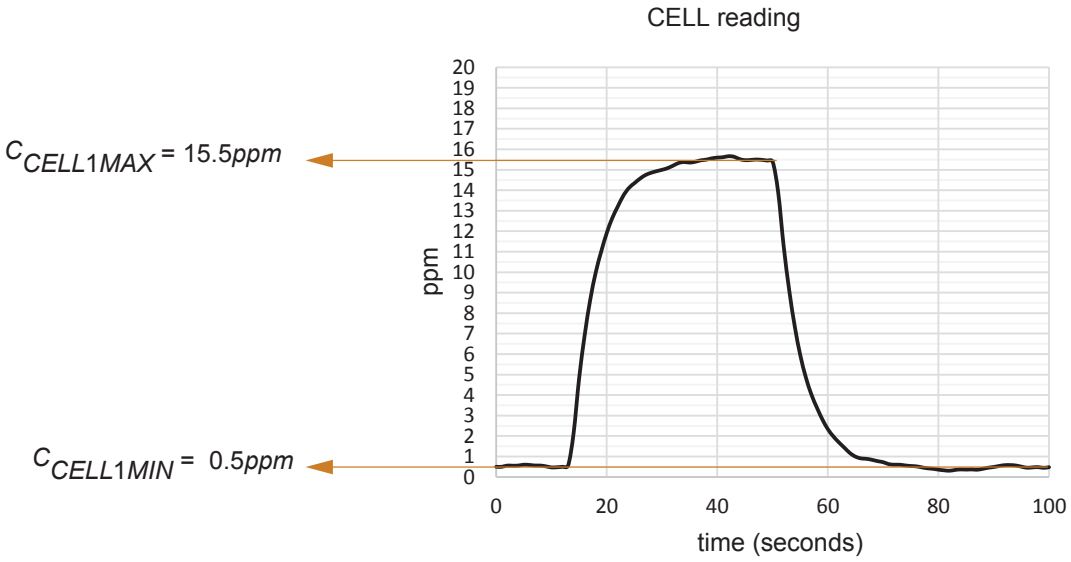


Fig 4-2 Typical trend for calibration gas measurement

10 **Log in to the manager level in WOIS and update the calibration factor.**

4.4 Abnormal operating situations

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